# IDL Reference Guide

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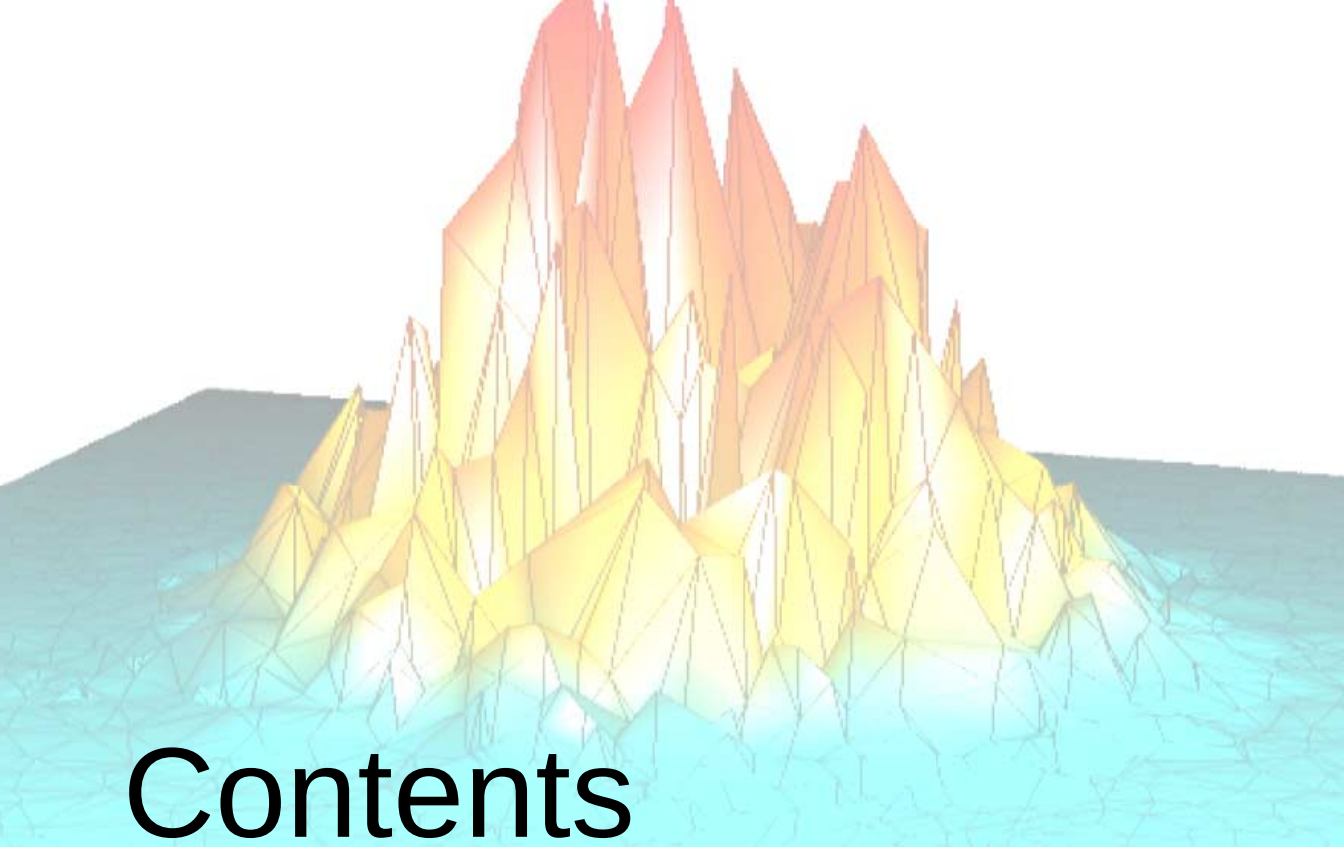
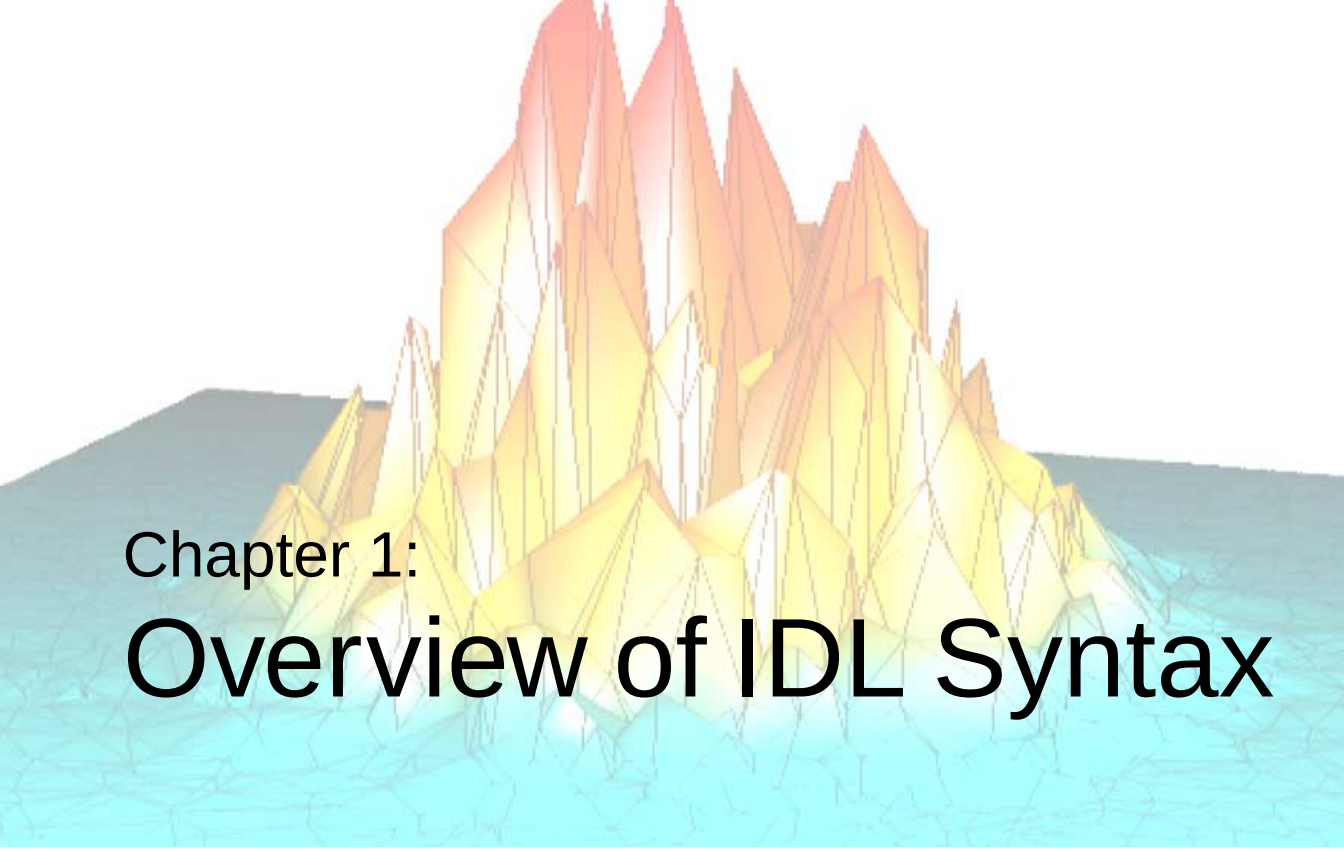
## Acknowledgments



# Contents

## Part II: Object Class and Method Reference



# Chapter 1: Overview of IDL Syntax

This reference is a complete listing of all built-in IDL functions, procedures, statements, executive commands, and objects, collectively referred to as "commands." Every IDL language element that can be used either at the command line or in a program is listed alphabetically. A description of each routine follows its name.

**Note**

Descriptions of Scientific Data Formats routines (CDF_*, EOS_*, HDF_*, and NCDF_* routines) can be found in the *Scientific Data Formats* book.

Routines written in the IDL language are noted as such, and the location of the `.pro` file within the IDL distribution is specified. You may wish to inspect the IDL source code for some of these routines to gain further insight into their inner workings.

Conventions used in this reference guide are described below.

# IDL Syntax

The following table lists the elements used in IDL syntax listings:

| Element | Description |
|---|---|
| [ ] (Square brackets) | Indicates that the contents are optional. Do not include the brackets in your call. |
| *[ ]* (Italicized square brackets) | Indicates that the square brackets are part of the statement (used to define an array). |
| Argument | Arguments are shown in italics, and must be specified in the order listed. |
| KEYWORD | Keywords are all caps, and can be specified in any order. For functions, all arguments and keywords must be contained within parentheses. |
| /KEYWORD | Indicates a boolean keyword. |
| *Italics* | Indicates arguments, expressions, or statements for which you must provide values. |
| { } (Braces) | • Indicates that you must choose one of the values they contain<br>• Encloses a list of possible values, separated by vertical lines ( \| )<br>• Encloses useful information about a keyword<br>• Defines an IDL structure (this is the only case in which the braces are included in the call). |
| \| (Vertical lines) | Separates multiple values or keywords. |
| [, $Value_1$, ... , $Value_n$] | Indicates that any number of values can be specified. |
| [, $Value_1$, ... , $Value_8$] | Indicates the maximum number of values that can be specified. |

*Table 1: Elements of IDL Syntax*

# Elements of Syntax

## Square Brackets ( [ ] )

- Content between square brackets is optional. Pay close attention to the grouping of square brackets. Consider the following examples:

  ROUTINE_NAME, *Value1* [, *Value2*] [, *Value3*]: You must include *Value1*. You do not have to include *Value2* or *Value3*. *Value2* and *Value3* can be specified independently.

  ROUTINE_NAME, *Value1* [, *Value2*, *Value3*]: You must include *Value1*. You do not have to include *Value2* or *Value3*, but you must include both *Value2* and *Value3*, or neither.

  ROUTINE_NAME [, *Value1* [, *Value2*]]: You can specify *Value1* without specifying *Value2*, but if you specify *Value2*, you must also specify *Value1*.

- Do not include square brackets in your statement unless the brackets are italicized. Consider the following syntax:

  *Result* = KRIG2D( *Z* [, *X*, *Y*] [, BOUNDS=*[xmin*, *ymin*, *xmax*, *ymax]*] )

  An example of a valid statement is:

  R = KRIG2D( Z, X, Y, BOUNDS=[0,0,1,1] )

- Note that when [, $Value_1$, ... , $Value_n$] is listed, you can specify any number of arguments. When an explicit number is listed, as in [, $Value_1$, ... , $Value_8$], you can specify only as many arguments as are listed.

## Braces ( { } )

- For certain keywords, a list of the possible values is provided. This list is enclosed in braces, and the choices are separated by a vertical line ( | ). Do not include the braces in your statement. For example, consider the following syntax:

  READ_JPEG [, TRUE={1 | 2 | 3 }]

  In this example, you must choose either 1, 2, or 3. An example of a valid statement is:

  READ_JPEG, TRUE=1

- Braces are used to enclose the allowable range for a keyword value. Unless otherwise noted, ranges provided are inclusive. Consider the following syntax:

  *Result* = CVTTOBM( *Array* [, THRESHOLD=*value*{0 to 255}] )

An example of a valid statement is:

*Result* = CVTTOBM( A, THRESHOLD=150 )

- Braces are also used to provide useful information about a keyword. For example:

  [, LABEL=*n*{label every *n*th gridline}]

  Do not include the braces or their content in your statement.

- Certain keywords are prefaced by X, Y, or Z. Braces are used for these keywords to indicate that you must choose one of the values it contains. For example, [{X | Y}RANGE=*array*] indicates that you can specify either XRANGE=*array* or YRANGE=*array*.

- Note that in IDL, braces are used to define structures. When defining a structure, you *do* want to include the braces in your statement.

### Italics

- Italicized words are arguments, expressions, or statements for which you must provide values. The value you provide can be a numerical value, such as 10, an expression, such as DIST(100), or a named variable. For keywords that expect a string value, the syntax is listed as KEYWORD=*string*. The value you provide can be a string, such as 'Hello' (enclosed in single quotation marks), or a variable that holds a string value.

- The italicized values that must be provided for keywords are listed in the most helpful terms possible. For example, [, XSIZE=*pixels*] indicates that the XSIZE keyword expects a value in pixels, while [, ORIENTATION=*ccw_degrees_from_horiz*] indicates that you must provide a value in degrees, measured counter-clockwise from horizontal.

## Procedures

IDL procedures use the following general syntax:

PROCEDURE_NAME, *Argument* [, *Optional_Argument*]

where PROCEDURE_NAME is the name of the procedure, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter to the procedure.

## Functions

IDL functions use the following general syntax:

*Result* = FUNCTION_NAME( *Argument* [, *Optional_Argument*] )

where *Result* is the returned value of the function, FUNCTION_NAME is the name of the function, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter. Note that all arguments and keyword arguments to functions should be supplied *within* the parentheses that follow the function's name.

Functions do not always have to be used in assignment statements (i.e., `A=SIN(10.2)`), they can be used just like any other IDL expression. For example, you could print the result of `SIN(10.2)` by entering the command:

```
PRINT, SIN(10.2)
```

# Arguments

The "Arguments" section describes each valid argument to the routine. Note that these arguments are positional parameters that must be supplied in the order indicated by the routine's syntax.

## Named Variables

Often, arguments that contain values upon return from the function or procedure ("output arguments") are described as accepting "named variables". A named variable is simply a valid IDL variable name. This variable *does not* need to be defined before being used as an output argument. Note, however that when an argument calls for a named variable, only a named variable can be used—sending an expression causes an error.

# Keywords

The "Keywords" section describes each valid keyword argument to the routine. Note that keyword arguments are formal parameters that can be supplied in any order.

Keyword arguments are supplied to IDL routines by including the keyword name followed by an equal sign ("=") and the value to which the keyword should be set. The value can be a value, an expression, or a *named variable* (a named variable is simply a valid IDL variable name).

**Note**

If you set a keyword equal to an *undefined* named variable, IDL will quietly ignore the value.

For example, to produce a plot with diamond-shaped plotting symbols, the PSYM keyword should be set to 4 as follows:

```
PLOT, FINDGEN(10), PSYM=4
```

Note the following when specifying keywords:

- Certain keywords are boolean, meaning they can be set to either 0 or 1. These keywords are switches used to turn an option on and off. Usually, setting such keywords equal to 1 causes the option to be turned on. Explicitly setting the keyword to 0 (or not including the keyword) turns the option off. In the syntax listings in this reference, all keywords that are preceded by a slash can be set by prefacing them by the slash. For example, SURFACE, DIST(10), /SKIRT is a shortcut for SURFACE, DIST(10), SKIRT=1. To turn the option back off, you must set the keyword equal to 0, as in SURFACE, DIST(10), SKIRT=0.

  In rare cases, a keyword's default value is 1. In these cases, the syntax is listed as KEYWORD=0, as in SLIDE_IMAGE [, *Image*] [, CONGRID=0]. In this example, CONGRID is set to 1 by default. If you specify CONGRID=0, you can turn it back on by specifying either /CONGRID or CONGRID=1.

- Some keywords are used to obtain values that can be used upon return from the function or procedure. These keywords are listed as KEYWORD=*variable*. Any valid variable name can be used for these keywords, and the variable does not need to be defined first. Note, however, that when a keyword calls for a named variable, only a named variable can be used—sending an expression causes an error.

  For example, the WIDGET_CONTROL procedure can return the user values of widgets in a named variable using the GET_UVALUE keyword. To return the user value for a widget ID (contained in the variable `mywidget`) in the variable `userval`, you would use the command:

  ```
  WIDGET_CONTROL, mywidget, GET_UVALUE = userval
  ```

  Upon return from the procedure, `userval` contains the user value. Note that `userval` did not have to be defined before the call to WIDGET_CONTROL.

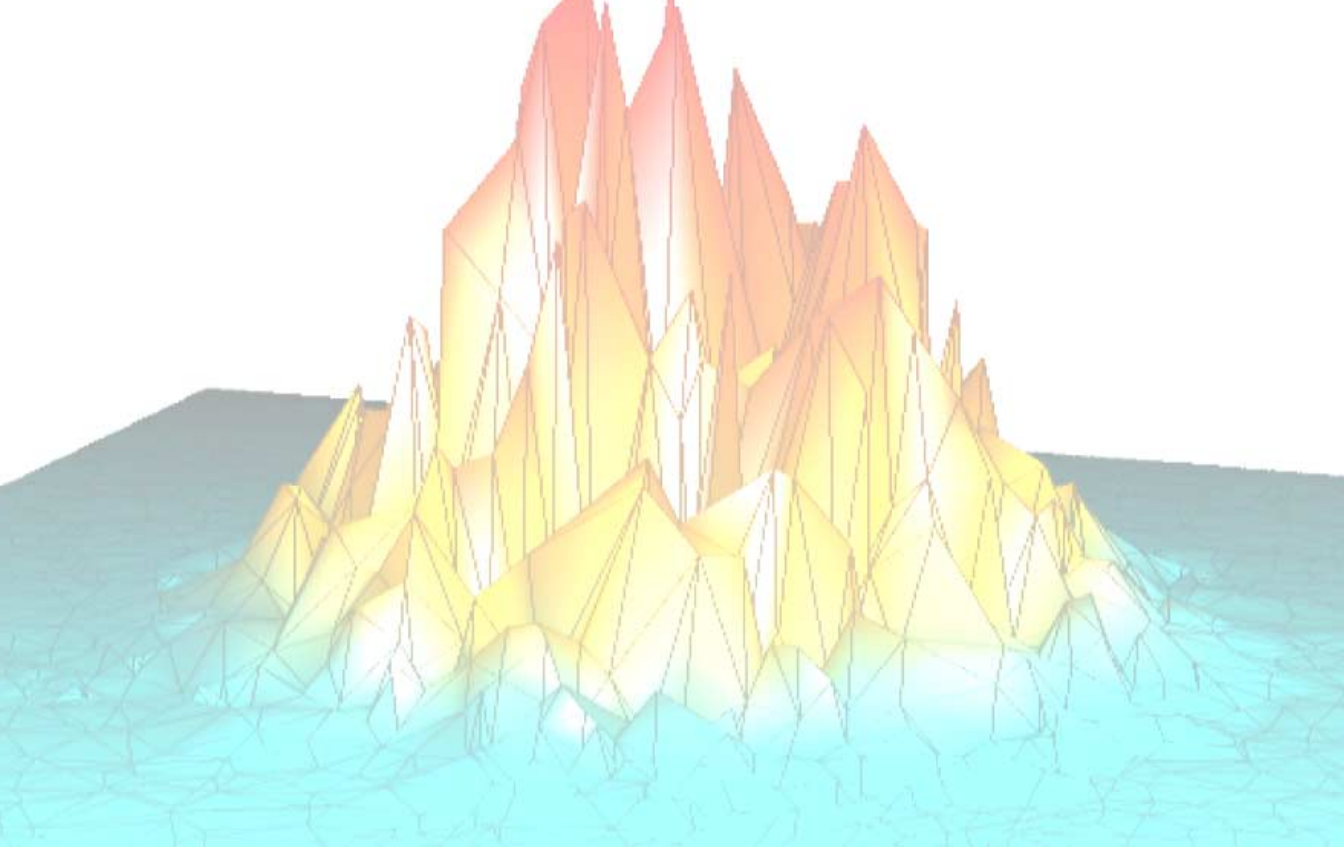
- Some routines have keywords that are mutually exclusive, meaning only one of the keywords can be present in a given statement. These keywords are grouped together, and separated by a vertical line. For example, consider the following syntax:

  PLOT, [*X*,] *Y* [, /DATA | , /DEVICE | , /NORMAL]

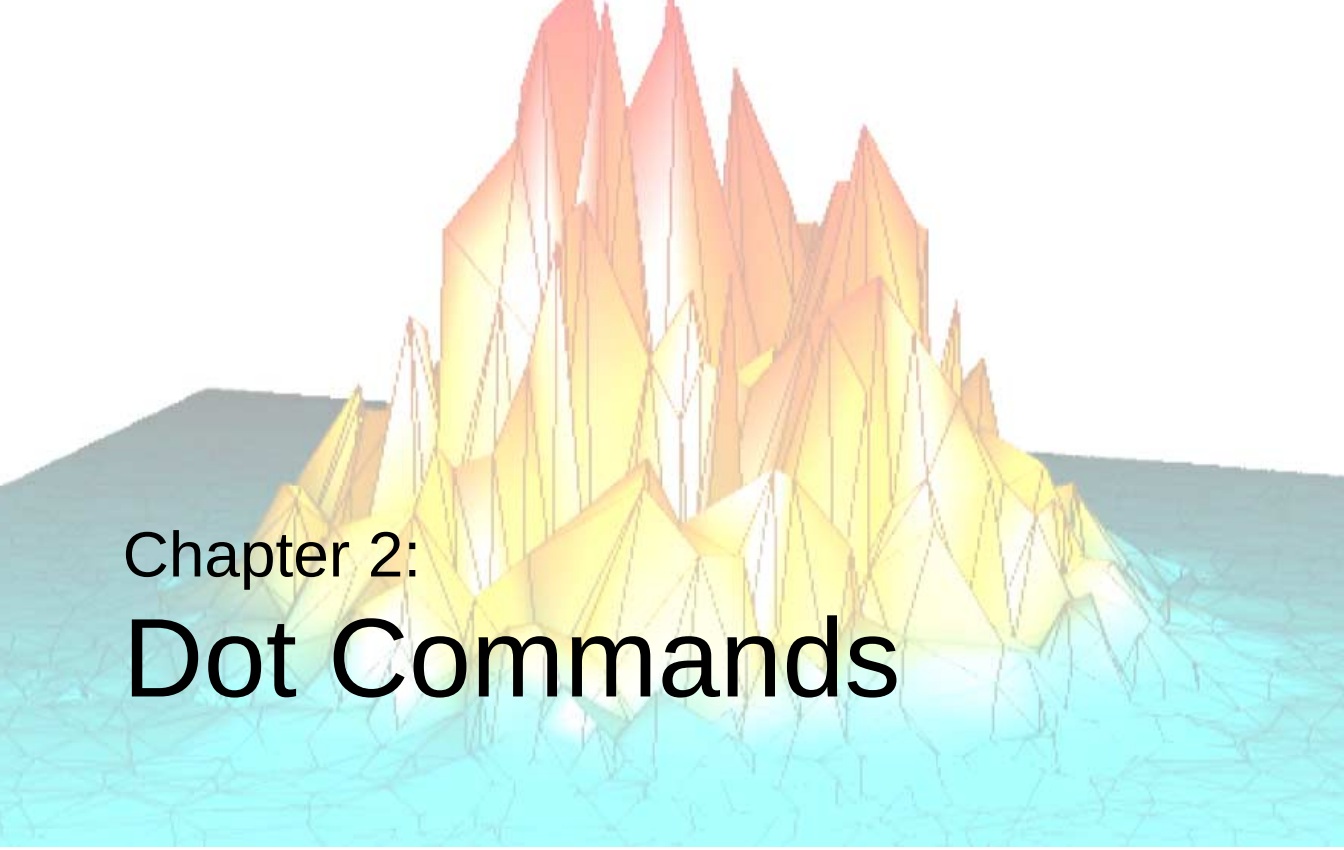
  In this example, you can choose either DATA, DEVICE, or NORMAL, but not more than one. An example of a valid statement is:

  PLOT, SIN(A), /DEVICE

- Keywords can be abbreviated to their shortest unique length. For example, the XSTYLE keyword can be abbreviated to XST because there are no other keywords in IDL that begin with XST. You cannot shorten XSTYLE to XS, however, because there are other keywords that begin with XS, such as XSIZE.



# Part I: IDL Command Reference



Chapter 2:

# Dot Commands

# .COMPILE

The .COMPILE command compiles and saves procedures and programs in the same manner as .RUN. If one or more filenames are specified, the procedures and functions contained therein are compiled *but not execauted*. If you enter this command at the Command Input Line of the IDLDE and the files are not yet open, IDL opens the files within Editor windows and compiles the procedures and functions contained therein.

See RESOLVE_ROUTINE for a way to invoke the same operation from within an IDL routine, and RESOLVE_ALL for a way to automatically compile all user-written or library functions called by all currently-compiled routines.

If the -f flag is specified, File is compiled from the source stored temporarily in TempFile rather than on disk in File itself. This allows you to make changes to File (in an IDLDE editor window, for example), store the modified source into the temporary file (IDLDE does it automatically), compile, and test the changes without overwriting the original code stored in File.

**Note**

.COMPILE is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.COMPILE [$File_1$, ..., $File_n$]

.COMPILE -f *File TempFile*

# .CONTINUE

The .CONTINUE command continues execution of a program that has stopped because of an error, a stop statement, or a keyboard interrupt. IDL saves the location of the beginning of the last statement executed before an error. If it is possible to correct the error condition in the interactive mode, the offending statement can be re-executed by entering .CONTINUE. After STOP statements, .CONTINUE continues execution at the next statement. The .CONTINUE command can be abbreviated; for example, .C. Execution of a program interrupted by typing Ctrl+C also can be resumed at the point of interruption with the .CONTINUE command.

**Note**

.CONTINUE is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.CONTINUE

# .EDIT

The .EDIT command opens files in IDL Editor windows when called from the Command Input Line of the IDLDE. This functionality is only available on the Windows and Motif platforms. Note that filenames are separated by spaces, not commas.

**Note**

.EDIT is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.EDIT $File_1$ [$File_2$ ... $File_n$]

# .FULL_RESET_SESSION

The .FULL_RESET_SESSION command does everything .RESET_SESSION does, plus the following:

- Removes all system routines installed via LINKIMAGE or a DLM.
- Removes all structure definitions installed via a DLM.
- Removes all message blocks added by DLMs.
- Unloads all sharable libraries loaded into IDL via CALL_EXTERNAL, LINKIMAGE, or a DLM.
- Re-initializes all DLMs to their unloaded initial state.

**Note**

.FULL_RESET_SESSION is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.FULL_RESET_SESSION

# .GO

The .GO command starts execution at the beginning of a previously-compiled main program.

**Note**

.GO is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.GO

# .OUT

The .OUT command continues executing statements in the current program until it returns.

**Note**

.OUT is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.OUT

# .RESET_SESSION

The .RESET_SESSION command resets much of the state of an IDL session without requiring the user to exit and restart the IDL session.

.RESET_SESSION does the following:

- Returns current execution point to $MAIN$ (RETALL).
- Removes all breakpoints.
- Clears the path cache (see PATH_CACHE for details).
- Closes all files except the standard 3 units, the JOURNAL file (if any), and any files in use by graphics drivers.
- Disables SHMDEBUG mode.
- Destroys/Removes the following:
  - All local variables in $MAIN$.
  - All widgets. Exit handlers are not called.
  - All windows and pixmaps for the current window system graphics device are closed. No other graphics state is reset.
  - All common blocks.
  - All handles
  - All user defined system variables
  - All pointer and object reference heap variables.
  - Object destructors are not called.
  - All user defined structure definitions.
  - All user defined object definitions.
  - All compiled user functions and procedures, including the main program ($MAIN$), if any.
  - Any memory segments created by SHMMAP.

The following are not reset:

- The current values of intrinsic system variables are retained.
- The saved commands and output log are preserved.

- Graphics drivers are not reset to their full uninitialized state. However, all windows and pixmaps for the current window system device are closed.
- The following files are not closed:
  - Stdin (LUN 0)
  - Stdout (LUN -1)
  - Stderr (LUN -2)
  - The journal file (!JOURNAL) if one is open.
  - Any files in use by graphics drivers (e.g. PostScript).
- Dynamically loaded graphics drivers (LINKIMAGE) are not removed, nor are any dynamic sharable libraries containing such drivers, even if the same library was also used for another purpose such as CALL_EXTERNAL, LINKIMAGE system routines, or DLMs. See the .FULL_RESET_SESSION executive command to unload dynamic libraries.

**Note**

.RESET_SESSION is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.RESET_SESSION

# .RETURN

The .RETURN command continues execution of a program until encountering a RETURN statement. This is convenient for debugging programs since it allows the whole program to run, stopping before returning to the next-higher program level so you can examine local variables.

Also see the RETURN command.

**Note**

.RETURN is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.RETURN

# .RNEW

The .RNEW command compiles and saves procedures and functions in the same manner as .RUN. In addition, all variables in the main program unit, except those in common blocks, are erased. The -T and -L filename switches have the same effect as with .RUN.

**Note**

.RNEW is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.RNEW [$File_1$, ..., $File_n$]

To save listing in a file: .RNEW -L *ListFile.lis* $File_1$ [, $File_2$, ..., $File_n$]

To display listing on screen: .RNEW -T $File_1$ [, $File_2$, ..., $File_n$]

## Example

Some statements using the .RUN and .RNEW commands are shown below.

| Statement | Description |
|---|---|
| `.RUN` | Accept a program from the keyboard. Retain the present variables. |
| `.RUN myfile` | Compile the file myfile.pro. If it is not found in the current directory, try to find it in the directory search path. |
| `.RUN -T A, B, C` | Compile the files a.pro, b.pro and c.pro. List the files on the terminal. |

*Table 2: Examples using .RUN and .RNEW*

| Statement | Description |
| --- | --- |
| `.RNEW -L myfile.lis myfile, yourfile` | Erase all variables and compile the files myfile.pro and yourfile.pro. Produce a listing on myfile.lis. |

*Table 2: Examples using .RUN and .RNEW*

# .RUN

The .RUN command compiles procedures, functions, and/or main programs in memory. Main programs are executed immediately. The command can be followed by a list of files to be compiled. Filenames are separated by blanks, tabs, or commas.

If a file specification is included in the command, IDL searches for the file first in the current directory, then in the directories specified by the system variable !PATH. See "Running IDL Program Files" in Chapter 9 of the *Using IDL* manual for more information on IDL's search strategy.

If a main program unit is encountered, execution of the program will begin after all files have been read if there were no errors. The values of all of the variables are retained. If the file isn't found, input is accepted from the keyboard until a complete program unit is entered.

Files containing IDL procedures, programs, and functions are assumed to have the file extension (suffix) `.pro`. Files created with the SAVE procedure are assumed to have the extension `.sav`. See Chapter 9, "Preparing and Running Programs in IDL" in the *Using IDL* manual for further information.

**Note**

.RUN is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.RUN [$File_1$, ..., $File_n$]

To save listing in a file: .RUN -L *ListFile.lis* $File_1$ [, $File_2$, ..., $File_n$]

To display listing on screen: .RUN -T $File_1$ [, $File_2$, ..., $File_n$]

**Note**

Subsequent calls to .RUN compile the procedure again.

### Using .RUN to Make Program Listings

The command arguments -T for terminal listing or -L filename for listing to a named file can appear after the command name and before the program filenames to produce a numbered program listing directed to the terminal or to a file.

For instance, to see a listing on the screen as a result of compiling a procedure contained in a file named `analyze.pro`, use the following command:

```
.RUN -T analyze
```

To compile the same procedure and save the listing in a file named `analyze.lis`, use the following command:

```
.RUN -L analyze.lis analyze
```

In listings produced by IDL, the line number of each statement is printed at the left margin. This number is the same as that printed in IDL error statements, simplifying location of the statement causing the error.

**Note**

If the compiled file contains more than one procedure or function, line numbering is reset to “1” each time the end of a program segment is detected.

Each level of block nesting is indented four spaces to the right of the preceding block level to improve the legibility of the program’s structure.

# .SKIP

The .SKIP command skips one or more statements. It is useful for moving past a program statement that caused an error. If the optional argument *n* is present, it gives the number of statements to skip; otherwise, a single statement is skipped.

Note that .SKIP does not execute or evaluate the code it is skipping. Rather, it arbitrarily alters the current program counter to the *n*th physical statement following the current point. This has implications that may not be obvious on initial consideration:

- .SKIP does not skip into a called routine.
- .SKIP moves to the *n*th physical statement following the current program location. This may not be the statement that execution would have actually have moved to if you had allowed the program to run normally.
- Arbitrarily moving the program counter in this way may leave your program in an unrunnable state, depending on resulting state of the local variables and the statements that the newly positioned program counter attempts to execute next.

In contrast, the .STEP executive command has none of the above drawbacks and can be used instead in many situations. The advantage of .SKIP over .STEP is that .SKIP can move past statements that .STEP cannot, such as:

- Statements with errors that cause execution to halt.
- Infinite loops, and similar logic errors.

For example, consider the following program segment:

```
...... ... ...
OPENR, 1, 'missing'
READF, 1, xxx, ..., ...
... ... ...
```

If the OPENR statement fails because the specified file does not exist, program execution will halt with the OPENR statement as the current statement. Execution can not be resumed with the executive command .CONTINUE because it attempts to re-execute the offending OPENR statement, causing the same error. The remainder of the program can be executed by entering .SKIP, which skips over the incorrect OPEN statement.

**Note**

.SKIP is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.SKIP [*n*]

# .STEP

The .STEP command executes one or more statements in the current program starting at the current position, stops, and returns control to the interactive mode. This command is useful in debugging programs. The optional argument *n* indicates the number of statements to execute. If *n* is omitted, a single statement is executed.

**Note**

.STEP is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.STEP [*n*] or .S [*n*]

# .STEPOVER

The .STEPOVER command executes one or more statements in the current program starting at the current position, stops, and returns control to the interactive mode. Unlike .STEP, if .STEPOVER executes a statement that calls another routine, the called routine runs until it ends before control returns to interactive mode. That is, a statement calling another routine is treated as a single statement.

The optional argument n indicates the number of statements to execute. If n is omitted, a single statement (or called routine) is executed.

**Note**

.STEPOVER is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.STEPOVER [*n*] or .SO [*n*]

# .TRACE

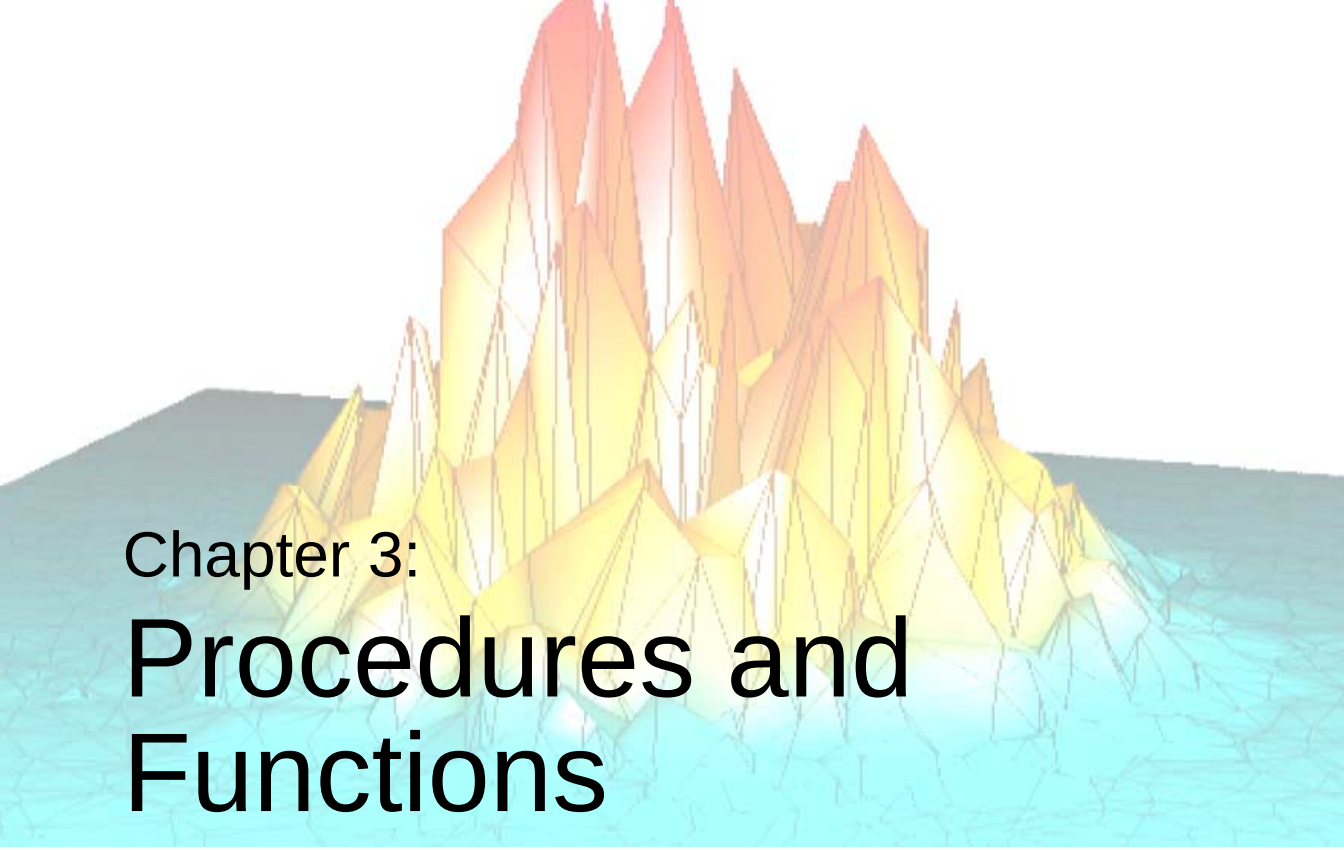
The .TRACE command continues execution of a program that has stopped because of an error, a stop statement, or a keyboard interrupt.

**Note**

.TRACE is an executive command. Executive commands can only be used at the IDL command prompt, not in programs.

## Syntax

.TRACE



Chapter 3:

# Procedures and Functions

# A_CORRELATE

The A_CORRELATE function computes the autocorrelation *Px*(*L*) or autocovariance *Rx*(*L*) of a sample population *X* as a function of the lag *L*.

$$P_x(L) = P_x(-L) = \frac{\sum_{k=0}^{N-L-1} (x_k - \bar{x})(x_{k+L} - \bar{x})}{\sum_{k=0}^{N-1} (x_k - \bar{x})^2}$$

$$R_x(L) = R_x(-L) = \frac{1}{N} \sum_{k=0}^{N-L-1} (x_k - \bar{x})(x_{k+L} - \bar{x})$$

where $\bar{x}$ is the mean of the sample population $x = (x_0, x_1, x_2, \ldots, x_{N-1})$.

**Note**

This routine is primarily designed for use in 1-D time-series analysis. The mean is subtracted before correlating. For image processing, methods based on FFT should be used instead if more than a few tens of points exist. For example:

```
Function AutoCorrelate, X
   Temp = FFT(X,-1)
   RETURN, FFT(Temp * CONJ(Temp), 1)
END
```

This routine is written in the IDL language. Its source code can be found in the file `a_correlate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = A_CORRELATE(*X*, *Lag* [, /COVARIANCE] [, /DOUBLE] )

# Arguments

## X

An *n*-element integer, single-, or double-precision floating-point vector.

## Lag

An *n*-element integer vector in the interval [-(*n*-2), (*n*-2)], specifying the signed distances between indexed elements of *X*.

# Keywords

## COVARIANCE

Set this keyword to compute the sample autocovariance rather than the sample autocorrelation.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

```
; Define an n-element sample population:
X = [3.73, 3.67, 3.77, 3.83, 4.67, 5.87, 6.70, 6.97, 6.40, 5.57]
; Compute the autocorrelation of X for LAG = -3, 0, 1, 3, 4, 8:
lag = [-3, 0, 1, 3, 4, 8]
result = A_CORRELATE(X, lag)
PRINT, result
```

IDL prints:

```
0.0146185  1.00000  0.810879  0.0146185  -0.325279  -0.151684
```

# Version History

Introduced: 4.0

# See Also

CORRELATE, C_CORRELATE, M_CORRELATE, P_CORRELATE, R_CORRELATE

# ABS

The ABS function returns the absolute value of its argument.

## Syntax

*Result* = ABS(*X*)

## Return Value

Returns the absolute value of its argument.

## Arguments

### X

The value for which the absolute value is desired. If *X* is of complex type, ABS returns the magnitude of the complex number:

$$\sqrt{\text{Real}^2 + \text{Imaginary}^2}$$

If X is of complex type, the result is returned as the corresponding floating point type. For all other types, the result has the same type as *X*. If *X* is an array, the result has the same structure, with each element containing the absolute value of the corresponding element of *X*.

ABS applied to any of the unsigned integer types results in the unaltered value of X being returned.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To print the absolute value of -25, enter:

```
PRINT, ABS(-25)
```

IDL prints:

```
25
```

## Version History

Introduced: Original

# ACOS

The ACOS function returns the angle, expressed in radians, whose cosine is *X* (i.e., the arc-cosine). For real input, the range of ACOS is between 0 and π.

For input of a complex number, Z = X + iY, the complex arccosine is given by,

$$acos(Z) = acos(B) - i\ alog(A + sqrt(A^2 - 1)) \quad \text{if } Y >= 0$$

$$acos(Z) = acos(B) + i\ alog(A + sqrt(A^2 - 1)) \quad \text{if } Y < 0$$

where

$$A = 0.5\ sqrt((X + 1)^2 + Y^2) + 0.5\ sqrt((X - 1)^2 + Y^2)$$

$$B = 0.5\ sqrt((X + 1)^2 + Y^2) - 0.5\ sqrt((X - 1)^2 + Y^2)$$

The separation of the two formulas at Y = 0 takes into account the branch-cut discontinuity along the real axis from -∞ to -1 and +1 to +∞, and ensures that cos(acos(Z)) is equal to Z. For reference, see formulas 4.4.37-39 in Abramowitz, M. and Stegun, I.A., 1964: Handbook of Mathematical Functions (Washington: National Bureau of Standards).

## Syntax

*Result* = ACOS(*X*)

## Return Value

Returns the angle, expressed in radians, whose cosine is *X* (i.e., the arc-cosine).

## Arguments

### X

The cosine of the desired angle. For real input, X should be in the range -1 to +1. If X is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. If X is an array, the result has the same structure, with each element containing the arc-cosine of the corresponding element of X.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

Find the angle whose cosine is 0.707 and print the result in degrees by entering:

```
PRINT, 180/!PI*ACOS(0.707)
IDL prints:
45.0086
```

Find the complex arccosine of 2 + i and print the result by entering:

```
PRINT, ACOS(COMPLEX(2,1))
IDL prints:
(     0.507356,     -1.46935)
```

See the ATAN function for an example of visualizing the complex arccosine.

# Version History

Introduced: Original

PHASE keyword: 5.6

# See Also

COS, COSH, ASIN, SIN, SINH, ATAN, TAN, TANH

# ADAPT_HIST_EQUAL

The ADAPT_HIST_EQUAL function performs adaptive histogram equalization, a form of automatic image contrast enhancement. The algorithm is described in Pizer et. al., “Adaptive Histogram Equalization and its Variations.”, Computer Vision, Graphics and Image Processing, 39:355-368. Adaptive histogram equalization involves applying contrast enhancement based on the local region surrounding each pixel. Each pixel is mapped to an intensity proportional to its rank within the surrounding neighborhood. This method of automatic contrast enhancement has proven to be broadly applicable to a wide range of images and to have demonstrated effectiveness.

This routine is written in the IDL language. Its source code can be found in the file `adapt_hist_equal.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = ADAPT_HIST_EQUAL (*Image* [, CLIP=*value*] [, FCN=*vector*] [, NREGIONS=*nregions*] [, TOP=*value*] )

## Return Value

The result of the function is a byte image with the same dimensions as the input image parameter.

## Arguments

### Image

A two-dimensional array representing the image for which adaptive histogram equalization is to be performed. This parameter is interpreted as unsigned 8-bit data, so be sure that the input values are properly scaled into the range of 0 to 255.

## Keywords

### CLIP

Set this keyword to a nonzero value to clip the histogram by limiting its slope to the given CLIP value, thereby limiting contrast. For example, if CLIP is set to 3, the slope of the histogram is limited to 3. By default, the slope and/or contrast is not

limited. Noise over-enhancement in nearly homogeneous regions is reduced by setting this parameter to values larger than 1.0.

### FCN

Set this keyword to the desired cumulative probability distribution function in the form of a 256 element vector. If omitted, a linear ramp, which yields equal probability bins results. This function is later normalized, so magnitude is inconsequential, though should increase monotonically.

### NREGIONS

Set this keyword to the size of the overlapped tiles, as a fraction of the largest dimensions of the image size. The default is 12, which makes each tile 1/12 the size of the largest image dimension.

### TOP

Set this keyword to the maximum value of the scaled output array. The default is 255.

## Examples

The following code snippet reads a data file in the `examples/data` subdirectory of the IDL distribution containing a cerebral angiogram, and then displays both the original image and the adaptive histogram equalized image:

```
OPENR, 1, FILEPATH('cereb.dat', $
   SUBDIRECTORY=['examples','data'])

;Image size = 512 x 512
a = BYTARR(512,512, /NOZERO)

;Read it
READU, 1, a
CLOSE, 1

; Reduce size of image for comparison
a = CONGRID(a, 256,256)

;Show original
TVSCL, a, 0

;Show processed
TV, ADAPT_HIST_EQUAL(a, TOP=!D.TABLE_SIZE-1), 1
```

## Version History

Introduced: 5.3

## See Also

H_EQ_CT, H_EQ_INT, HIST_2D, HIST_EQUAL, HISTOGRAM

# ALOG

The ALOG function returns the natural logarithm of *X*.

For input of a complex number, Z = X + iY, the complex number can be rewritten as Z = R exp(iθ), where R = abs(Z) and θ = atan(y,x). The complex natural log is then given by,

alog(Z) = alog(R) + i q

In the above formula, the use of the two-argument arctangent separates the solutions at Y = 0 and takes into account the branch-cut discontinuity along the real axis from -∞ to 0, and ensures that exp(alog(Z)) is equal to Z. For reference, see formulas 4.4.1-3 in Abramowitz, M. and Stegun, I.A., 1964: *Handbook of Mathematical Functions* (Washington: National Bureau of Standards).

## Syntax

*Result* = ALOG(*X*)

## Return Value

Returns the natural logarithm of *X*.

## Arguments

### X

The value for which the natural log is desired. For real input, X should be greater than or equal to zero. If X is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. If X is an array, the result has the same structure, with each element containing the natural log of the corresponding element of X.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS,

TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

Find the natural logarithm of 2 and print the result by entering:

```
PRINT, ALOG(2)
IDL prints:
0.693147
```

Find the complex natural log of sqrt(2) + i sqrt(2) and print the result by entering:

```
PRINT, ALOG(COMPLEX(sqrt(2), sqrt(2)))
IDL prints:
(     0.693147,     0.785398)
```

**Note**

The real part of the result is just ALOG(2) and the imaginary part gives the angle (in radians) of the complex number relative to the real axis.

See the ATAN function for an example of visualizing the complex natural log.

## Version History

Introduced: Original

## See Also

ALOG10, ATAN

# ALOG10

The ALOG10 function returns the logarithm to the base 10 of *X*.

For input of a complex number, Z = X + iY, the complex number can be rewritten as Z = R exp(iq), where R = abs(Z) and q = atan(y,x). The complex log base 10 is then given by,

alog10(Z) = alog10(R) + i q/alog(10)

In the above formula, the use of the two-argument arctangent separates the solutions at Y = 0 and takes into account the branch-cut discontinuity along the real axis from -∞ to 0, and ensures that 10^(alog10(Z)) is equal to Z. For reference, see formulas 4.4.1-3 in Abramowitz, M. and Stegun, I.A., 1964: *Handbook of Mathematical Functions* (Washington: National Bureau of Standards).

## Syntax

*Result* = ALOG10(*X*)

## Return Value

Returns the logarithm to the base 10 of *X*.

## Arguments

### X

The value for which the base 10 log is desired. For real input, X should be greater than or equal to zero. If X is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. If X is an array, the result has the same structure, with each element containing the base 10 log of the corresponding element of X.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS,

TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

Find the base 10 logarithm of 100 and print the result by entering:

```
PRINT, ALOG10(100)
IDL prints:
2.00000
```

See the ATAN function for an example of visualizing the complex logarithm.

## Version History

Introduced: Original

## See Also

ALOG, ATAN

# AMOEBA

The AMOEBA function performs multidimensional minimization of a function *Func*(*x*), where *x* is an *n*-dimensional vector, using the downhill simplex method of Nelder and Mead, 1965, *Computer Journal*, Vol 7, pp 308-313.

The downhill simplex method is not as efficient as Powell's method, and usually requires more function evaluations. However, the simplex method requires only function evaluations—not derivatives—and may be more reliable than Powell's method.

This routine is written in the IDL language. Its source code can be found in the file `amoeba.pro` in the `lib` subdirectory of the IDL distribution. AMOEBA is based on the routine `amoeba` described in section 10.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = AMOEBA( *Ftol* [, FUNCTION_NAME=*string*]
[, FUNCTION_VALUE=*variable*] [, NCALLS=*value*] [, NMAX=*value*]
[, P0=*vector*, SCALE=*vector* | , SIMPLEX=*array*] )

## Return Value

If the minimum is found, AMOEBA returns an *n*-element vector corresponding to the function's minimum value. If a minimum within the given tolerance is not found within the specified number of iterations, AMOEBA returns a scalar value of -1. Results are returned with the same precision (single- or double-precision floating-point) as is returned by the user-supplied function to be minimized.

## Arguments

### Ftol

The fractional tolerance to be achieved in the function value—that is, the fractional decrease in the function value in the terminating step. If the function you supply returns a single-precision result, *Ftol* should never be less than your machine's floating-point precision—the value contained in the EPS field of the structure returned by the MACHAR function. If the function you supply returns a double-precision floating-point value, Ftol should not be less than your machine' double-precision floating-point precision. See MACHAR for details.

# Keywords

## FUNCTION_NAME

Set this keyword equal to a string containing the name of the function to be minimized. If this keyword is omitted, AMOEBA assumes that an IDL function named “FUNC” is to be used.

The function to be minimized must be written as an IDL function and compiled prior to calling AMOEBA. This function must accept an *n*-element vector as its only parameter and return a scalar single- or double precision floating-point value as its result.

See the *Example* section below for an example function.

## FUNCTION_VALUE

Set this keyword equal to a named variable that will contain an (*n*+1)-element vector of the function values at the simplex points. The first element contains the function minimum.

## NCALLS

Set this keyword equal to a named variable that will contain a count of the number of times the function was evaluated.

## NMAX

Set this keyword equal to a scalar value specifying the maximum number of function evaluations allowed before terminating. The default is 5000.

## P0

Set this keyword equal to an *n*-element single- or double-precision floating-point vector specifying the initial starting point. Note that if you specify P0, you must also specify SCALE.

For example, in a 3-dimensional problem, if the initial guess is the point [0,0,0], and you know that the function’s minimum value occurs in the interval:

```
-10 < X[0] < 10, -100 < X[1] < 100, -200 < X[(2] < 200,
```

specify: P0=[0,0,0] and SCALE=[10, 100, 200].

Alternately, you can omit P0 and SCALE and specify SIMPLEX.

### SCALE

Set this keyword equal to a scalar or *n*-element vector containing the problem's characteristic length scale for each dimension. SCALE is used with P0 to form an initial (*n*+1) point simplex. If all dimensions have the same scale, set SCALE equal to a scalar.

If SCALE is specified as a scalar, the function's minimum lies within a distance of SCALE from P0. If SCALE is an N-dimensional vector, the function's minimum lies within the Ndim+1 simplex with the vertices P0, P0 + [1,0,...,0] * SCALE, P0 + [0,1,0,...,0] * SCALE, ..., and P0+[0,0,...,1] * SCALE.

### SIMPLEX

Set this keyword equal to an *n* by *n*+1 single- or double-precision floating-point array containing the starting simplex. After AMOEBA has returned, the SIMPLEX array contains the simplex enclosing the function minimum. The first point in the array, SIMPLEX[*,0], corresponds to the function's minimum. This keyword is ignored if the P0 and SCALE keywords are set.

## Examples

Use AMOEBA to find the slope and intercept of a straight line that fits a given set of points, minimizing the maximum error. The function to be minimized (FUNC, in this case) returns the maximum error, given p[0] = intercept, and p[1] = slope.

```
; First define the function FUNC:
FUNCTION FUNC, P
COMMON FUNC_XY, X, Y
RETURN, MAX(ABS(Y - (P[0] + P[1] * X)))
END

; Put the data points into a common block so they are accessible to
; the function:
COMMON FUNC_XY, X, Y

; Define the data points:
X = FINDGEN(17)*5
Y = [ 12.0,  24.3,  39.6,  51.0,  66.5,  78.4,  92.7, 107.8, $
    120.0, 135.5, 147.5, 161.0, 175.4, 187.4, 202.5, 215.4, 229.9]

; Call the function. Set the fractional tolerance to 1 part in
; 10^5, the initial guess to [0,0], and specify that the minimum
; should be found within a distance of 100 of that point:
R = AMOEBA(1.0e-5, SCALE=1.0e2, P0 = [0, 0], FUNCTION_VALUE=fval)
```

```
; Check for convergence:
IF N_ELEMENTS(R) EQ 1 THEN MESSAGE, 'AMOEBA failed to converge'

; Print results:
PRINT, 'Intercept, Slope:', r, $
       'Function value (max error): ', fval[0]
```

IDL prints:

```
Intercept, Slope:      11.4100      2.72800
Function value:       1.33000
```

## Version History

Introduced: 5.0

## See Also

DFPMIN, POWELL, SIMPLEX

# ANNOTATE

The ANNOTATE procedure starts an IDL widget program that allows you to interactively annotate images and plots with text and drawings. Drawing objects include lines, arrows, polygons, rectangles, circles, and ellipses. Annotation files can be saved and restored, and annotated displays can be written to TIFF or PostScript files. The Annotation widget will work on any IDL graphics window or draw widget.

This routine is written in the IDL language. Its source code can be found in the file `annotate.pro` in the `lib` subdirectory of the IDL distribution.

### Using the Annotation Widget

Before calling the Annotation widget, plot or display your data in an IDL graphics window or draw widget. Unless you specify otherwise (using the DRAWABLE or WINDOW keywords), annotations will be made in the current graphics window.

For information on using the Annotation widget, click on the widget's "Help" button.

## Syntax

ANNOTATE [, COLOR_INDICES=*array*] [, DRAWABLE=*widget_id* | , WINDOW=*index*] [, LOAD_FILE=*filename*] [, /TEK_COLORS]

## Arguments

None.

## Keywords

### COLOR_INDICES

An array of color indices from which the user can choose colors. For example, to allow the user to choose 10 colors, spread evenly over the available indices, set the keyword as follows:

```
COLOR_INDICES = INDGEN(10) * (!D.N_COLORS-1) / 9
```

If neither TEK_COLORS or COLOR_INDICES are specified, the default is to load 10 colors, evenly distributed over those available.

### DRAWABLE

The widget ID of the draw widget for the annotations. Do not set both DRAWABLE and WINDOW. If neither WINDOW or DRAWABLE are specified, the current window is used.

### LOAD_FILE

The name of an annotation format file to load after initialization.

### TEK_COLORS

Set this keyword and the Tektronix color table is loaded starting at color index TEK_COLORS(0), with TEK_COLORS(1) color indices. The Tektronix color table contains up to 32 distinct colors suitable for graphics. If neither TEK_COLORS or COLOR_INDICES are specified, the default is to load 10 colors, evenly distributed over those available.

### WINDOW

The window index number of the window to receive the annotations. Do not set both DRAWABLE and WINDOW. If neither WINDOW or DRAWABLE are specified, the current window is used.

## Examples

```
; Output an image in the current window:
TVSCL, HANNING(300,200)
; Annotate it:
ANNOTATE
```

## Version History

Introduced: Pre 4.0

## See Also

PLOTS, XYOUTS

# ARG_PRESENT

The ARG_PRESENT function is useful in user-written procedures that need to know if the lifetime of a value they are creating extends beyond the current routine's lifetime. This can be important for two reasons:

1. To avoid expensive computations that the caller is not interested in.
2. To prevent heap variable leakage that would result if the routine creates pointers or object references and assigns them to arguments that are *not* passed back to the caller.

## Syntax

*Result* = ARG_PRESENT(*Variable*)

## Return Value

Returns a nonzero value if the following conditions are met:

- The argument to ARG_PRESENT was passed as a plain or keyword argument to the current routine by its caller, and
- The argument to ARG_PRESENT is a named variable into which a value will be copied when the current routine exits.

In other words, ARG_PRESENT returns TRUE if the value of the specified variable will be passed back to the caller.

## Arguments

### Variable

The variable to be tested.

## Example

Suppose that you are writing an IDL procedure that has the following procedure definition line:

```
PRO myproc, RET_PTR = ret_ptr
```

The intent of the RET_PTR keyword is to pass back a pointer to a new pointer heap variable. The following command could be used to avoid creating (and possibly losing) a pointer if no named variable is provided by the caller:

```
IF ARG_PRESENT(ret_ptr) THEN BEGIN
```

The commands that follow would only be executed if `ret_ptr` is supplied and will be copied into a variable in the scope of the calling routine.

## Version History

Introduced: 5.0

## See Also

KEYWORD_SET, N_ELEMENTS, N_PARAMS

# ARRAY_EQUAL

The ARRAY_EQUAL function is a fast way to compare data for equality in situations where the index of the elements that differ are not of interest. This operation is much faster than using TOTAL(A NE B), because it stops the comparison as soon as the first inequality is found, an intermediate array is not created, and only one pass is made through the data. For best speed, ensure that the operands are of the same data type.

Arrays may be compared to scalars, in which case each element is compared to the scalar. For two arrays to be equal, they must have the same number of elements. If the types of the operands differ, the type of the least precise is converted to that of the most precise, unless the NO_TYPECONV keyword is specified to prevent it. This function works on all numeric types, strings, pointer references, and object references. In the case of pointer and object references, ARRAY_EQUAL compares the *references* (which are long integers), not the heap variables to which the references point.

## Syntax

*Result* = ARRAY_EQUAL( *Op1* , *Op2* [, /NO_TYPECONV ] )

## Return Value

Returns 1 (true) if, and only if, all elements of *Op1* are equal to *Op2*; returns 0 (false) at the first instance of inequality.

## Arguments

### Op1, Op2

The variables to be compared.

## Keywords

### NO_TYPECONV

By default, ARRAY_EQUAL converts operands of different types to a common type before performing the equality comparison. Set NO_TYPECONV to disallow this implicit type conversion. If NO_TYPECONV is specified, operands of different types are never considered to be equal, even if their numeric values are the same.

## Examples

```
; Return True (1) if all elements of a are equal to a 0 byte:
IF ARRAY_EQUAL(a, 0b) THEN ...
; Return True (1) if all elements of a are equal all elements of b:
IF ARRAY_EQUAL(a, b) THEN ...
```

## Version History

Introduced: 5.4

# ARRAY_INDICES

The ARRAY_INDICES function converts one-dimensional subscripts of an array into corresponding multi-dimensional subscripts.

This routine is written in the IDL language. Its source code can be found in the file `array_indices.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = ARRAY_INDICES(*Array, Index*)

## Return Value

If *Index* is a scalar, returns a vector containing *m* dimensional subscripts, where *m* is the number of dimensions of *Array.*

If *Index* is a vector containing *n* elements, returns an (*m* x *n*) array, with each row containing the multi-dimensional subscripts corresponding to that index.

## Arguments

### Array

An array of any type.

### Index

A scalar or vector containing the one-dimensional subscripts to be converted.

## Keywords

None.

# Examples

## Example 1

This example finds the location of the maximum value of a random 10 by 10 array:

```
seed = 111
array = RANDOMU(seed, 10, 10)
mx = MAX(array, location)
ind = ARRAY_INDICES(array, location)
PRINT, ind, array[ind[0],ind[1]], $
   FORMAT = '(%"Value at [%d, %d] is %f")'
```

IDL prints:

```
Value at [3, 6] is 0.973381
```

## Example 2

This example routine locates the highest point in the example Maroon Bells data set and places a flag at that point.

Enter the following code in the IDL editor:

```
PRO ExARRAY_INDICES

; Import Maroon Bells data.
file = FILEPATH('surface.dat', $
   SUBDIRECTORY = ['examples', 'data'])
data = READ_BINARY(file, DATA_DIMS = [350, 450], $
   DATA_TYPE = 2)

; Display data.
ISURFACE, data

; Calculate the value and one-dimensional
; array location of the highest point.
maxValue = MAX(data, maxPoint)

; Using ARRAY_INDICES to convert the one-
; dimensional array location to a two-
; dimensional aray location.
maxLocation = ARRAY_INDICES(data, maxPoint)

; Print the results.
PRINT, 'Highest Point Location:  ', maxLocation
PRINT, 'Highest Point Value:  ', maxValue

; Create flag for the highest point.
```

```
x = maxLocation[0]
y = maxLocation[1]
z = maxValue
xFlag = [x, x, x + 50., x]
yFlag = [y, y, y + 50., y]
zFlag = [z, z + 1000., z + 750., z + 500.]

; Display flag at the highest point.
IPLOT, xFlag, yFlag, zFlag, /OVERPLOT

END
```

Save the code as `ExARRAY_INDICES.pro`, compile it and run it. The following figure displays the output of this example:

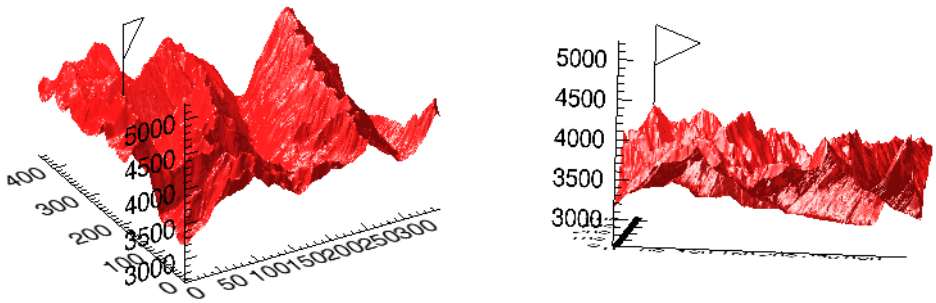



*Figure 3-1: Maroon Bells Surface Plot with Flag at Highest Point Before Rotation (Left) and After Rotation (Right)*

For a better view of the flag, use the Rotate tool to rotate the surface.

## Version History

Introduced: 6.0

## See Also

MAX, MIN, WHERE

# ARROW

The ARROW procedure draws one or more vectors with arrow heads.

This routine is written in the IDL language. Its source code can be found in the file `arrow.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

ARROW, *X0*, *Y0*, *X1*, *Y1* [, /DATA | , /NORMALIZED] [, HSIZE=*length*] [, COLOR=*index*] [, HTHICK=*value*] [, /SOLID] [, THICK=*value*]

## Arguments

### X0, Y0

Arrays or scalars containing the coordinates of the tail end of the vector or vectors. Coordinates are in DEVICE coordinates unless otherwise specified.

### X1,Y1

Arrays or scalars containing the coordinates of the arrowhead end of the vector or vectors. *X1* and *Y1* must have the save number of elements as *X0* and *Y0*.

## Keywords

### DATA

Set this keyword if vector coordinates are DATA coordinates.

### NORMALIZED

Set this keyword if vector coordinates are NORMALIZED coordinates.

### HSIZE

Use this keyword to set the length of the lines used to draw the arrowhead. The default is 1/64th the width of the display (!D.X_SIZE / 64.). If the HSIZE is positive, the value is assumed to be in device coordinate units. If HSIZE is negative, the arrowhead length is set to the vector length * ABS(HSIZE). The lines are separated by 60 degrees to make the arrowhead.

### COLOR

The color of the arrow. The default is the highest color index.

### HTHICK

The thickness of the arrowheads. The default is 1.0.

### SOLID

Set this keyword to make a solid arrow, using polygon fills, looks better for thick arrows.

### THICK

The thickness of the body. The default is 1.0.

## Examples

Draw an arrow from (100,150) to (300,350) in DEVICE units:

```
ARROW, 100, 150, 300, 350
```

Draw a sine wave with arrows from the line Y = 0 to SIN(X/4):

```
X = FINDGEN(50)
Y = SIN(x/4)
PLOT, X, Y
ARROW, X, REPLICATE(0,50), X, Y, /DATA
```

## Version History

Introduced: Pre 4.0

## See Also

ANNOTATE, PLOTS, VELOVECT

# ASCII_TEMPLATE

The ASCII_TEMPLATE function presents a graphical user interface (GUI) which generates a template defining an ASCII file format. Templates are IDL structure variables that may be used when reading ASCII files with the READ_ASCII routine. See READ_ASCII for details on reading ASCII files.

This routine is written in the IDL language. Its source code can be found in the file `ascii_template.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = ASCII_TEMPLATE( [*Filename*] [, BROWSE_LINES=*lines*] [, CANCEL=*variable*] [, GROUP=*widget_id*] )

## Return Value

Returns a template defining an ASCII file format.

## Arguments

### Filename

A string containing the name of a file to base the template on. If *Filename* is not specified, a dialog allows you to choose a file.

## Keywords

### BROWSE_LINES

Set this keyword equal to the number of lines that will be read in at a time when the “Browse” button is selected. The default is 50 lines.

### CANCEL

Set this keyword to a named variable that will contain the byte value 1 if the user clicked the “Cancel” button, or 0 otherwise.

### GROUP

The widget ID of an existing widget that serves as “group leader” for the ASCII_TEMPLATE graphical user interface. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

## The ASCII_TEMPLATE Interface

When the ASCII_TEMPLATE function is invoked, the following dialog is displayed:.

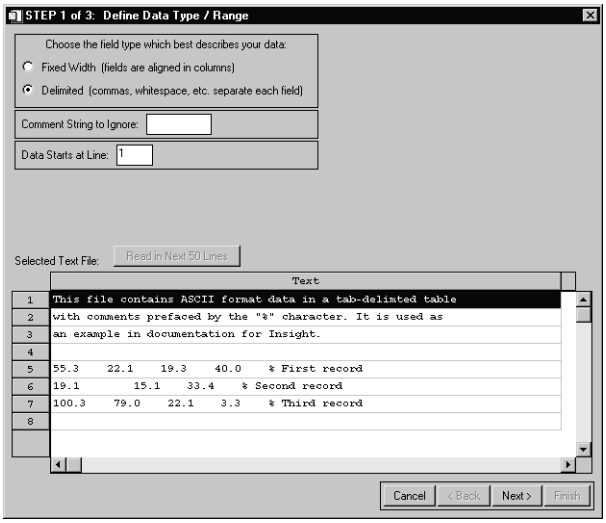



*Figure 3-2: ASCII Template - Define Data Type / Range*

**Note**

If no filename is supplied in the call to the ASCII_TEMPLATE function, a file selection dialog is displayed prior to the first ASCII_TEMPLATE screen.

The first page displays a representative sample of lines from the data file with their numbers on the left. Select the field type that best describes the data. Click the **Next** button on the bottom-right corner of the screen to move to the next page.

The second page displays the number of fields per line which is listed as three and the white space is selected for the data delimiter. Click the **Next** button on the bottom right corner of the screen to move to the next page.

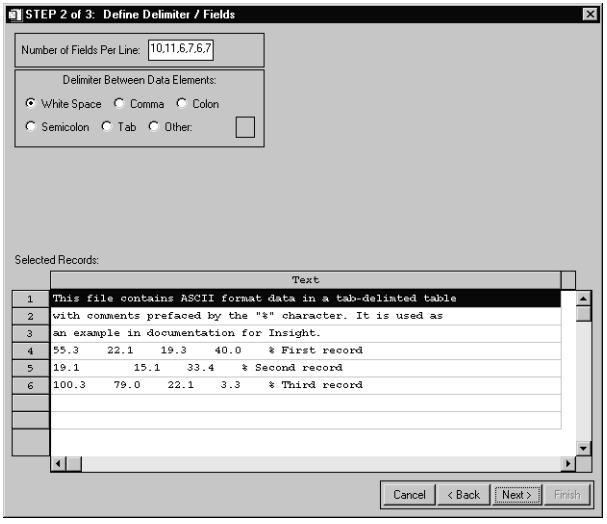



*Figure 3-3: ASCII Template - Define Delimiter / Fields*

The third page displays the columns in the data set which can be named and their data type specified. Name the fields by typing in the name text at the upper right of the form. Click the **Finish** button on the bottom-right corner of the screen.

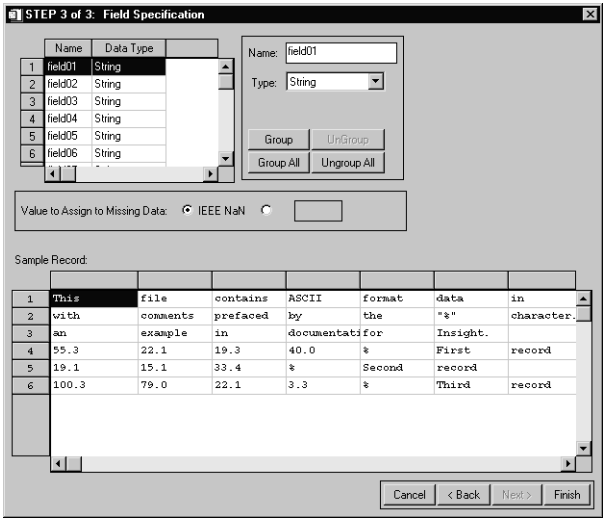



*Figure 3-4: ASCII Template - Field Specification*

## Examples

Use the following command to generate a template structure from the file “myFile”:

```
myTemplate = ASCII_TEMPLATE(myFile)
```

## Version History

Introduced: 5.0

## See Also

READ_ASCII, BINARY_TEMPLATE

# ASIN

The ASIN function returns the angle, expressed in radians, whose sine is *X* (i.e., the arc-sine).

For real input, the range of ASIN is between $-\pi/2$ and $\pi/2$.

For input of a complex number, Z = X + iY, the complex arcsine is given by,

$$\text{asin}(Z) = \text{asin}(B) + i\,\text{alog}(A + \text{sqrt}(A^2 - 1)) \quad \text{if } Y >= 0$$

$$\text{asin}(Z) = \text{asin}(B) - i\,\text{alog}(A + \text{sqrt}(A^2 - 1)) \quad \text{if } Y < 0$$

where

$$A = 0.5\,\text{sqrt}((X + 1)^2 + Y^2) + 0.5\,\text{sqrt}((X - 1)^2 + Y^2)$$

$$B = 0.5\,\text{sqrt}((X + 1)^2 + Y^2) - 0.5\,\text{sqrt}((X - 1)^2 + Y^2)$$

The separation of the two formulas at Y = 0 takes into account the branch-cut discontinuity along the real axis from $-\infty$ to -1 and +1 to $+\infty$, and ensures that sin(asin(Z)) is equal to Z. For reference, see formulas 4.4.37-39 in Abramowitz, M. and Stegun, I.A., 1964: *Handbook of Mathematical Functions* (Washington: National Bureau of Standards).

## Syntax

*Result* = ASIN(*X*)

## Return Value

Returns the angle, expressed in radians, whose sine is *X* (i.e., the arc-sine).

## Arguments

### X

The sine of the desired angle. For real input, X should be in the range -1 to +1. If X is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. If X is an array, the result has the same structure, with each element containing the arcsine of the corresponding element of X.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

Find the angle whose sine is 0.707 and print the result in degrees by entering:

```
PRINT, 180/!PI*ASIN(0.707)
IDL prints:
44.9913
```

Find the complex arcsine of 2 + i and print the result by entering:

```
PRINT, ASIN(COMPLEX(2,1))
IDL prints:
(      1.06344,      1.46935)
```

See the ATAN function for an example of visualizing the complex arcsine.

# Version History

Introduced: Original

# See Also

ACOS, COS, COSH, SIN, SINH, ATAN, TAN, TANH

# ASSOC

The ASSOC function associates an array structure with a file. It provides a basic method of random access input/output in IDL.

**Note**

Unformatted data files generated by FORTRAN programs under UNIX contain an extra long word before and after each logical record in the file. ASSOC does not interpret these extra bytes but considers them to be part of the data. This is true even if the F77_UNFORMATTED keyword is specified in the OPEN statement. Therefore, ASSOC should not be used with such files. Instead, such files should be processed using READU and WRITEU. An example of using IDL to read such data is given in "Using Unformatted Input/Output" in Chapter 10 of the *Building IDL Applications* manual.

**Note**

Associated file variables cannot be used for output with files opened using the COMPRESS keyword to OPEN. This is due to the fact that it is not possible to move the current file position backwards in a compressed file that is currently open for writing. ASSOC is allowed with compressed files opened for input only. However, such operations may be slow due to the large amount of work required to change the file position in a compressed file.

Effective use of ASSOC requires the ability to rapidly position the file to arbitrary positions. In general, files that require random access may not be good candidates for compression. If this is necessary however, such files can be processed using READU and WRITEU.

## Syntax

*Result* = ASSOC( *Unit*, *Array_Structure* [, *Offset*] [, /PACKED] )

## Return Value

Returns a value that when assigned to a variable, stores the association between an array structure and a file in an *associated variable*. This variable provides a means of mapping a file into vectors or arrays of a specified type and size.

# Arguments

## Unit

The IDL file unit to associate with *Array_Structure*.

## Array_Structure

An expression of the data type and structure to be associated with *Unit* are taken from *Array_Structure*. The actual value of *Array_Structure* is not used.

## Offset

The offset in the file to the start of the data in the file, in bytes.

# Keywords

## PACKED

When ASSOC is applied to structures, the default action is to map the actual definition of the structure for the current machine, including any holes required to properly align the fields. (IDL uses the same rules for laying out structures as the C language). If the PACKED keyword is specified, I/O using the resulting variable instead works in the same manner as READU and WRITEU, and data is moved one field at a time and there are no alignment gaps between the fields.

# Examples

Suppose that the file `images.dat` holds 5 images as 256-element by 256-element arrays of bytes. Open the file for reading and create an associated variable by entering:

```
OPENR, 1, 'images.dat' ;Open the file as file unit 1.
A = ASSOC(1, BYTARR(256, 256)) ;Make an associated variable.
```

Now A[0] corresponds to the first image in the file, A[1] is the second element, etc. To display the first image in the file, you could enter:

```
TV, A[0]
```

The data for the first image is read and then displayed. Note that the data associated with A[0] is not held in memory. It is read in every time there is a reference to A[0]. To store the image in the memory-resident array B, you could enter:

```
B = A[0]
```

**Note**

It is also possible to refer to individual elements within an associated array directly, using multiple subscripts. See "Multiple Subscripts With Associated File Variables" in Chapter 10 of the *Building IDL Applications* manual for details and examples.

## Version History

Introduced: Original

## See Also

OPEN, READU, "Associated Input/Output" in Chapter 10 of the *Building IDL Applications* manual.

# ATAN

The ATAN function returns the angle, expressed in radians, whose tangent is *X* (i.e., the arc-tangent). If two parameters are supplied, the angle whose tangent is equal to *Y/X* is returned.

For real input, the range of ATAN is between $-\pi/2$ and $\pi/2$ for the single argument case, and between $-\pi$ and $\pi$ if two arguments are given.

In the single argument case with a complex number, Z = X + *i*Y, the complex arctangent is given by,

$$\text{atan}(Z) = 0.5\ \text{atan}(2x,\ 1 - x^2 - y^2) + 0.25\ i\ \text{alog}((x^2 + (y+1)^2)/(x^2 + (y-1)^2))$$

In the above formula, the use of the two-argument arctangent separates the solutions at X = 0 and takes into account the branch-cut discontinuity along the imaginary axis from $-i\infty$ to $-i$ and $+i$ to $+i\infty$, and ensures that tan(atan(Z)) is equal to Z. For reference, see formulas 4.4.37-39 in Abramowitz, M. and Stegun, I.A., 1964: *Handbook of Mathematical Functions* (Washington: National Bureau of Standards).

In the two argument case with two complex numbers Zy and Zx, the complex arctangent is given by,

$$\text{atan}(Zy, Zx) = -i\ \text{alog}((Zx + iZy)/\text{sqrt}(Zx^2 + Zy^2))$$

In the two argument case (either real or complex), if both arguments are zero then the result is undefined.

## Syntax

*Result* = ATAN(*X* [, /PHASE] )

or

*Result* = ATAN(*Y*, *X*)

## Return Value

Returns the angle, expressed in radians, whose tangent is *X* (i.e., the arc-tangent). If two parameters are supplied, the angle whose tangent is equal to *Y/X* is returned.

# Arguments

## X

The tangent of the desired angle. If X is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. If X is an array, the result has the same structure, with each element containing the arctangent of the corresponding element of X.

## Y

An optional argument. If this argument is supplied, ATAN returns the angle whose tangent is equal to Y/X. If both arguments are arrays, the function matches up the corresponding elements of X and Y, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other arguments is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

# Keywords

## PHASE

If this keyword is set, and the argument is a complex number Z, then the complex phase angle is computed as ATAN(Imaginary(Z), Real_part(Z)). If this keyword is not set then the complex arctangent is computed as described above. If the argument is not complex, or if two arguments are present, then this keyword is ignored.

**Tip**

Using the PHASE keyword is equivalent to computing ATAN(Imaginary(Z), Real_part(Z)), but uses less memory and is faster.

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Example

Find the angle whose tangent is 0.5 and print the result in degrees by entering:

```
PRINT, 180/!PI*ATAN(0.5)
IDL prints:
26.5651
```

Find the angle whose tangent is 0.5, taking into account that the tangent came from the ratio -0.25/-0.5:

```
PRINT, 180/!PI*ATAN(-0.25, -0.5)
IDL prints:
-153.435
```

Find the complex arccosine of 2 + i and print the result by entering:

```
PRINT, ATAN(COMPLEX(2,1))
IDL prints:
(      1.17810,     0.173287)
```

Create a visualization of the complex arctangent:

```
   ; Create a grid of complex numbers.
   n = 100
   x = (FINDGEN(n)-(n-1)/2.0)/(n/4)
   z = DCOMPLEX(REBIN(x,n,n), REBIN(TRANSPOSE(x),n,n))

   ; Try any of these transcendental functions:
   ;   ACOS, COS, COSH, ASIN, SIN, SINH,
;   ATAN, TAN, TANH, ALOG, EXP
   fn = ATAN(z)
   oReal = OBJ_NEW('IDLgrSurface', FLOAT(fn), x, x, $
      COLOR=[255, 180, 0], STYLE=2)
   oImag = OBJ_NEW('IDLgrSurface', IMAGINARY(fn), x, x, $
      COLOR=[0, 150, 255], STYLE=2)

   ; Add graphics objects to a model and rotate to nice view.
   oModel = OBJ_NEW('IDLgrModel')
   oModel->Add, oReal
   oModel->Add, oImag
   oModel->ROTATE, [0,0,1], 25
   oModel->ROTATE, [1,0,0], -30

   ; Display using XOBJVIEW.
;Block input so we can destroy objects after.
   XOBJVIEW, oModel, /BLOCK, SCALE=1, $
```

```
      TITLE='Complex transcendental function', $
XSIZE=700, YSIZE=700
   OBJ_DESTROY, oModel
```

## Version History

Introduced: Original

## See Also

ACOS, COS, COSH, SIN, ASIN, SINH, TAN, TANH

# AXIS

The AXIS procedure draws an axis of the specified type and scale at a given position. The new scale is saved for use by subsequent overplots if the SAVE keyword parameter is set. By default, AXIS draws an X axis. The XAXIS, YAXIS, and ZAXIS keywords can be used to select a specific axis type and position.

## Syntax

AXIS [, *X* [, *Y* [, *Z*]]] [, /OBJECTS] [, XAXIS={0 | 1} | YAXIS={0 | 1} | ZAXIS={0 | 1 | 2 | 3}] [, /XLOG] [, /YNOZERO] [, /YLOG]

**Graphics Keywords:** [, CHARSIZE=*value*] [, CHARTHICK=*integer*]
[, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*]
[, /NODATA] [, /NOERASE] [, SUBTITLE=*string*] [, /T3D] [, TICKLEN=*value*]
[, {X | Y | Z}CHARSIZE=*value*]
[, {X | Y | Z}GRIDSTYLE=*integer*{0 to 5}]
[, {X | Y | Z}MARGIN=*[left, right]*]
[, {X | Y | Z}MINOR=*integer*]
[, {X | Y | Z}RANGE=*[min, max]*]
[, {X | Y | Z}STYLE=*value*]
[, {X | Y | Z}THICK=*value*]
[, {X | Y | Z}TICKFORMAT=*string*]
[, {X | Y | Z}TICKINTERVAL= *value*]
[, {X | Y | Z}TICKLAYOUT=*scalar*]
[, {X | Y | Z}TICKLEN=*value*]
[, {X | Y | Z}TICKNAME=*string_array*]
[, {X | Y | Z}TICKS=*integer*]
[, {X | Y | Z}TICKUNITS=*string*]
[, {X | Y | Z}TICKV=*array*]
[, {X | Y | Z}TICK_GET=*variable*]
[, {X | Y | Z}TITLE=*string*]
[, ZVALUE=*value*{0 to 1}]

## Arguments

### X, Y, and Z

Scalars giving the starting coordinates of the new axis. If no coordinates are specified, the axis is drawn in its default position as given by the [XYZ]AXIS keyword. When

drawing an X axis, the *X* coordinate is ignored, similarly the *Y* and *Z* arguments are ignored when drawing their respective axes (i.e., new axes will always point in the correct direction).

# Keywords

## SAVE

Set this keyword to indicate that the scaling to and from data coordinates established by the call to AXIS is to be saved in the appropriate axis system variable, !X, !Y, or !Z. If this keyword is not present, the scaling is not changed.

## XAXIS

Set this keyword to draw an X axis. If the *X* argument *is not* present, setting XAXIS equal to 0 draws an axis under the plot window with the tick marks pointing up, and setting XAXIS equal to one draws an axis above the plot window with the tick marks pointing down. If the *X* argument *is* present, the X axis is positioned accordingly, and setting XAXIS equal to 0 or 1 causes the tick marks to point up or down, respectively.

## XLOG

Set this keyword to specify a logarithmic X axis

## YAXIS

Set this keyword to draw a Y axis. If the *Y* argument *is not* present, setting YAXIS equal to 0 draws an axis on the left side of the plot window with the tick marks pointing right, and setting YAXIS equal to one draws an axis on the right side of the plot window with the tick marks pointing left. If the *Y* argument *is* present, the Y axis is positioned accordingly, and setting YAXIS equal to 0 or 1 causes the tick marks to point right or left, respectively.

**Note**

The YAXIS keyword must be specified in order use any Y* graphics keywords. See the note under “Graphics Keywords Accepted” on page 125 for more information.

## YLOG

Set this keyword to specify a logarithmic Y axis.

## YNOZERO

Set this keyword to inhibit setting the minimum Y axis value to zero when the Y data are all positive and non-zero, and no explicit minimum Y value is specified (using YRANGE, or !Y.RANGE). By default, the Y axis spans the range of 0 to the maximum value of Y, in the case of positive Y data. Set bit 4 in !Y.STYLE to make this option the default.

## ZAXIS

Set this keyword to draw a Z axis. If the *Z* argument is *not* present, setting ZAXIS has the following meanings:

- 0 = lower (front) right, with tickmarks pointing left
- 1 = lower (front) left, with tickmarks pointing right
- 2 = upper (back) left, with tickmarks pointing right
- 3 = upper (back) right, with tickmarks pointing left

If the *Z* argument *is* present, the Z axis is positioned accordingly, and setting ZAXIS equal to 0 or 1 causes the tick marks to point left or right, respectively.

Note that AXIS uses the 3D plotting transformation stored in the system variable field !P.T.

**Note**

The ZAXIS keyword must be specified in order use any Z* graphics keywords. See the note under Graphics Keywords Accepted for more information.

## Graphics Keywords Accepted

See Appendix B, “Graphics Keywords” for the description of graphics and plotting keywords not listed above.

**Note**

In order for the Y* or Z* graphics keywords to work with the AXIS procedure, the corresponding YAXIS or ZAXIS keyword must be specified. For example, the following code will *not* draw a title for the Y axis:

```
AXIS, YTITLE ='Y-axis Title'
```

To use the YTITLE graphics keyword, you must specify the YAXIS keyword to AXIS:

```
AXIS, YAXIS = 0, YTITLE ='Y-axis Title'
```

Because the AXIS procedure draws an X axis by default, it is not necessary to specify the XAXIS keyword in order to use the X* graphics keywords.

---

CHARSIZE, CHARTHICK, COLOR, DATA, DEVICE, FONT, NODATA, NOERASE, NORMAL, SUBTITLE, T3D, TICKLEN, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

## Examples

The following example shows how the AXIS procedure can be used with normal or polar plots to draw axes through the origin, dividing the plot window into four quadrants:

```
; Make the plot, polar in this example, and suppress the X and Y
; axes using the XSTYLE and YSTYLE keywords:
PLOT, /POLAR, XSTYLE=4, YSTYLE=4, TITLE='Polar Plot', r, theta

; Draw an X axis, through data Y coordinate of 0. Because the XAXIS
; keyword parameter has a value of 0, the tick marks point down:
AXIS,0,0,XAX=0,/DATA

; Similarly, draw the Y axis through data X = 0. The tick marks
; point left:
AXIS,0,0,0,YAX=0,/DATA
```

## Version History

Introduced: Original

## See Also

LABEL_DATE, PLOT

# BAR_PLOT

The BAR_PLOT procedure creates a bar graph. This routine is written in the IDL language. Its source code can be found in the file `bar_plot.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

BAR_PLOT, *Values* [, BACKGROUND=*color_index*] [, BARNAMES=*string_array*] [, BAROFFSET=*scalar*] [, BARSPACE=*scalar*] [, BARWIDTH=*value*] [, BASELINES=*vector*] [, BASERANGE=*scalar*{0.0 to 1.0}] [, COLORS=*vector*] [, /OUTLINE] [, /OVERPLOT] [, /ROTATE] [, TITLE=*string*] [, XTITLE=*string*] [, YTITLE=*string*]

## Arguments

### Values

A vector containing the values to be represented by the bars. Each element in *Values* corresponds to a single bar in the output.

## Keywords

### BACKGROUND

A scalar that specifies the color index to be used for the background color. By default, the normal IDL background color is used.

### BARNAMES

A string array, containing one string label per bar. If the bars are vertical, the labels are placed beneath them. If horizontal (rotated) bars are specified, the labels are placed to the left of the bars.

### BAROFFSET

A scalar that specifies the offset to be applied to the first bar, in units of “nominal bar width”. This keyword allows, for example, different groups of bars to be overplotted on the same graph. If not specified, the default offset is equal to BARSPACE.

## BARSPACE

A scalar that specifies, in units of “nominal bar width”, the spacing between bars. For example, if BARSPACE is 1.0, then all bars will have one bar-width of space between them. If not specified, the bars are spaced apart by 20% of the bar width.

## BARWIDTH

A floating-point value that specifies the width of the bars in units of “nominal bar width”. The nominal bar width is computed so that all the bars (and the space between them, set by default to 20% of the width of the bars) will fill the available space (optionally controlled with the BASERANGE keyword).

## BASELINES

A vector, the same size as *Values*, that contains the base value associated with each bar. If not specified, a base value of zero is used for all bars.

## BASERANGE

A floating-point scalar in the range 0.0 to 1.0, that determines the fraction of the total available plotting area (in the direction perpendicular to the bars) to be used. If not specified, the full available area is used.

## COLORS

A vector, the same size as *Values*, containing the color index to be used for each bar. If not specified, the colors are selected based on spacing the color indices as widely as possible within the range of available colors (specified by !D.N_COLORS).

## OUTLINE

If set, this keyword specifies that an outline should be drawn around each bar.

## OVERPLOT

If set, this keyword specifies that the bar plot should be overplotted on an existing graph.

## ROTATE

If set, this keyword indicates that horizontal rather than vertical bars should be drawn. The bases of horizontal bars are on the left, “Y” axis and the bars extend to the right.

### TITLE

A string containing the main title for the bar plot.

### XTITLE

A string containing the title for the X axis.

### YTITLE

A string containing the title for the Y axis.

## Examples

By using the overplotting capability, it is relatively easy to create stacked bar charts, or different groups of bars on the same graph.

The following example creates a two-dimensional array of 5 columns and 8 rows, and creates a plot with 5 bars, each of which is a “stacked” composite of 8 sections.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Load color table:
LOADCT, 5

;Make axes black:
!P.COLOR=0

;Create 5-column by 8-row array:
array = INDGEN(5,8)

;Create a 2D array, equal in size to array, that has identical
;color index values across each row to ensure that the same item is
;represented by the same color in all bars:
colors = INTARR(5,8)
FOR I = 0, 7 DO colors[*,I]=(20*I)+20

;With arrays and colors defined, create stacked bars (note that
;the number of rows and columns is arbitrary):

;Scale range to accommodate the total bar lengths:
!Y.RANGE = [0, MAX(array)]
nrows = N_ELEMENTS(array[0,*])
base = INTARR(nrows)
FOR I = 0, nrows-1 DO BEGIN
   BAR_PLOT, array[*,I], COLORS=colors[*,I], BACKGROUND=255, $
      BASELINES=base, BARWIDTH=0.75, BARSPACE=0.25, OVER=(I GT 0)
```

```
   base = array[*,I]
ENDFOR

;To plot each row of array as a clustered group of bars within the
;same graph, use the BASERANGE keyword to restrict the available
;plotting region for each set of bars, where NCOLS is the number of
;columns in array. (In this example, each group uses the same set
;of colors, but this could easily be changed.):

ncols = N_ELEMENTS(array[*,0])
FOR I = 0, nrows-1 DO BEGIN
   BAR_PLOT, array[*,I], COLORS=colors[*,I], BACKGROUND=255, $
      BARWIDTH=0.75, BARSPACE=0.25, BAROFFSET=I*(1.4*ncols), $
      OVER=(I GT 0), BASERANGE=0.12
ENDFOR
```

## Version History

Introduced: Pre 4.0

## See Also

PLOT, PSYM Graphics Keyword

# BEGIN...END

The BEGIN...END statement defines a block of statements. A block of statements is a group of statements that is treated as a single statement. Blocks are necessary when more than one statement is the subject of a conditional or repetitive statement. For more information on using BEGIN...END and other IDL program control statements, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

BEGIN

*statements*

END | ENDIF | ENDELSE | ENDFOR | ENDREP | ENDWHILE

The END identifier used to terminate the block should correspond to the type of statement in which BEGIN is used. The following table lists the correct END identifiers to use with each type of statement.

| Statement | END Identifier | Example |
|---|---|---|
| ELSE BEGIN | ENDELSE | `IF (0) THEN A=1 ELSE BEGIN`<br>`  A=2`<br>`ENDELSE` |
| FOR *variable=init*, *limit* DO BEGIN | ENDFOR | `FOR i=1,5 DO BEGIN`<br>`  PRINT, array[i]`<br>`ENDFOR` |
| IF *expression* THEN BEGIN | ENDIF | `IF (0) THEN BEGIN`<br>`  A=1`<br>`ENDIF` |
| REPEAT BEGIN | ENDREP | `REPEAT BEGIN`<br>`  A = A * 2`<br>`ENDREP UNTIL A GT B` |
| WHILE *expression* DO BEGIN | ENDWHILE | `WHILE ~ EOF(1) DO BEGIN`<br>`  READF, 1, A, B, C`<br>`ENDWHILE` |
| *LABEL*: BEGIN | END | `LABEL1: BEGIN`<br>`  PRINT, A`<br>`END` |
| *case_expression*: BEGIN | END | `CASE name OF`<br>`'Moe': BEGIN`<br>`  PRINT, 'Stooge'`<br>`  END`<br>`ENDCASE` |
| *switch_expression*: BEGIN | END | `SWITCH name OF`<br>`'Moe': BEGIN`<br>`  PRINT, 'Stooge'`<br>`  END`<br>`ENDSWITCH` |

*Table 3: Types of END Identifiers*

**Note**

CASE and SWITCH also have their own END identifiers. CASE should always be ended with ENDCASE, and SWITCH should always be ended with ENDSWITCH.

## Version History

Introduced: Original

# BESELI

The BESELI function returns the I Bessel function of order *N* for the argument *X*. The BESELI function is adapted from “SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers”, W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

## Syntax

*Result* = BESELI(*X*, *N* [, /DOUBLE] [, ITER=*variable*])

## Return Value

If both arguments are scalars, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *X* and *N*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the smallest input array.

**Note**

If the function does not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN.

## Arguments

### X

A scalar or array specifying the values for which the Bessel function is required. Values for *X* must be in the range 0 to 709.

### N

A scalar or array specifying the order of the Bessel function to calculate. Values for *N* should be greater than or equal to 0, and can be either integers or real numbers.

## Keywords

### DOUBLE

Set this keyword equal to one to return a double-precision result, or to zero to return a single-precision result. The computations will always be done using double precision.

The default is to return a single-precision result if both inputs are single precision, and to return a double-precision result in all other cases.

### ITER

Set this keyword equal to a named variable that will contain the number of iterations performed. If the routine converged, the stored value will be equal to the order *N*. If *X* or *N* are arrays, ITER will contain a scalar representing the maximum number of iterations.

**Note**

If the routine did not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN, and ITER will contain the largest order that *would have converged* for that *X* value.

## Examples

The following example plots the I and K Bessel functions for orders 0, 1 and 2:

```
X = FINDGEN(40)/10

;Plot I and K Bessel Functions:
PLOT, X, BESELI(X, 0), MAX_VALUE=4, $
   TITLE = 'I and K Bessel Functions'
OPLOT, X, BESELI(X, 1)
OPLOT, X, BESELI(X, 2)
OPLOT, X, BESELK(X, 0), LINESTYLE=2
OPLOT, X, BESELK(X, 1), LINESTYLE=2
OPLOT, X, BESELK(X, 2), LINESTYLE=2

;Annotate plot:
xcoords = [.18, .45, .95, 1.4, 1.8, 2.4]
ycoords = [2.1, 2.1,  2.1, 1.8, 1.6, 1.4]
labels = ['!8K!X!D0','!8K!X!D1','!8K!X!D2','!8I!X!D0',
   '!8I!X!D1','!8I!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

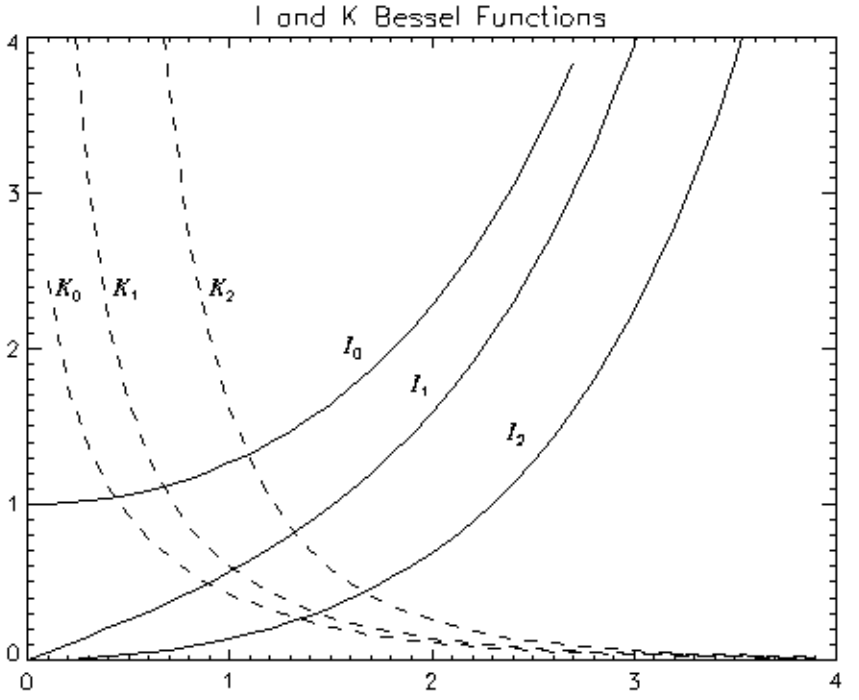



*Figure 1: I and K Bessel Functions.*

For an example calculating the accuracy of the Bessel function, see “Example 2” for the BESELJ routine.

## Version History

Introduced: Original

DOUBLE and ITER keywords: 5.6

## See Also

BESELJ, BESELK, BESELY

# BESELJ

The BESELJ function returns the J Bessel function of order *N* for the argument *X*. The BESELJ function is adapted from “SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers”, W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

## Syntax

*Result* = BESELJ(*X*, *N* [, /DOUBLE] [, ITER=*variable*])

## Return Value

If both arguments are scalars, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *X* and *N*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the smallest input array.

If *X* is double-precision, the result is double-precision, otherwise the result is single-precision.

**Note**

If the function does not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN.

## Arguments

### X

A scalar or array specifying the values for which the Bessel function is required. Values for *X* must be in the range 0 to $10^8$.

### N

A scalar or array specifying the order of the Bessel function to calculate. Values for *N* should be greater than or equal to 0, and can be either integers or real numbers.

# Keywords

## DOUBLE

Set this keyword equal to one to return a double-precision result, or to zero to return a single-precision result. The computations will always be done using double precision. The default is to return a single-precision result if both inputs are single precision, and to return a double-precision result in all other cases.

## ITER

Set this keyword equal to a named variable that will contain the number of iterations performed. If the routine converged, the stored value will be equal to the order *N*. If *X* or *N* are arrays, ITER will contain a scalar representing the maximum number of iterations.

**Note**

If the routine did not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN, and ITER will contain the largest order that *would have converged* for that *X* value.

# Examples

## Example 1

The following example plots the J and Y Bessel functions for orders 0, 1, and 2:

```
X = FINDGEN(100)/10

;Plot J and Y Bessel Functions:
PLOT, X, BESELJ(X, 0), TITLE = 'J and Y Bessel Functions'
OPLOT, X, BESELJ(X, 1)
OPLOT, X, BESELJ(X, 2)
OPLOT, X, BESELY(X, 0), LINESTYLE=2
OPLOT, X, BESELY(X, 1), LINESTYLE=2
OPLOT, X, BESELY(X, 2), LINESTYLE=2

;Annotate plot:
xcoords = [1, 1.66, 3, .7, 1.7, 2.65]
ycoords = [.8, .62,.52, -.42, -.42, -.42]
labels = ['!8J!X!D0','!8J!X!D1','!8J!X!D2','!8Y!X!D0',
   '!8Y!X!D1','!8Y!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

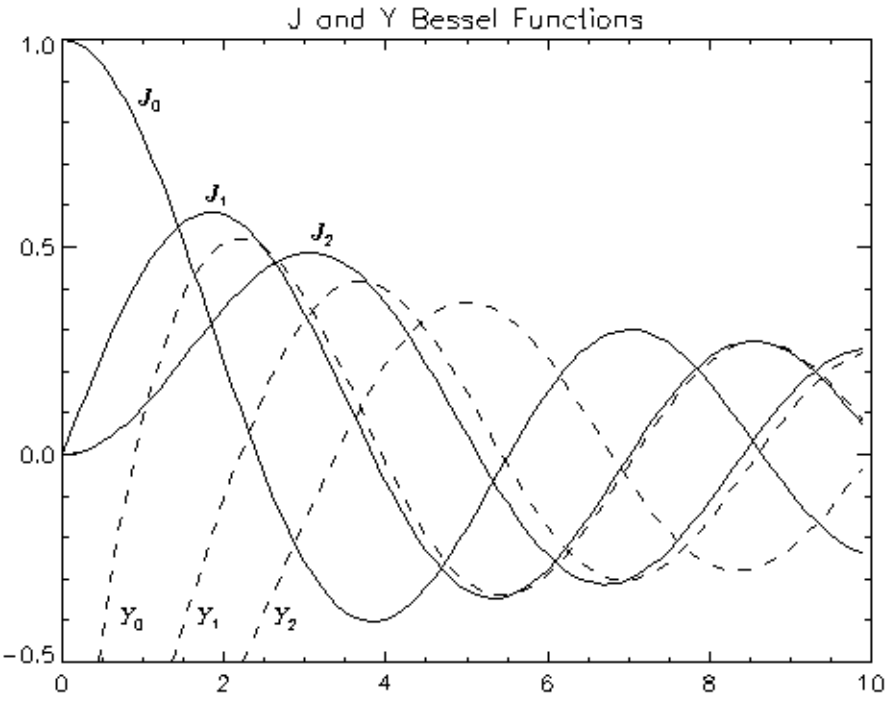



*Figure 2: The J and Y Bessel Functions.*

## Example 2

Different order Bessel functions have *recurrence relationships* to each other. These relationships can be used to determine how accurately IDL is computing the Bessel functions. In the following example, the recurrence relationships for each order are set to zero and the left side of the equations are plotted. The plots show how close the left side of the equations are to zero, and therefore, how accurate IDL's computation of the Bessel functions are.

This example uses the following recurrence relationship:

$$x(J_{n-1}(x) + J_{n+1}(x)) - 2nJ_n(x) = 0$$

where $J(x)$ is the Bessel function of the first kind of order $n$ –1, $n$, or $n$ + 1. (Similar recurrence relationships could be used for the other forms of the Bessel function.) Results are plotted for $n$ equal to 1 through 6.

```
PRO AnalyzingBESELJ

; Derive x values.
x = (DINDGEN(1000) + 1.)/100.

; Initialize display window.
WINDOW, 0, TITLE = 'Bessel Functions'

; Display the first 8 orders of the Bessel function of
; the first kind.
PLOT, x, BESELJ(x, 0), /XSTYLE, /YSTYLE, $
   XTITLE = 'x', YTITLE = 'f(x)', $
   TITLE = 'Bessel Functions of the First Kind'
OPLOT, x, BESELJ(x, 1), LINESTYLE = 1
OPLOT, x, BESELJ(x, 2), LINESTYLE = 2
OPLOT, x, BESELJ(x, 3), LINESTYLE = 3
OPLOT, x, BESELJ(x, 4), LINESTYLE = 4
OPLOT, x, BESELJ(x, 5), LINESTYLE = 5
OPLOT, x, BESELJ(x, 6), LINESTYLE = 0
OPLOT, x, BESELJ(x, 7), LINESTYLE = 1

; Initialize display window for recurrence relations.
WINDOW, 1, XSIZE = 896, YSIZE = 512, $
   TITLE = 'Testing the Recurrence Relations'
!P.MULTI = [0, 2, 3, 0, 0]

; Initialize title variable.
nString = ['0', '1', '2', '3', '4', '5', '6', '7']

; Display recurrence relationships for order 1 to 6.
; NOTE:  the results of these relationships should be
; very close to zero.
FOR n = 1, 6 DO BEGIN
   equation = x*(BESELJ(x, (n - 1)) + $
      BESELJ(x, (n + 1))) - 2.*FLOAT(n)*BESELJ(x, n)
   PLOT, x, equation, /XSTYLE, /YSTYLE, CHARSIZE = 1.5, $
      TITLE = 'n = ' + nString[n] + ':  Orders of ' + $
      nString[n - 1] + ', ' + nString[n] + ', and ' + $
      nString[n + 1]
   PRINT, 'n = ' + nString[n] + ':  '
   PRINT, 'minimum = ', MIN(equation)
   PRINT, 'maximum = ', MAX(equation)
ENDFOR

; Return display window back to its default setting, one
```

```
; display per window.
!P.MULTI = 0

END
```

The results for this example are shown in the following figure.

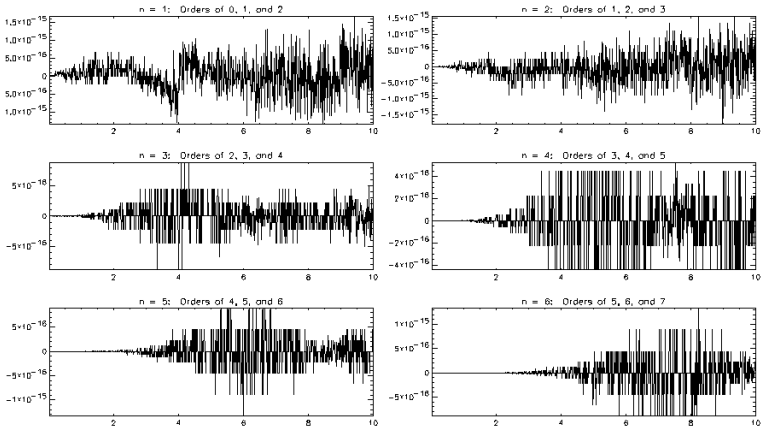



*Figure 3: Recurrence Relationship for J(x)*

All of these plots show that this Bessel function is calculated accurately within machine tolerance.

## Version History

Introduced: Original

DOUBLE and ITER keywords: 5.6

## See Also

BESELI, BESELK, BESELY

# BESELK

The BESELK function returns the K Bessel function of order *N* for the argument *X*. The BESELK function is adapted from “SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers”, W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

## Syntax

*Result* = BESELK( *X*, *N* [, /DOUBLE] [, ITER=*variable*])

## Return Value

If both arguments are scalars, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *X* and *N*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the smallest input array.

If *X* is double-precision, the result is double-precision, otherwise the result is single-precision.

**Note**

If the function does not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN.

## Arguments

### X

A scalar or array specifying the values for which the Bessel function is required. Values for *X* must be greater than or equal to zero.

### N

A scalar or array specifying the order of the Bessel function to calculate. Values for *N* should be greater than or equal to 0, and can be either integers or real numbers.

# Keywords

## DOUBLE

Set this keyword equal to one to return a double-precision result, or to zero to return a single-precision result. The computations will always be done using double precision. The default is to return a single-precision result if both inputs are single precision, and to return a double-precision result in all other cases.

## ITER

Set this keyword equal to a named variable that will contain the number of iterations performed. If the routine converged, the stored value will be equal to the order *N*. If *X* or *N* are arrays, ITER will contain a scalar representing the maximum number of iterations.

**Note**

If the routine did not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN, and ITER will contain the largest order that *would have converged* for that *X* value.

# Examples

The following example plots the I and K Bessel functions for orders 0, 1 and 2:

```
X = FINDGEN(40)/10

;Plot I and K Bessel Functions:
PLOT, X, BESELI(X, 0), MAX_VALUE=4, $
   TITLE = 'I and K Bessel Functions'
OPLOT, X, BESELI(X, 1)
OPLOT, X, BESELI(X, 2)
OPLOT, X, BESELK(X, 0), LINESTYLE=2
OPLOT, X, BESELK(X, 1), LINESTYLE=2
OPLOT, X, BESELK(X, 2), LINESTYLE=2

;Annotate plot:
xcoords = [.18, .45, .95, 1.4, 1.8, 2.4]
ycoords = [2.1, 2.1,  2.1, 1.8, 1.6, 1.4]
labels = ['!8K!X!D0','!8K!X!D1','!8K!X!D2','!8I!X!D0',
   '!8I!X!D1','!8I!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

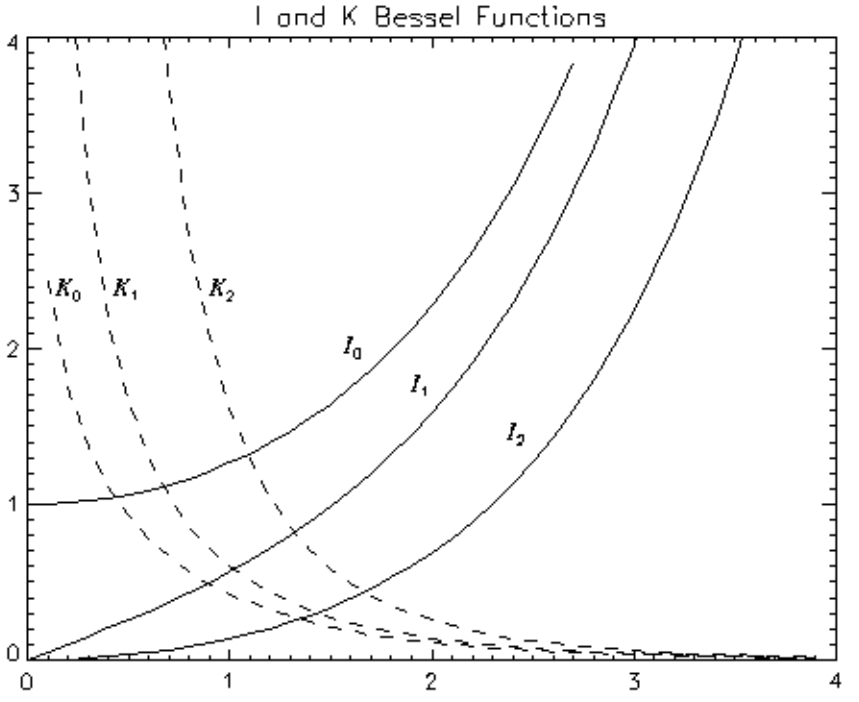



*Figure 4: I and K Bessel Functions.*

For an example calculating the accuracy of the Bessel function, see “Example 2” for the BESELJ routine.

## Version History

Introduced: 5.4

DOUBLE and ITER keywords: 5.6

## See Also

BESELI, BESELJ, BESELY

# BESELY

The BESELY function returns the Y Bessel function of order *N* for the argument *X*. The BESELY function is adapted from “SPECFUN - A Portable FORTRAN Package of Special Functions and Test Drivers”, W. J. Cody, Algorithm 715, *ACM Transactions on Mathematical Software*, Vol 19, No. 1, March 1993.

## Syntax

*Result* = BESELY(*X*, *N* [, /DOUBLE] [, ITER=*variable*])

## Return Value

If both arguments are scalars, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *X* and *N*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the smallest input array.

If *X* is double-precision, the result is double-precision, otherwise the result is single-precision.

**Note**

If the function does not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN.

## Arguments

### X

A scalar or array specifying the values for which the Bessel function is required. Values for *X* must be in the range 0 to $10^8$.

### N

A scalar or array specifying the order of the Bessel function to calculate. Values for *N* should be greater than or equal to 0, and can be either integers or real numbers.

# Keywords

## DOUBLE

Set this keyword equal to one to return a double-precision result, or to zero to return a single-precision result. The computations will always be done using double precision. The default is to return a single-precision result if both inputs are single precision, and to return a double-precision result in all other cases.

## ITER

Set this keyword equal to a named variable that will contain the number of iterations performed. If the routine converged, the stored value will be equal to the order *N*. If *X* or *N* are arrays, ITER will contain a scalar representing the maximum number of iterations.

**Note**

If the routine did not converge for an element of *X*, the corresponding element of the *Result* array will be set to the IEEE floating-point value NaN, and ITER will contain the largest order that *would have converged* for that *X* value.

# Examples

The following example plots the J and Y Bessel functions for orders 0, 1, and 2:

```
X = FINDGEN(100)/10

;Plot J and Y Bessel Functions:
PLOT, X, BESELJ(X, 0), TITLE = 'J and Y Bessel Functions'
OPLOT, X, BESELJ(X, 1)
OPLOT, X, BESELJ(X, 2)
OPLOT, X, BESELY(X, 0), LINESTYLE=2
OPLOT, X, BESELY(X, 1), LINESTYLE=2
OPLOT, X, BESELY(X, 2), LINESTYLE=2

;Annotate plot:
xcoords = [1, 1.66, 3, .7, 1.7, 2.65]
ycoords = [.8, .62,.52, -.42, -.42, -.42]
labels = ['!8J!X!D0','!8J!X!D1','!8J!X!D2','!8Y!X!D0',
   '!8Y!X!D1','!8Y!X!D2']
XYOUTS, xcoords, ycoords, labels, /DATA
```

This results in the following plot:

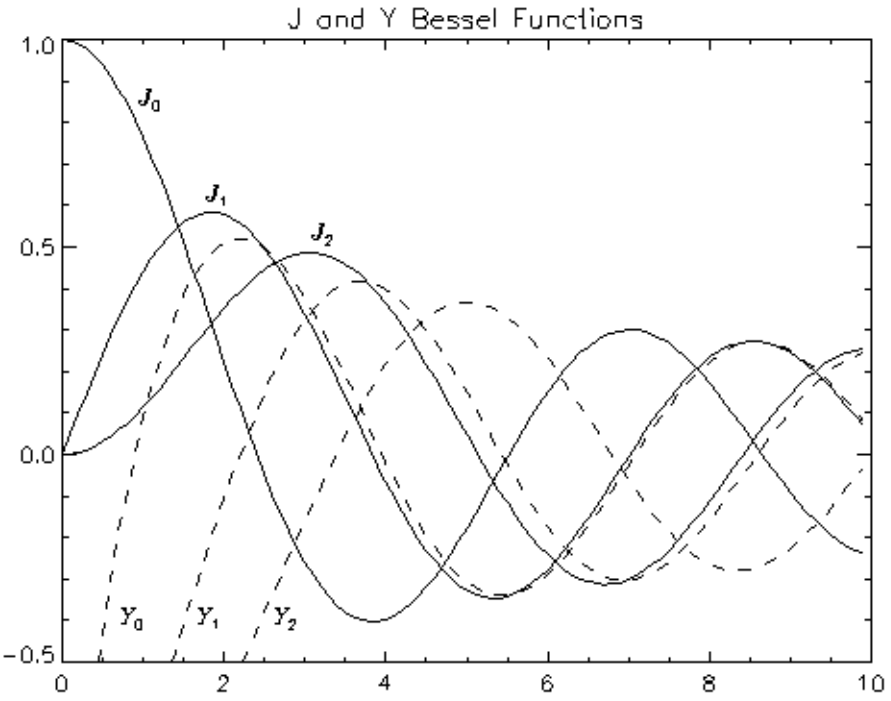



*Figure 5: The J and Y Bessel Functions.*

For an example calculating the accuracy of the Bessel function, see “Example 2” for the BESELJ routine.

## Version History

Introduced: Original

DOUBLE and ITER keywords: 5.6

## See Also

BESELI, BESELJ, BESELK

# BETA

The BETA function returns the value of the beta function B(*Z*, *W*). This routine is written in the IDL language. Its source code can be found in the file `beta.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = BETA( *Z*, *W* [, /DOUBLE] )

## Return Value

If both arguments are scalar, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *Z* and *W*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If both of the arguments are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

## Arguments

### Z, W

The point at which the beta function is to be evaluated. *Z* and *W* can be scalar or array. *Z* or *W* may be complex.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established

by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

To evaluate the beta function at the point (1.0, 1.1) and print the result:

```
PRINT, BETA(1.0, 1.1)
```

IDL prints:

```
0.909091
```

The exact solution is:

((1.00 * .95135077) / (1.10 * .95135077)) = 0.909091.

## Version History

Introduced: 4.0.1

*Z* and *W* arguments accept complex input: 5.6

## See Also

GAMMA, IBETA, IGAMMA, LNGAMMA

# BILINEAR

The BILINEAR function uses a bilinear interpolation algorithm to compute the value of a data array at each of a set of subscript values.

This routine is written in the IDL language. Its source code can be found in the file `bilinear.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = BILINEAR(*P, IX, JY*)

## Return Value

This function returns a two-dimensional interpolated array of the same type as the input array.

## Arguments

### P

A two-dimensional data array.

### IX and JY

Arrays containing the X and Y "virtual subscripts" of `P` for which to interpolate values. `IX` and `JY` can be either of the following:

- One-dimensional, *n*-element floating-point arrays of subscripts to look up in `P`. One-dimensional arrays will be converted to two-dimensional arrays in such a way that `IX` contains *n* identical rows and `JY` contains *n* identical columns.
- Two-dimensional, *n*-element floating-point arrays that uniquely specify the X subscripts (the `IX` array) and the Y subscripts (the `JY` array) of the points to be computed from the input array `P`.

In either case, `IX` must satisfy the expressions

0 <= MIN(IX) < N0  and 0 < MAX(IX) <= N0

where N0 is the total number of columns in the array `P`. `JY` must satisfy the expressions

0 <= MIN(JY) < M0  and 0 < MAX(JY) <= M0

where M0 is the total number of rows in the array P.

It is better to use two-dimensional arrays for IX and JY because the algorithm is somewhat faster. If IX and JY are specified as one-dimensional, the returned two-dimensional arrays IX and JY can be re-used on subsequent calls to take advantage of the faster 2D algorithm.

## Keywords

None.

## Examples

Create a 3 x 3 floating point array *P*:

```
P = FINDGEN(3,3)
```

Suppose we wish to find the value of a point half way between the first and second elements of the first row of P. Create the subscript arrays IX and JY:

```
IX = 0.5 ;Define the X subscript.
JY = 0.0 ;Define the Y subscript.
Z = BILINEAR(P, IX, JY) ;Interpolate.
PRINT, Z ;Print the value at the point IX,JY within P.
```

IDL prints:

```
0.500000
```

Suppose we wish to find the values of a 2 x 2 array of points in P. Create the subscript arrays IX and JY:

```
IX = [[0.5, 1.9], [1.1, 2.2]] ;Define the X subscripts.
JY = [[0.1, 0.9], [1.2, 1.8]] ;Define the Y subscripts.
Z = BILINEAR(P, IX, JY) ;Interpolate.
PRINT, Z ;Print the array of values.
```

IDL prints:

```
0.800000    4.60000
4.70000     7.40000
```

## Version History

Introduced: Original

## See Also

INTERPOL, INTERPOLATE, KRIG2D

# BIN_DATE

The BIN_DATE function converts a standard form ASCII date/time string to a binary string.

This routine is written in the IDL language. Its source code can be found in the file `bin_date.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = BIN_DATE(*Ascii_Time*)

## Return Value

The function returns a six-element integer array where:

- Element 0 is the year (e.g., 1994)
- Element 1 is the month (1-12)
- Element 2 is the day (1-31)
- Element 3 is the hour (0-23)
- Element 4 is minutes (0-59)
- Element 5 is seconds (0-59)

## Arguments

### Ascii_Time

A string containing the date/time to convert in standard ASCII format. If this argument is omitted, the current date/time is used. Standard form is a 24 character string:

```
DOW MON DD HH:MM:SS YYYY
```

where DOW is the day of the week, MON is the month, DD is the day of month, HH:MM:SS is the time in hours, minutes, second, and YYYY is the year.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

CALDAT, JULDAY, SYSTIME

# BINARY_TEMPLATE

The BINARY_TEMPLATE function presents a graphical user interface which allows the user to interactively generate a template structure for use with READ_BINARY.

The graphical user interface allows the user to define one or more fields in the binary file. The file may be big, little, or native byte ordering.

Individual fields can be edited by the user to define the dimensionality and type of data to be read. Where necessary, fields can be defined in terms of other previously defined fields using IDL expressions. Fields can also be designated as “Verify”. When a file is read using a template with “Verify” fields, those fields will be checked against a user defined value supplied via the template.

**Note**

Greater than (“>”) and less than (“<“) symbols can appear in the “New Field” and the “Modify Field” dialogs where the offset value is displayed. The presence of either symbol indicates that the supplied offset value is “relative” from the end of the previous field or from the initial position in the file. Greater than means offset forward. Less than means offset backward. “>0” and “<0” are synonymous and mean “offset zero bytes”. You can delete these special symbols (thereby indicating that their corresponding offset value is not “relative”) by typing over them in the “New Field” or “Modify Field” dialogs.

## Syntax

*Result* = BINARY_TEMPLATE ( [*Filename*] [, CANCEL=*variable*] [, GROUP=*widget_id*] [, N_ROWS=*rows*] [, TEMPLATE=*variable*] )

## Return Value

This function returns an anonymous structure that contains the template. If the user cancels out of the graphical user interface and no initial template was supplied, it returns zero.

## Arguments

### Filename

A scalar string containing the name of a binary file which may be used to test the template. As the user interacts with the BINARY_TEMPLATE graphical user

interface, the user's input will be tested for correctness against the binary data in the file. If *filename* is not specified, a dialog allows the user to choose the file.

# Keywords

## CANCEL

Set this keyword to a named variable that will contain the byte value 1 if the user clicked the "Cancel" button, or 0 otherwise.

## GROUP

The widget ID of an existing widget that serves as "group leader" for the BINARY_TEMPLATE interface. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

## N_ROWS

Set this keyword to the number of rows to be visible in the BINARY_TEMPLATE's table of fields.

**Note**

The N_ROWS keyword is analogous to the WIDGET_TABLE and the Y_SCROLL_SIZE keywords.

## TEMPLATE

Set this keyword to structure variable containing an initial template (usually from a previous call to BINARY_TEMPLATE). This template structure will be used to fill in the initial fields in the new BINARY_TEMPLATE. If TEMPLATE is specified and the user cancels out of the dialog, the specified template will be returned as the Result.

# The BINARY_TEMPLATE Interface

When the BINARY_TEMPLATE function is invoked, the following dialog is displayed:

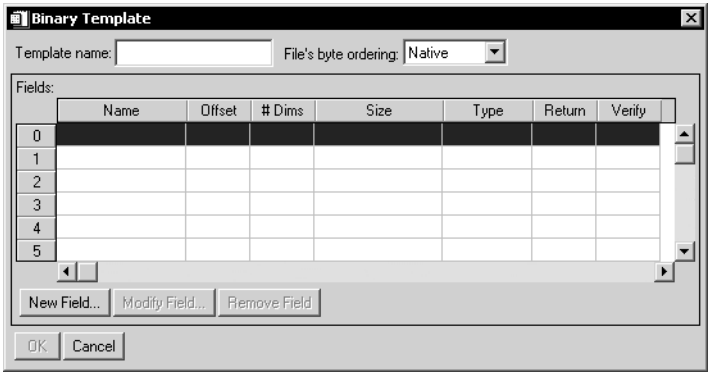



*Figure 3-5: Binary Template*

The **Template Name** is optional, and can be any string.

The byte order in the file is selected using the using the **File's byte ordering:** pull-down menu. The choices are:

- **Native** — The type of storage method that is native to the machine you are currently running. Little Endian for Intel microprocessor-based machines and Big Endian for Motorola microprocessor-based machines. No byte swapping will be performed.
- **Little Endian** — A method of storing numbers so that the least significant byte appears first in the number. For example, given the hexadecimal number A02B, the little endian method specifies the number to be stored as 2BA0. Specify this if the original file was created on a machine that uses an Intel microprocessor.
- **Big Endian** — A method of storing numbers so that the most significant byte appears first in the number. For example, given the hexadecimal number A02B, the big endian method specifies the number to be stored as A02B. Specify this if the original file was created on a machine that uses a Motorola microprocessor.

Fields are read in the order in which they are listed in the main dialog for BINARY_TEMPLATE, with offsets being added to the current file position pointer before each field is read. If a field has already been defined, clicking in the **Return** column will toggle the value of the field between Yes and No. Fields that are not marked for return can be used for calculations by other fields in the template. At least one field must be marked Yes for return in order for the BINARY_TEMPLATE function to return a template. Click **New Field...** to enter the description of a new template field. The New Field dialog appears:

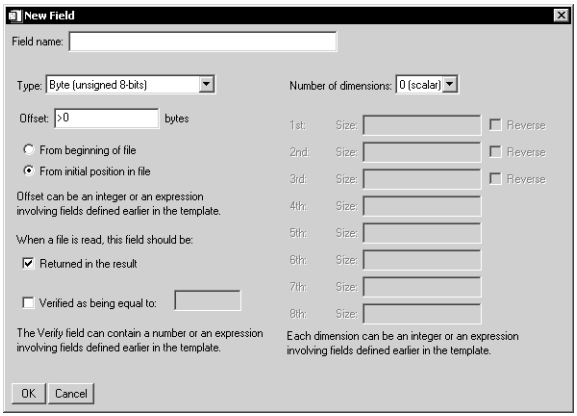



*Figure 3-6: Binary Template - New Field*

The **Field Name** can be any string.

The **Type** of each Template-specified field is selected from a droplist that offers the following IDL types: byte, integer, long, float, double, complex, dcomplex, uint, ulong, long64 and ulong64. Strings are read as an array of bytes for later conversion to type STRING.

**Offsets** can be specified using integer values, field names, or any valid IDL expression.

- An absolute integer offset specifies a fixed location (in bytes) from the beginning of the file (or the initial file position for an externally opened file).
- A relative integer offset specifies a position relative to the current file position pointer after the previous field (if any) is read. Relative offsets are shown in the BINARY_TEMPLATE user interface with a preceding > or < character, to indicate a positive (>) or negative (<) byte offset.

- Expressions can include the names of fields that will be read *before* the current field — that is, the field number of the referenced field must be lower than the field number of the field being defined.

The **Verify** field can contain an integer, field name, or any valid IDL expression. Only scalar fields can be verified. READ_BINARY reports an error if a verification fails.

The **Number of Dimensions** of a field can be set via a droplist of values 0 (scalar) to 8 (which is the maximum number of dimensions that an IDL variable can have.) The size of each dimension can be an integer, field name, or any valid IDL expression. Any of the first three dimensions of array data can also be specified to be reversed in order.

**Note**

If BINARY_TEMPLATE is called by a program that is running in the IDL Virtual Machine, the **Offsets**, **Verify,** and **Size** fields can contain integers or field names, but *not* an IDL expression.

Click **OK** to create the new field definition, and repeat to define all necessary fields.

The BINARY_TEMPLATE function returns a structure variable containing the template. The template variable can be saved and used as the value of the TEMPLATE keyword to the READ_BINARY function:

```
template = BINARY_TEMPLATE(file.dat)
Result = READ_BINARY('file.dat', TEMPLATE=template)
```

where file.dat is a binary data file to be read. The template variable can also be reused as the value of the TEMPLATE keyword to BINARY_TEMPLATE.

## Version History

Introduced: 5.3

## See Also

READ_BINARY, ASCII_TEMPLATE

# BINDGEN

The BINDGEN function creates a byte array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = BINDGEN($D_1$ [, ...,$D_8$])

## Return Value

This function returns a byte array with the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments or array elements are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create a four-element by four-element byte array, and store the result in the variable A, enter:

```
A = BINDGEN(4,4)
```

Each element in A holds the value of its one-dimensional subscript. That is, if you enter the command:

```
PRINT, A
```

IDL prints the result:

```
      0   1   2   3
      4   5   6   7
      8   9  10  11
     12  13  14  15
```

## Version History

Introduced: Original

## See Also

CINDGEN, DCINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# BINOMIAL

The BINOMIAL function computes the probability that in a cumulative binomial (Bernoulli) distribution, a random variable *X* is greater than or equal to a user-specified value *V*, given *N* independent performances and a probability of occurrence or success *P* in a single performance:

$$\text{Probability}(X \geq V) = \sum_{x = V}^{N} \frac{N!}{x!(N-x)!} P^{x} (1-P)^{(N-x)}$$

This routine is written in the IDL language. Its source code can be found in the file `binomial.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = BINOMIAL(*V*, *N*, *P* [, /DOUBLE] [, /GAUSSIAN] )

## Return Value

This function returns a single- or double-precision floating point scalar or array that contains the value of the probability.

## Arguments

### V

A non-negative integer specifying the minimum number of times the event occurs in *N* independent performances.

### N

A non-negative integer specifying the number of performances.

### P

A non-negative single- or double-precision floating-point scalar or array, in the interval [0.0, 1.0], that specifies the probability of occurrence or success of a single independent performance.

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## GAUSSIAN

Set this keyword to use the Gaussian approximation, by using the normalized variable $Z = (V - NP)/\mathrm{SQRT}(NP(1 - P))$.

**Note**

The Gaussian approximation is useful when $N$ is large and neither $P$ nor $(1–P)$ is close to zero, where the binomial summation may overflow. If GAUSSIAN is not explicitly set, and the binomial summation overflows, then BINOMIAL will automatically switch to using the Gaussian approximation.

# Examples

Compute the probability of obtaining at least two 6s in rolling a die four times. The result should be 0.131944.

```
result = BINOMIAL(2, 4, 1.0/6.0)
```

Compute the probability of obtaining exactly two 6s in rolling a die four times. The result should be 0.115741.

```
result = BINOMIAL(2, 4, 1./6.) - BINOMIAL(3, 4, 1./6.)
```

Compute the probability of obtaining three or fewer 6s in rolling a die four times. The result should be 0.999228.

```
result = BINOMIAL(0, 4, 1./6.) - BINOMIAL(4, 4, 1./6.)
```

# Version History

Introduced: Pre 4.0

# See Also

CHISQR_PDF, F_PDF, GAUSS_PDF, T_PDF

# BLAS_AXPY

The BLAS_AXPY procedure updates an existing array by adding a multiple of another array. It can also be used to update one or more one-dimensional subvectors of an array according to the following vector operation:

$$Y = aX + Y$$

where a is a scale factor and X is an input vector.

BLAS_AXPY can be faster and use less memory than the usual IDL array notation (e.g. `Y=Y+A*X`) for updating existing arrays.

**Note**

BLAS_AXPY is much faster when operating on entire arrays and rows, than when used on columns or higher dimensions.

## Syntax

BLAS_AXPY, *Y*, *A*, *X* [, *D1*, *Loc1* [, *D2*, *Range*]]

## Arguments

### Y

The array to be updated. *Y* can be of any numeric type. BLAS_AXPY does not change the size and type of *Y*.

### A

The scaling factor to be multiplied with *X*. *A* may be any scalar or one-element array that IDL can convert to the type of *X*. BLAS_AXPY does not change *A*.

### X

The array to be scaled and added to array *Y*, or the vector to be scaled and added to subvectors of *Y*.

### D1

An optional parameter indicating which dimension of *Y* is to be updated.

### Loc1

A variable with the same number of elements as the number of dimensions of *Y*. The *Loc1* and *D1* arguments together determine which one-dimensional subvector (or subvectors, if *D1* and *Range* are provided) of *Y* is to be updated.

### D2

An optional parameter, indicating in which dimension of *Y* a group of one-dimensional subvectors are to be updated. *D2* should be different from *D1*.

### Range

A variable containing *D2* indices indicating where to put one-dimensional updates of *Y*.

## Keywords

None.

## Examples

The following examples show how to use the BLAS_AXPY procedure to add a multiple of an array, add a constant, and a group of subvectors.

```
seed = 5L
```

Create a multidimensional array:

```
A = FINDGEN(4, 5, 2)
```

Print A:

```
PRINT, A
```

IDL prints:

```
      0.000000      1.00000      2.00000      3.00000
       4.00000      5.00000      6.00000      7.00000
       8.00000      9.00000      10.0000      11.0000
       12.0000      13.0000      14.0000      15.0000
       16.0000      17.0000      18.0000      19.0000

       20.0000      21.0000      22.0000      23.0000
       24.0000      25.0000      26.0000      27.0000
       28.0000      29.0000      30.0000      31.0000
       32.0000      33.0000      34.0000      35.0000
       36.0000      37.0000      38.0000      39.0000
```

Create a random update:

```
B = RANDOMU(seed, 4, 5, 2)
```

Print B

```
PRINT, B
```

IDL prints:

```
      0.172861     0.680409     0.917078     0.917510
      0.766779     0.648501     0.334211     0.505953
      0.652182     0.158174     0.912751     0.257593
      0.810990     0.267308     0.188872     0.237323
      0.312265     0.551604     0.944883     0.673464

      0.613302    0.0874299     0.782052     0.374534
     0.0799968     0.581460     0.433864     0.459824
      0.634644     0.182057     0.832474     0.235194
      0.432587     0.453664     0.738821     0.355747
      0.933211     0.388659     0.269595     0.796325
```

Add a multiple of B to A (i.e., A = A + 4.5*B):

```
BLAS_AXPY, A, 4.5, B
```

Print A:

```
PRINT, A
```

IDL prints:

```
      0.777872      4.06184      6.12685      7.12880
       7.45051      7.91825      7.50395      9.27679
       10.9348      9.71178      14.1074      12.1592
       15.6495      14.2029      14.8499      16.0680
       17.4052      19.4822      22.2520      22.0306

       22.7599      21.3934      25.5192      24.6854
       24.3600      27.6166      27.9524      29.0692
       30.8559      29.8193      33.7461      32.0584
       33.9466      35.0415      37.3247      36.6009
       40.1994      38.7490      39.2132      42.5835
```

Add a constant to a subvector of A (i.e. A[*, 3, 1] = A[*, 3, 1] + 4.3):

```
BLAS_AXPY, A, 1., REPLICATE(4.3, 4), 1, [0, 3, 1]
```

Print A:

```
PRINT, A
```

IDL prints:

```
      0.777872      4.06184      6.12685      7.12880
```

```
      7.45051      7.91825      7.50395      9.27679
      10.9348      9.71178      14.1074      12.1592
      15.6495      14.2029      14.8499      16.0680
      17.4052      19.4822      22.2520      22.0306

      22.7599      21.3934      25.5192      24.6854
      24.3600      27.6166      27.9524      29.0692
      30.8559      29.8193      33.7461      32.0584
      38.2466      39.3415      41.6247      40.9009
      40.1994      38.7490      39.2132      42.5835
```

Create a vector update:

```
C = FINDGEN(5)
```

Print C:

```
PRINT, C
```

IDL prints:

```
      0.000000      1.00000      2.00000      3.00000      4.00000
```

Add C to a group of subvectors of A (i.e. FOR i = 0, 1 DO A[1, *, i] = A[1, *, i] + C):

```
BLAS_AXPY, A, 1., C, 2, [1, 0, 0], 3, LINDGEN(2)
```

Print A:

```
PRINT, A
```

IDL prints:

```
      0.777872      4.06184      6.12685      7.12880
       7.45051      8.91825      7.50395      9.27679
       10.9348      11.7118      14.1074      12.1592
       15.6495      17.2029      14.8499      16.0680
       17.4052      23.4822      22.2520      22.0306

       22.7599      21.3934      25.5192      24.6854
       24.3600      28.6166      27.9524      29.0692
       30.8559      31.8193      33.7461      32.0584
       38.2466      42.3415      41.6247      40.9009
       40.1994      42.7490      39.2132      42.5835
```

## Version History

Introduced: 5.1

## See Also

REPLICATE_INPLACE

# BLK_CON

The BLK_CON function computes a “fast convolution” of a digital signal and an impulse-response sequence. It returns the filtered signal.

This routine is written in the IDL language. Its source code can be found in the file `blk_con.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = BLK_CON( *Filter*, *Signal* [, B_LENGTH=*scalar*] [, /DOUBLE] )

## Return Value

This function returns a vector with the same length as *Signal*. If either of the input arguments are double-precision or the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

## Arguments

### Filter

A *P*-element floating-point vector containing the impulse-response sequence of the digital filter.

### Signal

An *n*-element floating-point vector containing the discrete signal samples.

## Keywords

### B_LENGTH

A scalar specifying the *block length* of the subdivided signal segments. If this parameter is not specified, a near-optimal value is chosen by the algorithm based upon the length *P* of the impulse-response sequence. If *P* is a value less than 11 or greater than 377, then B_LENGTH must be specified.

B_LENGTH must be greater than the filter length, *P*, and less than the number of signal samples.

### DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

## Examples

```
; Create a filter of length P = 32:
filter = REPLICATE(1.0,32)   ;Set all points to 1.0
filter(2*INDGEN(16)) = 0.5   ;Set even points to 0.5

; Create a sampled signal with random noise:
signal = SIN((FINDGEN(1000)/35.0)^2.5)
noise = (RANDOMU(SEED,1000)-.5)/2.
signal = signal + noise

; Convolve the filter and signal using block convolution:
result = BLK_CON(filter, signal)
```

## Version History

Introduced: Pre 4.0

## See Also

CONVOL

# BOX_CURSOR

The BOX_CURSOR procedure emulates the operation of a variable-sized box cursor (also known as a “marquee” selector).

**Warning**

BOX_CURSOR does not function properly when used within a draw widget. See the BUTTON_EVENTS and MOTION_EVENTS keywords in WIDGET_DRAW.

This routine is written in the IDL language. Its source code can be found in the file `box_cursor.pro` in the `lib` subdirectory of the IDL distribution.

### Using BOX_CURSOR

Once the box cursor has been realized, hold down the left mouse button to move the box by dragging. Hold down the middle mouse button to resize the box by dragging. (The corner nearest the initial mouse position is moved.) Press the right mouse button to exit the procedure and return the current box parameters.

On machines with only two mouse buttons, hold down the left and right buttons simultaneously to resize the box.

## Syntax

BOX_CURSOR, [ *X0*, *Y0*, *NX*, *NY* [, /INIT] [, /FIXED_SIZE]] [, /MESSAGE]

## Arguments

### X0, Y0

Named variables that will contain the coordinates of the lower left corner of the box cursor.

### NX, NY

Named variables that will contain the width and height of the cursor, in pixels.

# Keywords

## INIT

If this keyword is set, the arguments *X0*, *Y0*, *NX*, and *NY* contain the initial position and size of the box.

## FIXED_SIZE

If this keyword is set, *NX* and *NY* contain the initial size of the box. This size may not be changed by the user.

## MESSAGE

If this keyword is set, IDL prints a message describing operation of the cursor.

# Version History

Introduced: Pre 4.0

# See Also

Routines: CURSOR

Keywords to "IDL Graphics Devices" on page 3781: CURSOR_CROSSHAIR, CURSOR_IMAGE, CURSOR_STANDARD, CURSOR_XY

# BREAK

The BREAK statement provides a convenient way to immediately exit from a loop (FOR, WHILE, REPEAT), CASE, or SWITCH statement without resorting to GOTO statements.

**Note**

BREAK is an IDL statement. For information on using statements, see Chapter 12, "Program Control" in the *Building IDL Applications* manual.

## Syntax

BREAK

## Examples

This example exits the enclosing WHILE loop when the value of i hits 5.

```
I = 0
WHILE (1) DO BEGIN
   i = i + 1
   IF (i eq 5) THEN BREAK
ENDWHILE
```

## Version History

Introduced: 5.4

# BREAKPOINT

The BREAKPOINT procedure allows you to insert and remove breakpoints in programs for debugging. A breakpoint causes program execution to stop after the designated statement is executed. Breakpoints are specified using the source file name and line number. For multiple-line statements (statements containing "$", the continuation character), specify the line number of the last line of the statement.

You can insert breakpoints in programs without editing the source file. Enter the following:

```
HELP, /BREAKPOINT
```

to display the breakpoint table which gives the index, module and source file locations of each breakpoint.

## Syntax

BREAKPOINT [, *File*], *Index* [, AFTER=*integer*] [, /CLEAR]
[, CONDITION='*expression*'] [, /DISABLE] [, /ENABLE] [, /ON_RECOMPILE]
[, /ONCE] [, /SET]

## Arguments

### File

An optional string argument that contains the name of the source file. Note that if *File* is not in the current directory, the full path name must be specified even if *File* is in one of the directories specified by !PATH.

### Index

The line number at which to clear or set a breakpoint.

## Keywords

### AFTER

Set this keyword equal to an integer *n*. Execution will stop only after the *n*th time the breakpoint is hit. For example:

```
BREAKPOINT, /SET, 'test.pro', 8, AFTER=3
```

sets a breakpoint at the eighth line of the file `test.pro`, but only stops execution after the breakpoint has been encountered three times.

## CLEAR

Set this keyword to remove a breakpoint. The breakpoint to be removed is specified either by index, or by the source file and line number. Use command `HELP, /BREAKPOINT` to display the indices of existing breakpoints. For example:

```
; Clear breakpoint with an index of 3:
BREAKPOINT, /CLEAR, 3

; Clear the breakpoint corresponding to the statement in the file
; test.pro, line number 8:
BREAKPOINT, /CLEAR, 'test.pro',8
```

## CONDITION

Set this keyword to a string containing an IDL expression. When a breakpoint is encountered, the expression is evaluated. If the expression is true (if it returns a non-zero value), program execution is interrupted. The expression is evaluated in the context of the program containing the breakpoint. For example:

```
BREAKPOINT, 'myfile.pro', 6, CONDITION='i gt 2'
```

If i is greater than 2 at line 6 of `myfile.pro`, the program is interrupted.

## DISABLE

Set this keyword to disable the specified breakpoint, if it exists. The breakpoint can be specified using the breakpoint index or file and line number:

```
; Disable breakpoint with an index of 3:
BREAKPOINT, /DISABLE, 3

; Disable the breakpoint corresponding to the statement in the file
; test.pro, line number 8:
BREAKPOINT, /DISABLE, 'test.pro',8
```

## ENABLE

Set this keyword to enable the specified breakpoint if it exists. The breakpoint can be specified using the breakpoint index or file and line number:

```
; Enable breakpoint with an index of 3:
BREAKPOINT, /ENABLE, 3

; Enable the breakpoint corresponding to the statement in the file
; test.pro, line number 8:
```

```
BREAKPOINT, /ENABLE, 'test.pro',8
```

### ON_RECOMPILE

Set this keyword to specify that the breakpoint will not take effect until the next time the file containing it is compiled.

### ONCE

Set this keyword to make the breakpoint temporary. If ONCE is set, the breakpoint is cleared as soon as it is hit. For example:

```
BREAKPOINT, /SET, 'file.pro', 12, AFTER=3, /ONCE
```

sets a breakpoint at line 12 of `file.pro`. Execution stops when line 12 is encountered the third time, and the breakpoint is automatically cleared.

### SET

Set this keyword to set a breakpoint at the designated source file line. If this keyword is set, the first input parameter, *File* must be a string expression that contains the name of the source file. The second input parameter must be an integer that represents the source line number.

For example, to set a breakpoint at line 23 in the source file `xyz.pro`, enter:

```
BREAKPOINT, /SET, 'xyz.pro', 23
```

## Version History

Introduced: Pre 4.0

# BROYDEN

The BROYDEN function solves a system of *n* nonlinear equations (where $n \geq 2$) in *n* dimensions using a globally-convergent Broyden's method.

BROYDEN is based on the routine `broydn` described in section 9.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = BROYDEN( *X*, *Vecfunc* [, CHECK=*variable*] [, /DOUBLE] [, EPS=*value*] [, ITMAX=*value*] [, STEPMAX=*value*] [, TOLF=*value*] [, TOLMIN=*value*] [, TOLX=*value*] )

## Return Value

This function returns an *n*-element vector containing the solution.

## Arguments

### X

An *n*-element vector (where $n \geq 2$) containing an initial guess at the solution of the system.

### Vecfunc

A scalar string specifying the name of a user-supplied IDL function that defines the system of non-linear equations. This function must accept a vector argument *X* and return a vector result.

For example, suppose we wish to solve the following system:

$$\begin{bmatrix} 3x - \cos(yz) - 1/2 \\ x^2 - 81(y + 0.1)^2 + \sin(z) + 1.06 \\ e^{-xy} + 20z + \frac{10\pi - 3}{3} \end{bmatrix} = 0$$

To represent this system, we define an IDL function named BROYFUNC:

```
FUNCTION broyfunc, X
```

```
   RETURN, [3.0 * X[0] - COS(X[1]*X[2]) - 0.5,$
   X[0]^2 - 81.0*(X[1] + 0.1)^2 + SIN(X[2]) + 1.06,$
   EXP(-X[0]*X[1]) + 20.0 * X[2] + (10.0*!PI - 3.0)/3.0]
END
```

# Keywords

## CHECK

BROYDEN calls an internal function named `fmin()` to determine whether the routine has converged to a local rather than a global minimum (see *Numerical Recipes*, section 9.7). Use the CHECK keyword to specify a named variable which will be set to 1 if the routine has converged to a local minimum or to 0 if not. If the routine does converge to a local minimum, try restarting from a different initial guess to obtain the global minimum.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## EPS

Set this keyword to a number close to machine accuracy, used to remove noise from each iteration. The default is $10^{-7}$ for single precision, and $10^{-14}$ for double precision.

## ITMAX

Use this keyword to specify the maximum allowed number of iterations. The default is 200.

## STEPMAX

Use this keyword to specify the scaled maximum step length allowed in line searches. The default value is 100.0.

## TOLF

Set the convergence criterion on the function values. The default value is $1.0 \times 10^{-4}$.

## TOLMIN

Set the criterion for deciding whether spurious convergence to a minimum of the function `fmin()` has occurred. The default value is $1.0 \times 10^{-6}$.

### TOLX

Set the convergence criterion on *X*. The default value is 1.0 x $10^{-7}$.

## Examples

We can use BROYDEN to solve the non-linear system of equations defined by the BROYFUNC function above:

```
;Provide an initial guess as the algorithm's starting point:
X = [-1.0, 1.0, 2.0]

;Compute the solution:
result = BROYDEN(X, 'BROYFUNC')

;Print the result:
PRINT, result
```

IDL prints:

```
      0.500000  -1.10731e-07  -0.523599
```

The exact solution (to eight-decimal accuracy) is [0.5, 0.0, -0.52359877].

## Version History

Introduced: 4.0

## See Also

FX_ROOT, FZ_ROOTS, NEWTON

# BYTARR

The BYTARR function creates a byte vector or array.

## Syntax

*Result* = BYTARR( $D_1$[, ..., $D_8$] [, /NOZERO] )

## Return Value

This function returns a byte vector or array.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, BYTARR sets every element of the result to zero. If the NOZERO keyword is set, this zeroing is not performed (array elements contain random values) and BYTARR executes faster.

## Examples

To create B as a 3 by 3 by 5 byte array where each element is set to zero, enter:

```
B = BYTARR(3, 3, 5)
```

## Version History

Introduced: Original

## See Also

COMPLEXARR, DBLARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# BYTE

The BYTE function returns a result equal to *Expression* converted to byte type. If *Expression* is a string, each string is converted to a byte vector of the same length as the string. Each element of the vector is the character code of the corresponding character in the string. The BYTE function can also be used to extract data from *Expression* and place it in a byte scalar or array without modification, if more than one parameter is present. See "Type Conversion Functions" on page 56 for details.

## Syntax

*Result* = BYTE( *Expression[, Offset [, $D_1$[, ..., $D_8$]]]* )

## Return Value

This function returns the result of the *Expression* converted to byte type.

## Arguments

### Expression

The expression to be converted to type byte.

### Offset

The byte offset from the beginning of *Expression*. Specifying this argument allows fields of data extracted from *Expression* to be treated as byte data without conversion.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Example

If the variable A contains the floating-point value 10.0, it can be converted to byte type and saved in the variable B by entering:

```
B = BYTE(A)
```

# Version History

Introduced: Original

# See Also

COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG, ULONG64

# BYTEORDER

The BYTEORDER procedure converts integers between host and network byte ordering or floating-point values between the native format and XDR (IEEE) format. This routine can also be used to swap the order of bytes within both short and long integers. If the type of byte swapping is not specified via one of the keywords below, bytes within short integers are swapped (even and odd bytes are interchanged).

The size of the parameter, in bytes, must be evenly divisible by two for short integer swaps, and by four for long integer swaps. BYTEORDER operates on both scalars and arrays. The parameter must be a variable, not an expression or constant, and may not contain strings. The contents of *Variable* are overwritten by the result.

Network byte ordering is “big endian”. That is, multiple byte integers are stored in memory beginning with the most significant byte.

## Syntax

BYTEORDER, *Variable*$_1$, ..., *Variable*$_n$ [, /DTOVAX] [, /DTOXDR] [, /FTOVAX] [, /FTOXDR] [, /HTONL] [, /HTONS] [, /L64SWAP] [, /LSWAP] [, /NTOHL] [, /NTOHS] [, /SSWAP] [, /SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN] [, /VAXTOD] [, /VAXTOF] [, /XDRTOD] [, /XDRTOD]

## Arguments

### Variable$_n$

A named variable (not an expression or constant) that contains the data to be converted. The contents of *Variable* are overwritten by the new values.

## Keywords

### DTOVAX

Set this keyword to convert native (IEEE) double-precision floating-point format to VAX D float format. See “Note on Accessing Data in VAX Floating Point Format” on page 186.

### DTOXDR

Set this keyword to convert native double-precision floating-point format to XDR (IEEE) format.

### FTOVAX

Set this keyword to convert native (IEEE) single-precision floating-point format to VAX F float format. See "Note on Accessing Data in VAX Floating Point Format" on page 186.

### FTOXDR

Set this keyword to convert native single-precision floating-point format to XDR (IEEE) format.

### HTONL

Set this keyword to perform host to network conversion, longwords.

### HTONS

Set this keyword to perform host to network conversion, short integers.

### L64SWAP

Set this keyword to perform a 64-bit swap (8 bytes). Swap the order of the bytes within each 64-bit word. For example, the eight bytes within a 64-bit word are changed from ($B_0$, $B_1$, $B_2$, $B_3$ $B_4$, $B_5$, $B_6$, $B_7$), to ($B_7$, $B_6$, $B_5$, $B_4$, $B_3$, $B_2$, $B_1$, $B_0$).

### LSWAP

Set this keyword to perform a 32-bit longword swap. Swap the order of the bytes within each longword. For example, the four bytes within a longword are changed from ($B_0$, $B_1$, $B_2$, $B_3$), to ($B_3$, $B_2$, $B_1$, $B_0$).

### NTOHL

Set this keyword to perform network to host conversion, longwords.

### NTOHS

Set this keyword to perform network to host conversion, short integers.

### SSWAP

Set this keyword to perform a short word swap. Swap the bytes within short integers. The even and odd numbered bytes are interchanged. This is the default action, if no other keyword is set.

### SWAP_IF_BIG_ENDIAN

If this keyword is set, the BYTEORDER request will only be performed if the platform running IDL uses “big endian” byte ordering. On little endian machines, the BYTEORDER request quietly returns without doing anything. Note that this keyword does not refer to the byte ordering of the input data, but to the computer hardware.

### SWAP_IF_LITTLE_ENDIAN

If this keyword is set, the BYTEORDER request will only be performed if the platform running IDL uses “little endian” byte ordering. On big endian machines, the BYTEORDER request quietly returns without doing anything. Note that this keyword does not refer to the byte ordering of the input data, but to the computer hardware.

### VAXTOD

Set this keyword to convert VAX D float format to native (IEEE) double-precision floating-point format. See “Note on Accessing Data in VAX Floating Point Format” on page 186.

### VAXTOF

Set this keyword to convert VAX F float format to native (IEEE) single-precision floating-point format. See “Note on Accessing Data in VAX Floating Point Format” on page 186.

### XDRTOD

Set this keyword to convert XDR (IEEE) format to native double-precision floating-point.

### XDRTOF

Set this keyword to convert XDR (IEEE) format to native single-precision floating-point.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Obsolete Keywords

The following keywords are obsolete:

- DTOGFLOAT
- GFLOATTOD

For information on obsolete keywords, See Appendix I, "Obsolete Features".

## Note on Accessing Data in VAX Floating Point Format

When converting between VAX and IEEE formats, you should be aware of the following basic numerical issues in order to get the best results. Translation of floating-point values from IDL's native IEEE format to the VAX format and back (that is, VAX to IEEE to VAX) is not a completely reversible operation, and should be avoided when possible. There are many cases where the recovered values will differ from the original values, including:

- The VAX floating-point format lacks support for the IEEE special values (*NaN* and *Infinity*). Hence, their special meaning is lost when they are converted to VAX format and cannot be recovered.
- The IEEE and VAX floating formats have intrinsic differences in precision and range, which can cause information to be lost in both directions. When converting from one format to another, IDL rounds the value to the nearest representable value in the target format.

As a practical matter, an initial conversion of existing VAX format data to IEEE cannot be avoided if the data is to be used on modern machines. However, each format conversion can add a small amount of error to the resulting values, so it is important to minimize the number of such conversions. RSI recommends using IEEE/VAX conversions only to read existing VAX format data, and strongly

recommends that all new files be created using the native IEEE format. This introduces only a single unavoidable conversion, and minimizes the resulting conversion error.

## Version History

Introduced: Pre 4.0

## See Also

SWAP_ENDIAN

# BYTSCL

The BYTSCL function scales all values of *Array* that lie in the range (*Min* ≤ *x* ≤ *Max*) into the range (0 ≤ *x* ≤ *Top*). For floating-point input, each value is scaled using the formula (*Top* + 0.9999)*x/(*Max* - *Min*). For integer input, each value is scaled using the formula ((*Top* + 1)*x - 1)/(*Max* - *Min*).

## Syntax

*Result* = BYTSCL( *Array* [, MAX=*value*] [, MIN=*value*] [, /NAN] [, TOP=*value*] )

## Return Value

The returned result has the same structure as the original parameter and is of byte type.

## Arguments

### Array

The array to be scaled and converted to bytes.

## Keywords

### MAX

Set this keyword to the maximum value of *Array* to be considered. If MAX is not provided, *Array* is searched for its maximum value. All values greater or equal to MAX are set equal to TOP in the result.

**Note**

The data type of the value specified for MAX should match the data type of the input array. Since MAX is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

### MIN

Set this keyword to the minimum value of *Array* to be considered. If MIN is not provided, *Array* is searched for its minimum value. All values less than or equal to MIN are set equal to 0 in the result.

**Note**

The data type of the value specified for MIN should match the data type of the input array. Since MIN is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See “Special Floating-Point Values” on page 434 for more information on IEEE floating-point values.)

### TOP

Set this keyword to the maximum value of the scaled result. If TOP is not specified, 255 is used. Note that the minimum value of the scaled result is always 0.

### Thread Pool Keywords

This routine is written to make use of IDL’s *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

BYTSCL is often used to scale images into the appropriate range for 8-bit displays. As an example, enter the following commands:

```
; Create a simple image array:
IM = DIST(200)

; Display the array as an image:
TV, IM

; Scale the image into the full range of bytes (0 to 255) and
; re-display it:
IM = BYTSCL(IM)

; Display the new image:
TV, IM
```

## Version History

Introduced: Original

## See Also

BYTE, TVSCL

# C_CORRELATE

The C_CORRELATE function computes the cross correlation *Pxy*(*L*) or cross covariance *Rxy*(*L*) of two sample populations *X* and *Y* as a function of the lag *L*

$$P_{xy}(L) = \begin{cases} \dfrac{\sum_{k=0}^{N-|L|-1} (x_{k+|L|} - \bar{x})(y_k - \bar{y})}{\sqrt{\left[\sum_{k=0}^{N-1} (x_k - \bar{x})^2\right]\left[\sum_{k=0}^{N-1} (y_k - \bar{y})^2\right]}} & \text{For } L < 0 \\ \dfrac{\sum_{k=0}^{N-L-1} (x_k - \bar{x})(y_{k+L} - \bar{y})}{\sqrt{\left[\sum_{k=0}^{N-1} (x_k - \bar{x})^2\right]\left[\sum_{k=0}^{N-1} (y_k - \bar{y})^2\right]}} & \text{For } L \geq 0 \end{cases}$$

$$R_{xy}(L) = \begin{cases} \frac{1}{N} \sum_{k=0}^{N-|L|-1} (x_{k+|L|} - \bar{x})(y_k - \bar{y}) & \text{For } L < 0 \\ \frac{1}{N} \sum_{k=0}^{N-L-1} (x_k - \bar{x})(y_{k+L} - \bar{y}) & \text{For } L \geq 0 \end{cases}$$

where $\bar{x}$ and $\bar{y}$ are the means of the sample populations $x = (x_0, x_1, x_2, \ldots, x_{N-1})$ and $y = (y_0, y_1, y_2, \ldots, y_{N-1})$, respectively.

This routine is written in the IDL language. Its source code can be found in the file `c_correlate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = C_CORRELATE( *X*, *Y*, *Lag* [, /COVARIANCE] [, /DOUBLE] )

## Return Value

Returns the cross correlation *Pxy*(*L*) or cross covariance *Rxy*(*L*) of two sample populations *X* and *Y* as a function of the lag *L*.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector.

### Y

An *n*-element integer, single-, or double-precision floating-point vector.

### Lag

A scalar or *n*-element integer vector in the interval [-(*n*-2), (*n*-2)], specifying the signed distances between indexed elements of *X*.

## Keywords

### COVARIANCE

Set this keyword to compute the sample cross covariance rather than the sample cross correlation.

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

```
; Define two n-element sample populations:
X = [3.73, 3.67, 3.77, 3.83, 4.67, 5.87, 6.70, 6.97, 6.40, 5.57]
Y = [2.31, 2.76, 3.02, 3.13, 3.72, 3.88, 3.97, 4.39, 4.34, 3.95]

; Compute the cross correlation of X and Y for LAG = -5, 0, 1, 5,
; 6, 7:
lag = [-5, 0, 1, 5, 6, 7]
result = C_CORRELATE(X, Y, lag)
PRINT, result
```

IDL prints:

```
-0.428246  0.914755  0.674547  -0.405140  -0.403100  -0.339685
```

## Version History

Introduced: 4.0

## See Also

A_CORRELATE, CORRELATE, M_CORRELATE, P_CORRELATE, R_CORRELATE

# CALDAT

The CALDAT procedure computes the month, day, year, hour, minute, or second corresponding to a given Julian date. The inverse of this procedure is JULDAY.

**Note**

The Julian calendar, established by Julius Caesar in the year 45 BCE, was corrected by Pope Gregory XIII in 1582, excising ten days from the calendar. The CALDAT procedure reflects the adjustment for dates after October 4, 1582. See the example below for an illustration.

This routine is written in the IDL language. Its source code can be found in the file `caldat.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

CALDAT, *Julian*, *Month* [, *Day* [, *Year* [, *Hour* [, *Minute* [, *Second*]]]]]

## Arguments

### Julian

A numeric value or array that specifies the Julian Day Number (which begins at noon) to be converted to a calendar date.

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000, respectively.

**Note**

Julian Day Numbers should be maintained as double-precision floating-point data when the numbers are used to determine hours, minutes, and seconds.

### Month

A named variable that, on output, contains a longword integer or longword integer array representing the number of the desired month (1 = January, ..., 12 = December).

### Day

A named variable that, on output, contains a longword integer or longword integer array representing the number of the day of the month (1-31).

### Year

A named variable that, on output, contains a longword integer or longword integer array representing the number of the desired year (e.g., 1994).

### Hour

A named variable that, on output, contains a longword integer or longword integer array representing the number of the hour of the day (0-23).

### Minute

A named variable that, on output, contains a longword integer or longword integer array representing the number of the minute of the hour (0-59).

### Second

A named variable that, on output, contains a double-precision floating-point value or a double-precision floating-point array representing the number of the second of the minute (0-59).

## Keywords

None.

## Examples

In 1582, Pope Gregory XIII adjusted the Julian calendar to correct for its inaccuracy of slightly more than 11 minutes per year. As a result, the day following October 4, 1582 was October 15, 1582. CALDAT follows this convention, as illustrated by the following commands:

```
CALDAT, 2299160, Month1, Day1, Year1
CALDAT, 2299161, Month2, Day2, Year2
PRINT, Month1, Day1, Year1
PRINT, Month2, Day2, Year2
```

IDL prints:

```
10     4     1582
10    15     1582
```

**Warning**

You should be aware of this discrepancy between the original and revised Julian calendar reckonings if you calculate dates before October 15, 1582.

Be sure to distinguish between *Month* and *Minute* when assigning variable names. For example, the following code would cause the Month value to be the same as the Minute value:

```
;Find date corresponding to Julian day 2529161.36:
CALDAT, 2529161.36, M, D, Y, H, M, S
PRINT, M, D, Y, H, M, S
```

IDL prints:

```
0     4     2212      18       0      0.00000000
```

Moreover, Julian Day Numbers should be maintained as double-precision floating-point data when the numbers are used to determine hours, minutes, and seconds.

So, instead of the previous call to CALDAT, use something like:

```
CALDAT, 2529161.36D, Month, Day, Year, Hour, Minute, Second
PRINT, Month, Day, Year, Hour, Minute, Second
```

IDL prints:

```
7     4     2212      20       38      23.999989
```

You can also use arrays for the *Julian* argument:

```
CALDAT, DINDGEN(4) + 2449587.0D, m, d, y
PRINT, m, d, y
```

IDL prints:

```
           8           8           8           8
          22          23          24          25
        1994        1994        1994        1994
```

# Version History

Introduced: Pre 4.0

# See Also

BIN_DATE, JULDAY, SYSTIME

# CALENDAR

The CALENDAR procedure displays a calendar for a month or an entire year on the current plotting device. This IDL routine imitates the UNIX `cal` command.

This routine is written in the IDL language. Its source code can be found in the file `calendar.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

CALENDAR [[, *Month*] , *Year*]

## Arguments

### Month

The number of the month for which a calendar is desired (1 is January, 2 is February, ..., 12 is December). If called without arguments, CALENDAR draws a calendar for the current month.

### Year

The number of the year for which a calendar should be drawn. If YEAR is provided without MONTH, a calendar for the entire year is drawn. If called without arguments, CALENDAR draws a calendar for the current month.

## Example

```
; Display a calendar for the year 2038.
CALENDAR, 2038
; Display the calendar for October, 1582.
CALENDAR, 10, 1582
```

## Version History

Introduced: Original

## See Also

SYSTIME

# CALL_EXTERNAL

The CALL_EXTERNAL function calls a function in an external sharable object and returns a scalar value. Parameters can be passed by reference (the default) or by value. See Chapter 9, “CALL_EXTERNAL” in the *External Development Guide* manual for examples.

CALL_EXTERNAL is supported under all operating systems supported by IDL, although there are system specific details of which you must be aware. This function requires no interface routines and is much simpler and easier to use than the LINKIMAGE procedure. However, CALL_EXTERNAL performs no checking of the type and number of parameters. Programming errors are likely to cause IDL to crash or to corrupt your data.

**Warning**

Input and output actions should be performed within IDL code, using IDL’s built-in input/output facilities, or by using the internal IDL_Message() function. Performing input or output from external code, especially to the user console or tty (e.g. using `printf()` or equivalent functionality in other languages to send text to stdout) may create errors or generate unexpected results.

CALL_EXTERNAL supports the IDL Portable Convention, a portable calling convention that works on all platforms. This convention passes two arguments to the called routine, an argument count (`argc`) and an array of arguments (`argv`).

CALL_EXTERNAL also offers a feature called Auto Glue that can greatly simplify use of the CALL_EXTERNAL portable convention if you have the appropriate C compiler installed on your system. Auto glue automatically writes the glue function required to convert the (argc, argv) arguments to the actual function call, and then compiles and loads the glue function transparently. If you want IDL to simply write the glue function for you, but not compile it, the WRITE_WRAPPER keyword can be used.

The result of the CALL_EXTERNAL function is a scalar value returned by the external function. By default, this is a scalar long (32-bit) integer. This default can be changed by specifying one of the keywords described below that alter the result type.

## Syntax

*Result* = CALL_EXTERNAL(*Image*, *Entry* [, $P_0$, ..., $P_{N-1}$] [, /ALL_VALUE] [, /B_VALUE | , /D_VALUE | , /F_VALUE | , /I_VALUE | , /L64_VALUE | , /S_VALUE | , /UI_VALUE | , /UL_VALUE | , /UL64_VALUE] [, /CDECL]

[, RETURN_TYPE=*value*] [, /UNLOAD] [, VALUE=*byte_array*]
[, WRITE_WRAPPER=*wrapper_file*] )

**Auto Glue keywords:** [, /AUTO_GLUE] [, CC=*string*]
[, COMPILE_DIRECTORY=*string*] [, EXTRA_CFLAGS=*string*]
[, EXTRA_LFLAGS=*string*] [, /IGNORE_EXISTING_GLUE] [, LD=*string*]
[, /NOCLEANUP] [, /SHOW_ALL_OUTPUT] [, /VERBOSE]

# Return Value

This function calls a function in an external sharable object and returns a scalar value.

# Arguments

## Image

The name of the file, which must be a sharable library (UNIX), or DLL (Windows), which contains the routine to be called.

## Entry

A string containing the name of the symbol in the library which is the entry point of the routine to be called.

## $P_0$, ..., $P_{N-1}$

The parameters to be passed to the external routine. All array and structure arguments are passed by reference (address). The default is to also pass scalars by reference, but the ALL_VALUE or VALUE keywords can be used to pass them by value. Care must be taken to ensure that the type, structure, and passing mechanism of the parameters passed to the external routine match what it expects. There are some restrictions on data types that can be passed by value, and the user needs to be aware of how IDL passes strings. Both issues discussed in further detail below.

# Keywords

## ALL_VALUE

Set this keyword to indicate that all parameters are passed by value. There are some restrictions on data types that should be considered when using this keyword, as discussed below.

## B_VALUE

If set, this keyword indicates that the called function returns a byte value.

## CDECL

The Microsoft Windows operating system has two distinct system defined standards that govern how routines pass arguments: `stdcall`, which is used by much of the operating system as well as languages such as Visual Basic, and `cdecl`, which is used widely for programming in the C language. These standards differ in how and when arguments are pushed and removed from the system stack. The standard used by a given function is determined when the function is compiled, and can usually be controlled by the programmer. If you call a function using the wrong standard (e.g. calling a `stdcall` function as if it were `cdecl`, or the reverse), you could get incorrect results, corrupted memory, or you could crash IDL. Unfortunately, there is no way for IDL to know which convention a given function uses; this information must be supplied by the user of CALL_EXTERNAL. If the CDECL keyword is present, IDL will use the `cdecl` convention to call the function. Otherwise, `stdcall` is used.

## D_VALUE

If set, this keyword indicates that the called function returns a double-precision floating value.

## F_VALUE

If set, this keyword indicates that the called function returns a single-precision floating value.

## I_VALUE

If set, this keyword indicates that the called function returns an integer value.

## L64_VALUE

If set, this keyword indicates that the called function returns a 64-bit integer value.

## RETURN_TYPE

The type code to set the type of the result. See the description of the SIZE function for a list of the IDL type codes.

## S_VALUE

If set, this keyword indicates that the called function returns a pointer to a null-terminated string.

## UI_VALUE

If set, this keyword indicates that the called function returns an unsigned integer value.

## UL_VALUE

If set, this keyword indicates that the called function returns an unsigned long integer value.

## UL64_VALUE

If set, this keyword indicates that the called function returns an unsigned 64-bit integer value.

## UNLOAD

Normally, IDL keeps *Image* loaded in memory after the call to CALL_EXTERNAL completes. This is done for efficiency—loading a sharable object can be a slow operation. Setting the UNLOAD keyword will cause IDL to unload *Image* after the call to it is complete. This is useful if you are debugging code in *Image*, as it allows you to iterate on your code without having to exit IDL between tests. It can also be a good idea if you do not intend to make any subsequent calls to routines within *Image*.

If IDL is unable to unload the sharable object, it will issue an error to that effect. In addition to any operating system reported problem that might occur, there are 2 situations in which IDL cannot perform the UNLOAD operation:

- If the sharable library has been used for any other purpose in addition to CALL_EXTERNAL (e.g. LINKIMAGE).

## VALUE

A byte array, with as many elements as there are optional parameters, indicating the method of parameter passing. Arrays are always passed by reference. If parameter $P_i$ is a scalar, it is passed by reference if VALUE[*i*] is 0; and by value if it is non-zero. There are some restrictions on data types that should be considered when using this keyword, as discussed below.

### WRITE_WRAPPER

If set, WRITE_WRAPPER supplies the name of a file for CALL_EXTERNAL to create containing the C function required to convert the (`argc`, `argv`) interface used by the CALL_EXTERNAL portable calling convention to the interface of the target function. If WRITE_WRAPPER is specified, CALL_EXTERNAL writes the specified file, but does not attempt to actually call the function specified by Entry. The result from CALL_EXTERNAL is an integer 0 in this case, and has no special meaning. Use of WRITE_WRAPPER implies the PORTABLE keyword.

**Note**

This is similar to Auto Glue only in that CALL_EXTERNAL writes a function on your behalf. Unlike Auto Glue, WRITE_WRAPPER does not attempt to compile the resulting function or to use it. You might want to use WRITE_WRAPPER to generate IDL interfaces for an external library in cases where you intend to combine the interfaces with other code or otherwise modify it before using it with IDL.

## Auto Glue Keywords

Auto Glue, discussed in the section "Auto Glue" on page 205, offers a simplified way to use the CALL_EXTERNAL portable calling convention. The following keywords control its use. Many of these keywords correspond to the same keywords to the MAKE_DLL procedure, and are covered in more detail in the documentation for that routine.

### AUTO_GLUE

Set this keyword to enable the CALL_EXTERNAL Auto Glue feature.

### CC

If present, a template string to be used in generating the C compiler command(s) to compile the automatically generated glue function. For a more complete description of this keyword, see MAKE_DLL.

### COMPILE_DIRECTORY

Specifies the directory to use for creating the necessary intermediate files and the final glue function sharable library. For a more complete description of this keyword, see MAKE_DLL.

## EXTRA_CFLAGS

If present, a string supplying extra options to the command used to execute the C compiler. For a more complete description of this keyword, see MAKE_DLL.

## EXTRA_LFLAGS

If present, a string supplying extra options to the command used to execute the linker. For a more complete description of this keyword, see MAKE_DLL.

## IGNORE_EXISTING_GLUE

Normally, if Auto Glue finds a pre-existing glue function, it will use it without attempting to build it again. Set IGNORE_EXISTING_GLUE to override this caching behavior and force CALL_EXTERNAL to rebuild the glue function sharable library.

## LD

If present, a template string to be used in generating the linker command to build the glue function sharable library. For a more complete description of this keyword, see MAKE_DLL.

## NOCLEANUP

If set, CALL_EXTERNAL will not remove intermediate files generated in order to build the glue function sharable library after the library has been built. This keyword can be used to preserve information for debugging in case of error, or for additional information on how Auto Glue works. For a more complete description of this keyword, see MAKE_DLL.

## SHOW_ALL_OUTPUT

Auto Glue normally produces no output unless an error prevents successful building of the glue function sharable library. Set SHOW_ALL_OUTPUT to see all output produced by the process of building the library. For a more complete description of this keyword, see MAKE_DLL.

## VERBOSE

If set, VERBOSE causes CALL_EXTERNAL to issue informational messages as it carries out the task of locating, building, and executing the glue function. For a more complete description of this keyword, see MAKE_DLL.

### Obsolete Keywords

The following keywords are obsolete:

- DEFAULT
- PORTABLE
- VAX_FLOAT

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## String Parameters

IDL represents strings internally as IDL_STRING descriptors, which are defined in the C language as:

```
typedef struct {
  unsigned short slen;
  unsigned short stype;
  char *s;
} IDL_STRING;
```

To pass a string by reference, IDL passes the address of its IDL_STRING descriptor. To pass a string by value the string pointer (the `s` field of the descriptor) is passed. Programmers should be aware of the following when manipulating IDL strings:

- Called code should treat the information in the passed IDL_STRING descriptor and the string itself as read-only, and should not modify these values.
- The `slen` field contains the length of the string without including the NULL termination that is required at the end of all C strings.
- The `stype` field is used internally by IDL to know keep track of how the memory for the string was obtained, and should be ignored by CALL_EXTERNAL users.
- `s` is the pointer to the actual C string represented by the descriptor. If the string is NULL, IDL represents it as a NULL (0) pointer, not as a pointer to an empty null terminated string. Hence, called code that expects a string pointer should check for a NULL pointer before dereferencing it.

These issues are examined in greater detail in the IDL *External Development Guide*.

## Calling Convention

CALL_EXTERNAL uses the IDL Portable convention for calling user-supplied routines. The IDL Portable calling convention can be simplified by using the Auto Glue extension, described below.

The portable interface convention passes all arguments as elements of an array of C void pointers (void *). The C language prototype for a user function called this way looks like one of the following:

```
RET_TYPE xxx(int argc, void *argv[])
```

Where RET_TYPE is one of the following: `UCHAR`, `short`, `IDL_UINT`, `IDL_LONG`, `IDL_ULONG`, `IDL_LONG64`, `IDL_ULONG64`, `float`, `double`, or `char *`. The return type used must agree with the type assumed by CALL_EXTERNAL as specified via the keywords described above.

`Argc` is the number of arguments, and the vector `argv` contains the arguments themselves, one argument per element. Arguments passed by reference map directly to these (`void *`) pointers, and can be cast to the proper type and then dereferenced directly by the called function. Passing arguments by value is allowed, but since the values are passed in (`void *`) pointers, there are some limitations and restrictions on what is possible:

- Types that are larger than a pointer cannot be passed by value, and CALL_EXTERNAL will issue an error if this is attempted. This limitation applies only to the standard portable calling convention. Auto Glue does not have this limitation, and is able to pass such variables by value.
- Integer values can be easily passed by value. IDL widens any of the integer types to the C int type and they are then converted to a (void *) pointer using a C cast operation.
- There is no C language-defined conversion between pointers and floating point types, so IDL copies the data for the value directly into the pointer element. Although such values can be retrieved by the called routine with the correct C casting operations, this is inconvenient and error prone. It is best to pass non-integer data by reference.

## Auto Glue

Auto Glue is an extension to the IDL Portable Calling Convention that makes it easier to use.

The portable calling convention requires your function to use the IDL defined (`argc`, `argv`) interface for passing arguments. However, functions not explicitly written for use with CALL_EXTERNAL may not have this interface. A common solution using the portable convention is for the IDL user to write a *glue* function that serves as an interface between IDL and the called function. The entire purpose of this glue function, which is usually very simple, is to convert the IDL (argc, argv) method of passing parameters to a form acceptable to the called function. Writing this wrapper function is easy for programmers who understand the C language, the system C compiler and linker, and how sharable libraries work on their target operating system. However, it is also tedious and error prone, and can be difficult for users that do not already have these skills.

Auto Glue uses the MAKE_DLL procedure to automate the process of using glue code to call functions via the CALL_EXTERNAL portable calling convention. Since it depends so closely on MAKE_DLL, an understanding of how MAKE_DLL works is necessary to fully understand Auto Glue. As with MAKE_DLL, Auto Glue requires that your system have a suitable C compiler installed. Please refer to the documentation for MAKE_DLL.

Auto Glue maintains a cache of previously built glue functions, and will reuse them on subsequent requests, even between IDL sessions. Glue function libraries can be recognized by their name, which starts with the prefix `idl_ce`, and ends with the proper suffix for a sharable library on the target system (most UNIX: `.so`, AIX: `.a`, HP-UX: `.sl`, Windows: `.dll`). CALL_EXTERNAL finds a suitable glue function by performing the following steps in order, stopping after the first one that works:

1. Look for a `ce_glue` subdirectory within the IDL distribution `bin` subdirectory for the current platform. (For example, on a Windows system the subdirectory would be located in `<IDL_DEFAULT>\bin\bin.x86`.) If this directory exists, it looks there for a sharable library containing the appropriate glue function.

**Note**

For customer security reasons, the `ce_glue` subdirectory does not exist in the IDL distribution as shipped by RSI, and IDL does not use it to create glue functions. However, if an individual site creates this directory and places glue library files within it, IDL will use them. Multiple IDL sessions on a given system can all share these same glue files, even when run by different users on a multi-user system. If you keep your IDL distribution on a network based file server shared by multiple clients, and if you provide a sufficient selection of glue files, it is possible that your users will not require a locally installed C compiler to use Auto Glue.

If you do create the `ce_glue` subdirectory on a multi-user system, we recommend that you make it along with all files contained within belong to the owner of the IDL distribution, and apply file protections that prevent non-privileged users from creating files in the directory or modifying them.

2. Look in the directory given by the COMPILE_DIRECTORY keyword, or if COMPILE_DIRECTORY is not present, in the directory given by the !MAKE_DLL.COMPILE_DIRECTORY system variable for the appropriate glue function.
3. If this step is reached, there is no pre-existing glue function available. CALL_EXTERNAL will create one in the same directory searched in the previous step by generating a C language file containing the needed glue function, and then compiling and linking it into a sharable library using the functionality of the MAKE_DLL procedure.

- IDL loads the sharable library containing the glue function found in the previous step, as well as the library you specified with the Image argument.
- CALL_EXTERNAL calls the glue function, causing your function to be called with the correct parameters.

The first time CALL_EXTERNAL encounters the need for a glue function that does not already exist, it will automatically build it, and then use it without any external indication that this has happened. You may notice a brief hesitation in IDL's execution as it waits for this process to occur. Once a glue function exists, IDL can load it immediately on subsequent calls (even in unrelated later IDL sessions), and no delay will occur.

## Example: Using Auto Glue To Call System Library Routines

Under Sun Solaris, there is a function in the system math library called hypot() that computes the length of the hypotenuse of a right-angled triangle:

```
sqrt(x*x + y*y)
```

This function has the C prototype:

```
double hypot(double x, double y)
```

The following IDL function uses Auto Glue to call this routine:

```
FUNCTION HYPOT, X, Y
   ; Use the 32-bit or the 64-bit math library?
   LIBM=(!VERSION.MEMORY_BITS EQ 64) $
      ? '/usr/lib/sparcv9/libm.so' : '/usr/lib/libm.so'
   RETURN, CALL_EXTERNAL(LIBM, 'hypot', double(x), double(y), $
      /ALL_VALUE, /D_VALUE, /AUTO_GLUE)
END
```

## Important Changes Since IDL 5.0

The current version of CALL_EXTERNAL differs from IDL versions up to and including IDL 5.0 in a few ways that are important to users moving code to the current version:

- Under Windows, CALL_EXTERNAL would pass IDL strings by value no matter how the ALL_VALUE or VALUE keywords were set. This was inconsistent with all the other platforms and created unnecessary confusion. IDL now uses these keywords to decide how to pass strings on all platforms. Windows users with existing code that expects strings to be passed by value without having specified it via one of these keywords will need to adjust their use of CALL_EXTERNAL or their code.
- Older versions of IDL would quietly pass by value arguments that are larger than a pointer without issuing an error when using the portable calling convention. Although this might work on some hardware, it is error prone and can cause IDL to crash. IDL now issues an error in this case. Programmers with existing code moving to a current version of IDL should change their code to pass such data by reference.

## Examples

See Chapter 9, “CALL_EXTERNAL” in the *External Development Guide* manual.

## Version History

Introduced: Pre 4.0

## See Also

LINKIMAGE

# CALL_FUNCTION

CALL_FUNCTION function calls the IDL function specified by the string *Name*, passing any additional parameters as its arguments.

Although not as flexible as the EXECUTE function, CALL_FUNCTION is much faster. Therefore, CALL_FUNCTION should be used in preference to EXECUTE whenever possible.

## Syntax

*Result* = CALL_FUNCTION(*Name* [, $P_1$, ..., $P_n$])

## Return Value

The result of the called function (specified by the string *Name)* is passed back as the result of this routine.

## Arguments

### Name

A string containing the name of the function to be called. This argument can be a variable, which allows the called function to be determined at runtime.

### $P_i$

The arguments to be passed to the function given by *Name*. These arguments are the positional and keyword arguments documented for the called function, and are passed to the called function exactly as if it had been called directly.

## Keywords

None.

## Examples

The following command indirectly calls the IDL function SQRT (the square root function) with an argument of 4 and stores the result in the variable R:

```
R = CALL_FUNCTION('SQRT', 4)
```

## Version History

Introduced: Pre 4.0

## See Also

CALL_PROCEDURE, CALL_METHOD, EXECUTE

# CALL_METHOD

The CALL_METHOD function or procedure calls the object method specified by *Name*, passing any additional parameters as its arguments.

**Note**

CALL_METHOD can also be used as a function or a procedure.

Although not as flexible as the EXECUTE function, CALL_METHOD is much faster. Therefore, CALL_METHOD should be used in preference to EXECUTE whenever possible.

## Syntax

*Result* = CALL_METHOD(*Name*, *ObjRef*, [, $P_1$, ..., $P_n$])

or

CALL_METHOD, *Name*, *ObjRef*, [, $P_1$, ..., $P_n$]

## Return Value

Returns the results generated by the named function method when applicable.

## Arguments

### Name

A string containing the name of the method to be called. This argument can be a variable, which allows the called method to be determined at runtime.

### ObjRef

A scalar object reference that will be passed to the method as the *Self* argument.

### $P_i$

The arguments to be passed to the method given by *Name*. These arguments are the positional and keyword arguments documented for the called method, and are passed to the called method exactly as if it had been called directly.

## Keywords

None.

## Version History

Introduced: 5.1

## See Also

CALL_FUNCTION, CALL_PROCEDURE, EXECUTE

# CALL_PROCEDURE

CALL_PROCEDURE calls the procedure specified by *Name*, passing any additional parameters as its arguments.

Although not as flexible as the EXECUTE function, CALL_PROCEDURE is much faster. Therefore, CALL_PROCEDURE should be used in preference to EXECUTE whenever possible.

## Syntax

CALL_PROCEDURE, *Name* [, $P_1$, ..., $P_n$]

## Arguments

### Name

A string containing the name of the procedure do be called. This argument can be a variable, which allows the called procedure to be determined at runtime.

### $P_i$

The arguments to be passed to the procedure given by *Name*. These arguments are the positional and keyword arguments documented for the called procedure, and are passed to the called procedure exactly as if it had been called directly.

## Example

The following example shows how to call the PLOT procedure indirectly with a number of arguments. First, create a dataset for plotting by entering:

```
B = FINDGEN(100)
```

Call PLOT indirectly to create a polar plot by entering:

```
CALL_PROCEDURE, 'PLOT', B, B, /POLAR
```

A “spiral” plot should appear.

## Version History

Introduced: Pre 4.0

## See Also

CALL_FUNCTION, CALL_METHOD, EXECUTE

# CASE

The CASE statement selects one, and only one, statement for execution, depending on the value of an expression. This expression is called the case selector expression. Each statement that is part of a CASE statement is preceded by an expression that is compared to the value of the selector expression. CASE executes by comparing the CASE expression with each selector expression in the order written. If a match is found, the statement is executed and control resumes directly below the CASE statement.

The ELSE clause of the CASE statement is optional. If included, it matches any selector expression, causing its code to be executed. For this reason, it is usually written as the last clause in the CASE statement. The ELSE statement is executed only if none of the preceding statement expressions match. If an ELSE clause is not included and none of the values match the selector, an error occurs and program execution stops.

The BREAK statement can be used within CASE statements to force an immediate exit from the CASE.

In this CASE statement, only one clause is selected, and that clause is the first one whose value is equal to the value of the case selector expression.

**Tip**

Each clause is tested in order, so it is most efficient to order the most frequently selected clauses first.

CASE is similar to the SWITCH statement. For more information on using CASE and other IDL program control statements, as well as the differences between CASE and SWITCH, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

CASE *expression* OF

*expression*: *statement*

...

*expression*: *statement*

[ ELSE: *statement* ]

ENDCASE

## Examples

This example illustrates how the CASE statement, unlike SWITCH, executes only the one statement that matches the case expression:

```
x=2

CASE x OF
   1: PRINT, 'one'
   2: PRINT, 'two'
   3: PRINT, 'three'
   4: PRINT, 'four'
ENDCASE
```

IDL Prints:

```
two
```

## Version History

Introduced: Original

# CATCH

The CATCH procedure provides a generalized mechanism for the handling of exceptions and errors within IDL. Calling CATCH establishes an error handler for the current procedure that intercepts all errors that can be handled by IDL, excluding non-fatal warnings such as math errors.

When an error occurs, each active procedure, beginning with the offending procedure and proceeding up the call stack to the main program level, is examined for an error handler. If an error handler is found, control resumes at the statement after the call to CATCH. The index of the error is returned in the argument to CATCH. The !ERROR_STATE system variable is also set. If no error handlers are found, program execution stops, an error message is issued, and control reverts to the interactive mode. A call to ON_IOERROR in the procedure that causes an I/O error supersedes CATCH, and takes the branch to the label defined by ON_IOERROR.

This mechanism is similar, but not identical to, the `setjmp/longjmp` facilities in C and the `catch/throw` facilities in C++.

Error handling is discussed in more detail in Chapter 18, “Controlling Errors” in the *Building IDL Applications* manual.

## Syntax

CATCH, [*Variable*] [, /CANCEL]

## Arguments

### Variable

A named variable in which the error index is returned. When an error handler is established by a call to CATCH, *Variable* is set to zero. If an error occurs, *Variable* is set to the error index, and control is transferred to the statement after the call to CATCH. The error index is also returned in the CODE field of the !ERROR_STATE system variable, i.e., !ERROR_STATE.CODE.

# Keywords

## CANCEL

Set this keyword to cancel the error handler for the current procedure. This cancellation does not affect other error handlers that may be established in other active procedures.

**Note**

If the CANCEL keyword is set, the *Variable* argument must not be present.

# Examples

The following procedure illustrates the use of CATCH:

```
PRO CATCH_EXAMPLE

   ; Define variable A:
   A = FLTARR(10)

   ; Establish error handler. When errors occur, the index of the
   ; error is returned in the variable Error_status:
   CATCH, Error_status

   ;This statement begins the error handler:
   IF Error_status NE 0 THEN BEGIN
      PRINT, 'Error index: ', Error_status
      PRINT, 'Error message: ', !ERROR_STATE.MSG
      ; Handle the error by extending A:
      A=FLTARR(12)
      CATCH, /CANCEL
   ENDIF

   ; Cause an error:
   A[11]=12

   ; Even though an error occurs in the line above, program
   ; execution continues to this point because the event handler
   ; extended the definition of A so that the statement can be
   ; re-executed.
   HELP, A
END
```

Running the ABC procedure causes IDL to produce the following output and control returns to the interactive prompt:

```
Error index:          -144
Error message:
Attempt to subscript A with <INT (      11)> is out of range.
A               FLOAT     = Array[12]
```

## Version History

Introduced: Pre 4.0

## See Also

!ERROR_STATE, ON_ERROR, ON_IOERROR, Chapter 18, “Controlling Errors” in the *Building IDL Applications* manual.

# CD

The CD procedure is used to set and/or change the current working directory. This routine changes the working directory for the IDL session and any child processes started from IDL during that session after the directory change is made. Under UNIX, CD does not affect the working directory of the process that started IDL. The PUSHD, POPD, and PRINTD procedures provide a convenient interface to CD.

## Syntax

CD [, *Directory*] [, CURRENT=*variable*]

## Arguments

### Directory

A scalar string specifying the path of the new working directory. If *Directory* is specified as a null string, the working directory is changed to the user's home directory (UNIX) or to the directory specified by !DIR (Windows). If this argument is not specified, the working directory is not changed.

## Keywords

### CURRENT

If CURRENT is present, it specifies a named variable into which the current working directory is stored as a scalar string. The returned directory is the working directory before the directory is changed. Thus, you can obtain the current working directory and change it in a single statement:

```
CD, new_dir, CURRENT=old_dir
```

**Note**

The return value of the CURRENT keyword does not include a directory separator at the end of the string.

## Examples

#### Windows

To change drives:

```
CD, 'C:'
```

To specify a full path:

```
CD, 'C:\MyData\January'
```

To change from the `C:\MyData` directory to the `C:\MyData\January` directory:

```
CD, 'January'
```

To go back up a directory, use "..". For example, if the current directory is `C:\MyData\January`, you could go up to the `C:\MyData` directory with the following command:

```
CD, '..'
```

If the current directory is `C:\MyData\January`, you could change to the `C:\MyData\February` directory with the following command:

```
CD, '..\February'
```

### Unix

To specify a full path:

```
CD, '/home/data/'
```

To change to the `january` subdirectory of the current directory:

```
CD, 'january'
```

To go back up a directory, use "..". For example, if the current directory is `/home/data/january`, you could go up to the `/home/data/` directory with the following command:

```
CD, '..'
```

If the current directory is `/home/data/january`, you could change to the `/home/data/february` directory with the following command:

```
CD, '../february'
```

## Version History

Introduced: Pre 4.0

## See Also

PUSHD, POPD

# CDF Routines

For information, see Chapter 2, “Common Data Format” in the *IDL Scientific Data Formats* manual.

# CEIL

The CEIL function returns the closest integer greater than or equal to its argument.

## Syntax

*Result* = CEIL(*X* [, /L64] )

## Return Value

If the input value *X* is integer type, *Result* has the same value and type as *X*. Otherwise, *Result* is a 32-bit longword integer with the same structure as *X*.

## Arguments

### X

The value for which the ceiling function is to be evaluated. This value can be any numeric type (integer, floating, or complex).

## Keywords

### L64

If set, the result type is 64-bit integer regardless of the input type. This is useful for situations in which a floating point number contains a value too large to be represented in a 32-bit integer.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To print the ceiling function of 5.1, enter:

```
PRINT, CEIL(5.1)
; IDL prints:
6
```

To print the ceiling function of 3000000000.1, the result of which is too large to represent in a 32-bit integer:

```
PRINT, CEIL(3000000000.1D, /L64)
; IDL prints:
3000000001
```

## Version History

Introduced: Pre 4.0

## See Also

COMPLEXROUND, FLOOR, ROUND

# CHEBYSHEV

The CHEBYSHEV function returns the forward or reverse Chebyshev polynomial expansion of a set of data. Note: Results from this function are subject to roundoff error given discontinuous data.

This routine is written in the IDL language. Its source code can be found in the file `chebyshev.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CHEBYSHEV(*D*, *N*)

## Return Value

Returns the forward or reverse Chebyshev polynomial expansion of a set of data.

## Arguments

### D

A vector containing the values at the zeros of Chebyshev polynomial.

### N

A flag that, if set to -1, returns a set of Chebyshev polynomials. If set to +1, the original data is returned.

## Keywords

None.

## Version History

Introduced: Original

## See Also

FFT, WTN

# CHECK_MATH

The CHECK_MATH function returns and clears the accumulated math error status.

## Syntax

*Result* = CHECK_MATH( [, MASK=*bitmask*] [, /NOCLEAR] [, /PRINT] )

## Return Value

The returned value is the sum of the bit values (described in the following table) of the accumulated errors. Note that not all machines detect all errors.

| Value | Condition |
|---|---|
| 0 | No errors detected since the last interactive prompt or call to CHECK_MATH |
| 1 | Integer divided by zero |
| 2 | Integer overflow |
| 16 | Floating-point divided by zero |
| 32 | Floating-point underflow |
| 64 | Floating-point overflow |
| 128 | Floating-point operand error. An illegal operand was encountered, such as a negative operand to the SQRT or ALOG functions, or an attempt to convert to integer a number whose absolute value is greater than $2^{31}$ - 1 |

*Table 4: Math Error Status Values*

Note that each type of error is only represented once in the return value—any number of “Integer divided by zero” errors will result in a return value of 1.

The math error status is cleared (reset to zero) when CHECK_MATH is called, or when errors are reported. Math errors are reported either never, when the interpreter returns to an interactive prompt, or after execution of each IDL statement, depending on the value of the !EXCEPT system variable (see “!EXCEPT” on page 3899). See “Examples” below for further discussion.

# Keywords

## MASK

If present, the mask of exceptions to check. Otherwise, all exceptions are checked. Exceptions that are pending but not specified by MASK are not reported, and not cleared. Set this keyword equal to the sum of the bit values for each exception to be checked. For a list of the bit values corresponding to various exceptions, see CHECK_MATH.

## NOCLEAR

By default, CHECK_MATH returns the pending exceptions (as specified via the MASK keyword) and clears them from its list of pending exceptions. If NOCLEAR is set, the exceptions are not cleared and remain pending.

## PRINT

Set this keyword to print an error message to the IDL command log if any accumulated math errors exist. If this keyword is not present, CHECK_MATH executes silently.

# Examples

To simply check and clear the accumulated math error status using all the defaults, enter:

```
PRINT, CHECK_MATH()
```

IDL prints the accumulated math error status code and resets to zero.

## CHECK_MATH and !EXCEPT

Because the accumulated math error status is cleared when it is reported, the behavior and appropriate use of CHECK_MATH depends on the value of the system variable !EXCEPT.

- If !EXCEPT is set equal to 0, math exceptions are not reported automatically, and thus CHECK_MATH will always return the error status accumulated since the last time it was called.
- If !EXCEPT is set equal to 1, math exceptions are reported when IDL returns to the interactive command prompt. In this case, CHECK_MATH will return appropriate error codes when used *within* an IDL procedure, but will always return zero when called at the IDL prompt.

- If !EXCEPT is set equal to 2, math exceptions are reported after each IDL statement. In this case, CHECK_MATH will return appropriate error codes only when used *within an IDL statement*, and will always return zero otherwise.

For example:

```
;Set value of !EXCEPT to zero.
!EXCEPT=0

;Both of these operations cause errors.
PRINT, 1./0., 1/0
```

IDL prints:

```
Inf    1
```

The special floating-point value Inf is returned for 1./0. There is no integer analogue to the floating-point Inf.

```
;Check the accumulated error status.
PRINT, CHECK_MATH()
```

IDL prints:

```
      17
```

CHECK_MATH reports floating-point and integer divide-by-zero errors.

```
;Set value of !EXCEPT to one.
!EXCEPT=1

;Both of these operations cause errors.
PRINT, 1./0., 1/0
```

IDL prints:

```
Inf    1
% Program caused arithmetic error: Integer divide by 0
% Program caused arithmetic error: Floating divide by 0
```

This time IDL also prints error messages.

```
;Check the accumulated error status.
PRINT, CHECK_MATH()
```

IDL prints:

```
      0
```

The status was reset.

However, if we do not allow IDL to return to an interactive prompt before checking the math error status:

```
;Set value of !EXCEPT to one.
!EXCEPT=1

;Call to CHECK_MATH happens before returning to the
;IDL command prompt.
PRINT, 1./0., 1/0 & PRINT, CHECK_MATH()
```

IDL prints:

```
Inf    1
17
```

In this case, the math error status code (17) is printed, but because the error status has been cleared by the call to CHECK_MATH, no error messages are printed when IDL returns to the interactive command prompt. Finally,

```
;Set value of !EXCEPT to two.
!EXCEPT=2

;Call to CHECK_MATH happens before returning to the
;IDL command prompt.
PRINT, 1./0., 1/0 & PRINT, CHECK_MATH()
```

IDL prints:

```
Inf       1
% Program caused arithmetic error: Integer divide by 0
% Program caused arithmetic error: Floating divide by 0
% Detected at  $MAIN$
           0
```

Errors are printed before executing the CHECK_MATH function, so CHECK_MATH reports no errors. However, if we include the call to CHECK_MATH in the first PRINT command, we see the following:

```
;Call to CHECK_MATH is part of a single IDL statement.
PRINT, 1./0., 1/0, CHECK_MATH()
```

IDL prints:

```
Inf    1    17
```

## Printing Error Messages

The following code fragment prints abbreviated names of errors that have occurred:

```
;Create a string array of error names.
ERRS = ['Divide by 0', 'Underflow', 'Overflow', $
        'Illegal Operand']

;Get math error status.
J = CHECK_MATH()
FOR I = 4, 7 DO IF ISHFT(J, -I) AND 1 THEN $

;Check to see if an error occurred and print the corresponding
;error message.
   PRINT, ERRS(I-4), ' Occurred'
```

## Testing Critical Code

### Example 1

Assume you have a critical section of code that is likely to produce an error. The following example shows how to check for errors, and if one is detected, how to repeat the code with different parameters.

```
; Clear error status from previous operations, and print error
; messages if an error exists:
JUNK = CHECK_MATH(/PRINT)

; Disable automatic printing of subsequent math errors:
!EXCEPT=0

;Critical section goes here.
AGAIN: ...

; Did an arithmetic error occur? If so, print error message and
; request new values:
IF CHECK_MATH() NE 0 THEN BEGIN
PRINT, 'Math error occurred in critical section.'

; Get new parameters from user:
READ, 'Enter new values.',...

; Enable automatic printing of math errors:
!EXCEPT=2

;And retry:
GOTO, AGAIN
ENDIF
```

### Example 2

This example demonstrates the use of the MASK keyword to check for a specific error, and the NOCLEAR keyword to prevent exceptions from being cleared:

```
PRO EXAMPLE2_CHECKMATH

   PRINT, 1./0
   PRINT, CHECK_MATH(MASK=16,/NOCLEAR)
   PRINT, CHECK_MATH(MASK=2,/NOCLEAR)

END
```

IDL prints:

```
Inf
16
0
% Program caused arithmetic error: Floating divide by 0
```

## Version History

Introduced: Original

## See Also

FINITE, ISHFT, MACHAR, “!VALUES” on page 3895, “!EXCEPT” on page 3899, “Math Errors” in Chapter 18 of the *Building IDL Applications* manual.

# CHISQR_CVF

The CHISQR_CVF function computes the cutoff value *V* in a Chi-square distribution with *Df* degrees of freedom such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

This routine is written in the IDL language. Its source code can be found in the file `chisqr_cvf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CHISQR_CVF(*P*, *Df*)

## Return Value

Returns computes the cutoff value *V* in a Chi-square distribution with *Df* degrees of freedom such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

## Arguments

### P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

### Df

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the Chi-square distribution.

## Keywords

None.

## Examples

Use the following command to compute the cutoff value in a Chi-square distribution with three degrees of freedom such that the probability that a random variable X is greater than the cutoff value is 0.100. The result should be 6.25139.

```
PRINT, CHISQR_CVF(0.100, 3)
```

IDL prints:

```
6.25139
```

## Version History

Introduced: 4.0

## See Also

CHISQR_PDF, F_CVF, GAUSS_CVF, T_CVF

# CHISQR_PDF

The CHISQR_PDF function computes the probability *P* that, in a Chi-square distribution with *Df* degrees of freedom, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

This routine is written in the IDL language. Its source code can be found in the file `chisqr_pdf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CHISQR_PDF(*V*, *Df*)

## Return Value

If both arguments are scalar, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *V* and *Df*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If any of the arguments are double-precision, the result is double-precision, otherwise the result is single-precision.

## Arguments

### V

A scalar or array that specifies the cutoff value(s).

### Df

A positive scalar or array that specifies the number of degrees of freedom of the Chi-square distribution.

## Keywords

None.

## Examples

Use the following command to compute the probability that a random variable X, from the Chi-square distribution with three degrees of freedom, is less than or equal to 6.25. The result should be 0.899939.

```
result = CHISQR_PDF(6.25, 3)
PRINT, result
```

IDL prints:

```
0.899939
```

Compute the probability that a random variable X from the Chi-square distribution with three degrees of freedom, is greater than 6.25. The result should be 0.100061.

```
PRINT, 1 - chisqr_pdf(6.25, 3)
```

IDL prints:

```
0.100061
```

## Version History

Introduced: 4.0

## See Also

BINOMIAL, CHISQR_CVF, F_PDF, GAUSS_PDF, T_PDF

# CHOLDC

Given a positive-definite symmetric *n* by *n* array *A*, the CHOLDC procedure constructs its Cholesky decomposition $A = LL^T$, where *L* is a lower triangular array and $L^T$ is the transpose of *L*.

CHOLDC is based on the routine `choldc` described in section 2.9 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_CHOLDC procedure.

## Syntax

CHOLDC, *A*, *P* [, /DOUBLE]

## Arguments

### A

An *n* by *n* array. On input, only the upper triangle of *A* need be given. On output, *L* is returned in the lower triangle of *A*, except for the diagonal elements, which are returned in the vector *P*.

### P

An *n*-element vector containing the diagonal elements of *L*.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

See “CHOLSOL” on page 238.

## Version History

Introduced: 4.0

## See Also

CHOLSOL, LA_CHOLDC

# CHOLSOL

The CHOLSOL function returns an *n*-element vector containing the solution to the set of linear equations Ax = b, where A is the positive-definite symmetric array returned by the CHOLDC procedure.

CHOLSOL is based on the routine `cholsl` described in section 2.9 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_CHOLSOL procedure.

## Syntax

*Result* = CHOLSOL( *A*, *P*, *B* [, /DOUBLE] )

## Return Value

Returns an *n*-element vector containing the solution to the set of linear equations Ax = b, where A is the positive-definite symmetric array returned by the CHOLDC.

## Arguments

### A

An *n* by *n* positive-definite symmetric array, as output by CHOLDC. Only the lower triangle of *A* is accessed.

### P

The diagonal elements of the Cholesky factor *L*, as computed by CHOLDC.

### B

An *n*-element vector containing the right-hand side of the equation.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

To solve a positive-definite symmetric system Ax = b:

```
;Define the coefficient array:
A = [[ 6.0, 15.0, 55.0], $
   [15.0, 55.0, 225.0], $
   [55.0, 225.0, 979.0]]

;Define the right-hand side vector B:
B = [9.5, 50.0, 237.0]

;Compute Cholesky decomposition of A:
CHOLDC, A, P

;Compute and print the solution:
PRINT, CHOLSOL(A, P, B)
```

IDL prints:

```
  -0.499998  -1.00000  0.500000
```

The exact solution vector is [-0.5, -1.0, 0.5].

## Version History

Introduced: 4.0

## See Also

CHOLDC, CRAMER, GS_ITER, LA_CHOLSOL, LU_COMPLEX, LUSOL, SVSOL, TRISOL

# CINDGEN

The CINDGEN function returns a complex, single-precision, floating-point array with the specified dimensions.

## Syntax

*Result* = CINDGEN($D_1$[, ..., $D_8$])

## Return Value

Returns a complex, single-precision, floating-point array with the specified dimensions. Each element of the array has its real part set to the value of its one-dimensional subscript. The imaginary part is set to zero.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create C, a 4-element vector of complex values with the real parts set to the value of their subscripts, enter:

```
C = CINDGEN(4)
```

## Version History

Introduced: Original

## See Also

BINDGEN, DCINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# CIR_3PNT

The CIR_3PNT procedure returns the radius and center of a circle, given 3 points on the circle. This is analogous to finding the circumradius and circumcircle of a triangle; the center of the circumcircle is the point at which the three perpendicular bisectors of the triangle formed by the points meet.

This routine is written in the IDL language. Its source code can be found in the file `cir_3pnt.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

CIR_3PNT, *X*, *Y*, *R*, *X0*, *Y0*

## Arguments

### X

A three-element vector containing the X-coordinates of the points.

### Y

A three-element vector containing the Y-coordinates of the points.

### R

A named variable that will contain the radius of the circle. The procedure returns 0.0 if the points are co-linear.

### X0

A named variable that will contain the X-coordinate of the center of the circle. The procedure returns 0.0 if the points are co-linear.

### Y0

A named variable that will contain the Y-coordinate of the center of the circle. The procedure returns 0.0 if the points are co-linear.

## Keywords

None.

## Examples

```
X = [1.0, 2.0, 3.0]
Y = [1.0, 2.0, 1.0]
CIR_3PNT, X, Y, R, X0, Y0
PRINT, 'The radius is: ', R
PRINT, 'The center of the circle is at: ', X0, Y0
```

## Version History

Introduced: Pre 4.0

## See Also

PNT_LINE, SPH_4PNT

# CLOSE

The CLOSE procedure closes the file units specified as arguments. All open files are also closed when IDL exits.

## Syntax

CLOSE[, $Unit_1$, ..., $Unit_n$] [, /ALL] [, EXIT_STATUS=*variable*] [, /FILE] [, /FORCE]

## Arguments

### $Unit_i$

The IDL file units to close.

## Keywords

### ALL

Set this keyword to close all open file units. In addition, any file units that were allocated via GET_LUN are freed.

### EXIT_STATUS

Set this keyword to a named variable that will contain the exit status reported by a UNIX child process started via the UNIT keyword to SPAWN. This value is the exit value reported by the process by calling EXIT, and is analogous to the value returned by $? under most UNIX shells. If used with any other type of file, 0 is returned. EXIT_STATUS is not allowed in conjunction with the ALL or FILE keywords.

### FILE

Set this keyword to close all file units from 1 to 99. File units greater than 99, which are associated with the GET_LUN and FREE_LUN procedures, are not affected.

### FORCE

Overrides the IDL file output buffer and forces the file to be closed no matter what errors occur in the process.

IDL buffers file output for performance reasons. If it is not possible to properly flush this data when a file close is requested, an error is normally issued and the file

remains open. An example of this might be that your disk does not have room to write the remaining data. This default behavior prevents data from being lost. To override it and force the file to be closed no matter what errors occur in the process, specify FORCE.

## Examples

If file units 1 and 3 are open, they can both be closed at the same time by entering the command:

```
CLOSE, 1, 3
```

## Version History

Introduced: Original

## See Also

OPEN

# CLUST_WTS

The CLUST_WTS function computes the weights (the cluster centers) of an *m*-column, *n*-row array, where *m* is the number of variables and *n* is the number of observations or samples.

This routine is written in the IDL language. Its source code can be found in the file `clust_wts.pro` in the `lib` subdirectory of the IDL distribution.

For more information on cluster analysis, see:

Everitt, Brian S. *Cluster Analysis*. New York: Halsted Press, 1993. ISBN 0-470-22043-0

## Syntax

*Result* = CLUST_WTS( *Array* [, /DOUBLE] [, N_CLUSTERS=*value*] [, N_ITERATIONS=*integer*] [, VARIABLE_WTS=*vector*] )

## Return Value

Returns an *m*-column, N_CLUSTERS-row array of cluster centers by computing the weights (the cluster centers) of an *m*-column, *n*-row array, where *m* is the number of variables and *n* is the number of observations or samples.

## Arguments

### Array

An *m*-column, *n*-row array of any data type except string, single- or double-precision complex.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### N_CLUSTERS

Set this keyword equal to the number of cluster centers. The default is to compute *n* cluster centers.

### N_ITERATIONS

Set this keyword equal to the number of iterations used when in computing the cluster centers. The default is to use 20 iterations.

### VARIABLE_WTS

Set this keyword equal to an *m*-element vector of floating-point variable weights. The elements of this vector are used to give greater or lesser importance to each variable (each column) in determining the cluster centers. The default is to give all variables equal weighting using a value of 1.0.

## Examples

See “CLUSTER” on page 248.

## Version History

Introduced: 5.0

## See Also

CLUSTER, “Multivariate Analysis” in Chapter 22 of the *Using IDL* manual.

# CLUSTER

The CLUSTER function computes the classification of an *m*-column, *n*-row array, where *m* is the number of variables and *n* is the number of observations or samples. The classification is based upon a cluster analysis of sample-based distances.

This routine is written in the IDL language. Its source code can be found in the file `cluster.pro` in the `lib` subdirectory of the IDL distribution.

For more information on cluster analysis, see:

Everitt, Brian S. *Cluster Analysis*. New York: Halsted Press, 1993. ISBN 0-470-22043-0

## Syntax

*Result* = CLUSTER( *Array*, *Weights* [, /DOUBLE] [, N_CLUSTERS=*value*] )

## Return Value

Results in a 1-column, *n*-row array of cluster number assignments that correspond to each sample.

## Arguments

### Array

An M-column, N-row array of type float or double.

### Weights

An array of weights (the cluster centers) computed using the CLUST_WTS function. The dimensions of this array vary according to keyword values.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### N_CLUSTERS

Set this keyword equal to the number of clusters. The default is based upon the row dimension of the *Weights* array.

## Examples

```
; Define an array with 4 variables and 10 observations:
array = $
[[ 1.5, 43.1, 29.1,  1.9], $
 [24.7, 49.8, 28.2, 22.8], $
 [30.7, 51.9,  7.0, 18.7], $
 [ 9.8,  4.3, 31.1,  0.1], $
 [19.1, 42.2,  0.9, 12.9], $
 [25.6, 13.9,  3.7, 21.7], $
 [ 1.4, 58.5, 27.6,  7.1], $
 [ 7.9,  2.1, 30.6,  5.4], $
 [22.1, 49.9,  3.2, 21.3], $
 [ 5.5, 53.5,  4.8, 19.3]]

; Compute the cluster weights, using two distinct clusters:
weights = CLUST_WTS(array, N_CLUSTERS=2)

; Compute the classification of each sample:
result = CLUSTER(array, weights, N_CLUSTERS=2)

; Print each sample (each row) of the array and its corresponding
; cluster assignment:
FOR k = 0, N_ELEMENTS(result)-1 DO PRINT, $
array[*,k], result(k), FORMAT = '(4(f4.1, 2x), 5x, i1)'
```

IDL prints:

```
 1.5  43.1  29.1   1.9       1
24.7  49.8  28.2  22.8       0
30.7  51.9   7.0  18.7       0
 9.8   4.3  31.1   0.1       1
19.1  42.2   0.9  12.9       0
25.6  13.9   3.7  21.7       0
 1.4  58.5  27.6   7.1       1
 7.9   2.1  30.6   5.4       1
22.1  49.9   3.2  21.3       0
 5.5  53.5   4.8  19.3       0
```

## Version History

Introduced: 5.0

## See Also

CLUST_WTS, PCOMP, STANDARDIZE, “Multivariate Analysis” in Chapter 22 of the *Using IDL* manual.

# COLOR_CONVERT

The COLOR_CONVERT procedure converts colors to and from the RGB (Red Green Blue), HLS (Hue Lightness Saturation), and HSV (Hue Saturation Value) color systems. A keyword parameter indicates the type of conversion to be performed (one of the keywords must be specified). The first three parameters contain the input color triple(s) which may be scalars or arrays of the same size. The result is returned in the last three parameters, $O_0$, $O_1$, and $O_2$. RGB values are bytes in the range 0 to 255.

Hue is measured in degrees, from 0 to 360. Saturation, Lightness, and Value are floating-point numbers in the range 0 to 1. A Hue of 0 degrees is the color red. Green is 120 degrees. Blue is 240 degrees. A reference containing a discussion of the various color systems is: Foley and Van Dam, *Fundamentals of Interactive Computer Graphics*, Addison-Wesley Publishing Co., 1982.

## Syntax

COLOR_CONVERT, $I_0$, $I_1$, $I_2$, $O_0$, $O_1$, $O_2$ {, /HLS_RGB | , /HSV_RGB | , /RGB_HLS | , /RGB_HSV}

## Arguments

### $I_0$, $I_1$, $I_2$

The input color triple(s). These arguments may be either scalars or arrays of the same length.

### $O_0$, $O_1$, $O_2$

The variables to receive the result. Their structure is copied from the input parameters.

## Keywords

### HLS_RGB

Set this keyword to convert from HLS to RGB.

### HSV_RGB

Set this keyword to convert from HSV to RGB.

### RGB_HLS

Set this keyword to convert from RGB to HLS.

### RGB_HSV

Set this keyword to convert from RGB to HSV.

## Examples

The command:

```
COLOR_CONVERT, 255, 255, 0, h, s, v, /RGB_HSV
```

converts the RGB color triple (255, 255, 0), which is the color yellow at full intensity and saturation, to the HSV system. The resulting hue in the variable h is 60.0 degrees. The saturation and value, s and v, are set to 1.0.

## Version History

Introduced: Pre 4.0

## See Also

HLS, HSV

# COLOR_QUAN

The COLOR_QUAN function quantizes a TrueColor image and returns a pseudo-color image and palette to display the image on standard pseudo-color displays. The output image and palette can have from 2 to 256 colors.

COLOR_QUAN solves the general problem of accurately displaying decomposed, TrueColor images, that contain a palette of up to $2^{24}$ colors, on pseudo-color displays that can only display 256 (or fewer) simultaneous colors.

## Using COLOR_QUAN

One of two color quantization methods can be used:

- Method 1 is a statistical method that attempts to find the N colors that most accurately represent the original color distribution. This algorithm uses a variation of the Median Cut Algorithm, described in “Color Image Quantization for Frame Buffer Display”, from *Computer Graphics*, Volume 16, Number 3 (July, 1982), Page 297. It repeatedly subdivides the color space into smaller and smaller rectangular boxes, until the requested number of colors are obtained.

  The original colors are then mapped to the nearest output color, and the original image is resampled to the new palette with optional Floyd-Steinberg color dithering. The resulting pseudo-color image and palette are usually a good approximation of the original image.

  The number of colors in the output palette defaults to the number of colors supported by the currently-selected graphics output device. The number of colors can also be specified by the COLOR keyword parameter.

- Method 2, selected by setting the keyword parameter CUBE, divides the three-dimensional color space into equal-volume cubes. Each color axis is divided into CUBE segments, resulting in $CUBE^3$ volumes. The original input image is sampled to this color space using Floyd-Steinberg dithering, which distributes the quantization error to adjacent pixels.

  The CUBE method has the advantage that the color tables it produces are independent of the input image, so that multiple quantized images can be viewed simultaneously. The statistical method usually provides a better-looking result and a smaller global error.

COLOR_QUAN can use the same color mapping for a series of images. See the descriptions of the GET_TRANSLATION, MAP_ALL, and TRANSLATION keywords, below.

# Syntax

*Result* = COLOR_QUAN( *Image_R*, *Image_G*, *Image_B*, *R*, *G*, *B*)

or

*Result* = COLOR_QUAN( *Image*, *Dim*, *R*, *G*, *B* )

**Keywords:** [, COLORS=*integer*{2 to 256}] [, CUBE={2 | 3 | 4 | 5 | 6} | , GET_TRANSLATION=*variable* [, /MAP_ALL]] [, /DITHER] [, ERROR=*variable*] [, TRANSLATION=*vector*]

Note that the input image parameter can be passed as either three, separate color-component arrays (*Image_R*, *Image_G*, *Image_B*) or as a three-dimensional array containing all three components, *Image*, and a scalar, *Dim*, indicating the dimension over which the colors are interleaved.

# Return Value

Returns a pseudo-color image composed of 2 to 256 colors.

# Arguments

## Image_R, Image_G, Image_B

Arrays containing the red, green, and blue components of the decomposed TrueColor image. For best results, the input image(s) should be scaled to the range of 0 to 255.

## Image

A three-dimensional array containing all three components of the TrueColor image.

## Dim

A scalar that indicates the method of color interleaving in the *Image* parameter. A value of 1 indicates interleaving by pixel: (3, *n*, *m*). A value of 2 indicates interleaving by row: (*n*, 3, *m*). A value of 3 indicates interleaving by image: (*n*, *m*, 3).

### R, G, B

Three output byte arrays containing the red, green, and blue components of the output palette.

## Keywords

### COLORS

The number of colors in the output palette. This value must be at least 2 and not greater than 256. The default is the number of colors supported by the current graphics output device.

### CUBE

If this keyword is set, the color space is divided into $CUBE^3$volumes, to which the input image is quantized. This result is always Floyd-Steinberg dithered. The value of CUBE can range from 2 to 6; providing from $2^3 = 8$, to $6^3 = 216$ output colors. If this keyword is set, the COLORS, DITHER, and ERROR keywords are ignored.

### DITHER

Set this keyword to dither the output image. Dithering can improve the appearance of the output image, especially when using relatively few colors.

### ERROR

Set this optional keyword to a named variable. A measure of the quantization error is returned. This error is proportional to the square of the Euclidean distance, in RGB space, between corresponding colors in the original and output images.

### GET_TRANSLATION

Set this keyword to a named variable in which the mapping between the original RGB triples (in the TrueColor image) and the resulting pseudo-color indices is returned as a vector. Do not use this keyword if CUBE is set.

### MAP_ALL

Set this keyword to establish a mapping for all possible RGB triples into pseudo-color indices. Set this keyword only if GET_TRANSLATION is also present. Note that mapping all possible colors requires more compute time and slightly degrades the quality of the resultant color matching.

### TRANSLATION

Set this keyword to a vector of translation indices obtained by a previous call to COLOR_QUAN using the GET_TRANSLATION keyword. The resulting image is quantized using this vector.

## Examples

The following code segment reads a TrueColor, row interleaved, image from a disk file, and displays it on the current graphics display, using a palette of 128 colors:

```
;Open an input file:
OPENR, unit, 'XXX.DAT', /GET_LUN

;Dimensions of the input image:
a = BYTARR(512, 3, 480)

;Read the image:
READU, unit, a

;Close the file:
FREE LUN, unit

;Show the quantized image. The 2 indicates that the colors are
;interleaved by row:
TV, COLOR_QUAN(a, 2, r, g, b, COLORS=128)

;Load the new palette:
TVLCT, r, g, b
```

To quantize the image into 216 equal-volume color cubes, replace the call to COLOR_QUAN with the following:

```
TV, COLOR_QUAN(a, 2, r, g, b, CUBE=6)
```

## Version History

Introduced: Pre 4.0

## See Also

PSEUDO

# COLORMAP_APPLICABLE

The COLORMAP_APPLICABLE function determines whether the current visual class supports the use of a colormap, and if so, whether colormap changes affect pre-displayed Direct Graphics or if the graphics must be redrawn to pick up colormap changes.

This routine is written in the IDL language. Its source code can be found in the file `colormap_applicable.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = COLORMAP_APPLICABLE( *redrawRequired* )

## Return Value

The function returns a long value of 1 if the current visual class allows modification of the color table, and 0 otherwise.

## Arguments

### redrawRequired

A named variable to retrieve a value indicating whether the visual class supports automatic updating of graphics. The value is 0 if the graphics are updated automatically, or 1 if the graphics must be redrawn to pick up changes to the colormap.

## Keywords

None.

## Examples

To determine whether to redisplay an image after a colormap change:

```
result = COLORMAP_APPLICABLE(redrawRequired)
IF ((result GT 0) AND (redrawRequired GT 0)) THEN BEGIN
   my_redraw
ENDIF
```

## Version History

Introduced: 5.2

# COMFIT

The COMFIT function fits the paired data {*xi*, *yi*} to one of six common types of approximating models using a gradient-expansion least-squares method.

This routine is written in the IDL language. Its source code can be found in the file `comfit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = COMFIT( *X*, *Y*, *A* {, /EXPONENTIAL | , /GEOMETRIC | , /GOMPERTZ | , /HYPERBOLIC | , /LOGISTIC | , /LOGSQUARE} [, SIGMA=*variable*] [, WEIGHTS=*vector*] [, YFIT=*variable*] )

## Return Value

Results in a vector containing the model parameters $a_0$, $a_1$, $a_2$, etc.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector.

### Y

An *n*-element integer, single-, or double-precision floating-point vector.

### A

A vector of initial estimates for each model parameter. The length of this vector depends upon the type of model selected.

## Keywords

**Note**

One of the following keywords specifying a type of model must be set when using COMFIT. If you do not specify a model, IDL will display a warning message when COMFIT is called.

## EXPONENTIAL

Set this keyword to compute the parameters of the exponential model.

$$y = a_0 a_1^x + a_2$$

## GEOMETRIC

Set this keyword to compute the parameters of the geometric model.

$$y = a_0 x^{a_1} + a_2$$

## GOMPERTZ

Set this keyword to compute the parameters of the Gompertz model.

$$y = a_0 a_1^{a_2 x} + a_3$$

## HYPERBOLIC

Set this keyword to compute the parameters of the hyperbolic model.

$$y = \frac{1}{a_0 + a_1 x}$$

## LOGISTIC

Set this keyword to compute the parameters of the logistic model.

$$y = \frac{1}{a_0 a_1^x + a_2}$$

## LOGSQUARE

Set this keyword to compute the parameters of the logsquare model.

$$y = a_0 + a_1 \log(x) + a_2 \log(x)^2$$

## SIGMA

Set this keyword to a named variable that will contain a vector of standard deviations for the computed model parameters.

### WEIGHTS

Set this keyword equal to a vector of weights for $Y_i$. This vector should be the same length as *X* and *Y*. The error for each term is weighted by $WEIGHTS_i$ when computing the fit. Frequently, $WEIGHTS_i = 1.0/\sigma^2_i$, where σ is the measurement error or standard deviation of $Y_i$ (Gaussian or instrumental weighting), or WEIGHTS = 1/Y (Poisson or statistical weighting). If WEIGHTS is not specified, $WEIGHTS_i$ is assumed to be 1.0.

### YFIT

Set this keyword to a named variable that will contain an *n*-element vector of y-data corresponding to the computed model parameters.

## Examples

```
; Define two n-element vectors of paired data:
X = [ 2.27, 15.01, 34.74, 36.01, 43.65, 50.02, 53.84, 58.30, $
     62.12, 64.66, 71.66, 79.94, 85.67, 114.95]
Y = [ 5.16, 22.63, 34.36, 34.92, 37.98, 40.22, 41.46, 42.81, $
     43.91, 44.62, 46.44, 48.43, 49.70, 55.31]

; Define a 3-element vector of initial estimates for the logsquare
; model:
A = [1.5, 1.5, 1.5]

; Compute the model parameters of the logsquare model, A[0], A[1],
; & A[2]:
result = COMFIT(X, Y, A, /LOGSQUARE)
```

The result should be the 3-element vector: [1.42494, 7.21900, 9.18794].

## Version History

Introduced: 4.0

## See Also

CURVEFIT, LADFIT, LINFIT, LMFIT, POLY_FIT, SVDFIT

# COMMON

The COMMON statement creates a common block.

**Note**

For more information on using COMMON, see Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual.

## Syntax

COMMON *Block_Name*, $Variable_1$, ..., $Variable_n$

## Version History

Introduced: Original

# COMPILE_OPT

The COMPILE_OPT statement allows you to give the IDL compiler information that changes some of the default rules for compiling the function or procedure within which the COMPILE_OPT statement appears.

RSI recommends the use of

```
COMPILE_OPT IDL2
```

in all new code intended for use in a reusable library. We further recommend the use of

```
COMPILE_OPT idl2, HIDDEN
```

in all such routines that are not intended to be called directly by regular users (e.g. helper routines that are part of a larger package).

**Note**

For information on using COMPILE_OPT, see Chapter 4, "Procedures and Functions" in the *Building IDL Applications* manual.

## Syntax

COMPILE_OPT $opt_1$ [, $opt_2$, ..., $opt_n$]

## Arguments

### $opt_n$

This argument can be any of the following:

- **IDL2** — A shorthand way of saying:

  ```
  COMPILE_OPT DEFINT32, STRICTARR
  ```

- **DEFINT32** — IDL should assume that lexical integer constants default to the 32-bit type rather than the usual default of 16-bit integers. This takes effect from the point where the COMPILE_OPT statement appears in the routine being compiled and remains in effect until the end of the routine. The following table illustrates how the DEFINT32 argument changes the interpretation of integer constants:

| Constant | Normal Type | DEFINT32 Type |
|---|---|---|
| **Without type specifier:** | | |
| `42` | INT | LONG |
| `'2a'x` | INT | LONG |
| `42u` | UINT | ULONG |
| `'2a'xu` | UINT | ULONG |
| **With type specifier:** | | |
| `0b` | BYTE | BYTE |
| `0s` | INT | INT |
| `0l` | LONG | LONG |
| `42.0` | FLOAT | FLOAT |
| `42d` | DOUBLE | DOUBLE |
| `42us` | UINT | UINT |
| `42ul` | ULONG | ULONG |
| `42ll` | LONG64 | LONG64 |
| `42ull` | ULONG64 | ULONG64 |

*Table 5: Examples of the Effect of the DEFINT32 Argument*

- **HIDDEN** — This routine should not be displayed by HELP, unless the FULL keyword to HELP is used. This directive can be used to hide helper routines that regular IDL users are not interested in seeing.

  A side-effect of making a routine hidden is that IDL will not print a “Compile module” message for it when it is compiled from the library to satisfy a call to it. This makes hidden routines appear built-in to the user.

- **LOGICAL_PREDICATE** — When running this routine, from the point where the COMPILE_OPT statement appears until the end of the routine, treat

any non-zero or non-NULL predicate value as “true,” and any zero or NULL predicate value as “false.”

### Background

A predicate expression is an expression that is evaluated as being “true” or “false” as part of a statement that controls program execution. IDL evaluates such expressions in the following contexts:

- `IF...THEN...ELSE` statements
- `? :` inline conditional expressions
- `WHILE...DO` statements
- `REPEAT...UNTIL` statements
- when evaluating the result from an INIT function method to determine if a call to OBJ_NEW successfully created a new object

By default, IDL uses the following rules to determine whether an expression is true or false:

- **Integer** — An integer is considered true if its least significant bit is 1, and false otherwise. Hence, odd integers are true and even integers (including zero) are false. This interpretation of integer truth values is sometimes referred to as “bitwise,” reflecting the fact that the value of the least significant bit determines the result.
- **Other** — Non-integer numeric types are true if they are non-zero, and false otherwise. String and heap variables (pointers and object references) are true if they are non-NULL, and false otherwise.

The LOGICAL_PREDICATE option alters the way IDL evaluates predicate expressions. When LOGICAL_PREDICATE is set for a routine, IDL uses the following rules to determine whether an expression is true or false:

- **Numeric Types** — A number is considered true if its value is non-zero, and false otherwise.
- **Other Types** — Strings and heap variables (pointers and object references) are considered true if they are non-NULL, or false otherwise.

### Note on the NOT Operator

When using the LOGICAL_PREDICATE compile option, you must be aware of the fact that applying the IDL NOT operator to integer data computes a *bitwise* negation (1’s complement), and is generally not applicable for use in logical computations. Consider the common construction:

```
WHILE (NOT EOF(lun)) DO BEGIN
...
ENDWHILE
```

The EOF function returns 0 while the file specified by LUN has data left, and returns 1 when hits the end of file. However, the expression “NOT 1” has the numeric value -2. When the LOGICAL_PREDICATE option is not in use, the WHILE statement sees -2 as false; if the LOGICAL_PREDICATE is in use, -2 is a true value and the above loop will not terminate as desired.

The proper way to write the above loop uses the ~ logical negation operator:

```
WHILE (~ EOF(lun)) DO BEGIN
...
ENDWHILE
```

It is worth noting that this version will work properly whether or not the LOGICAL_PREDICATE compile option is in use. Logical negation operations should always use the ~ operator in preference to the NOT operator, reserving NOT exclusively for bitwise computations.

- **OBSOLETE** — If the user has !WARN.OBS_ROUTINES set to True, attempts to compile a call to this routine will generate warning messages that this routine is obsolete. This directive can be used to warn people that there may be better ways to perform the desired task.
- **STRICTARR** — While compiling this routine, IDL will not allow the use of parentheses to index arrays, reserving their use only for functions. Square brackets are then the only way to index arrays. Use of this directive will prevent the addition of a new function in future versions of IDL, or new libraries of IDL code from any source, from changing the meaning of your code, and is an especially good idea for library functions.

  Use of STRICTARR can eliminate many uses of the FORWARD_FUNCTION definition.

**Note**

STRICTARR has no effect on the use of parentheses to reference structure tags using the tag index, which is not an array indexing operation. For example, no syntax error will occur when compiling the following code:

```
COMPILE_OPT STRICTARR
mystruct = {a:0, b:1}
byindex_0 = mystruct.(0)
```

For more on referencing structure tags by index, see "Advanced Structure Usage" in Chapter 7 of the *Building IDL Applications* manual.

- **STRICTARRSUBS** — When IDL subscripts one array using another array as the source of array indices, the default behavior is to clip any out-of-range indices into range and then quietly use the resulting data without error. This behavior is described in "Array Subscripting" in Chapter 6 of the *Building IDL Applications* manual. Specifying STRICTARRSUBS will instead cause IDL to treat such out-of-range array subscripts within the body of the routine containing the COMPILE_OPT statement as an error. The position of the STRICTARRSUBS option within the module is not important: All subscripting operations within the entire body of the specified routine will be treated this way.

## Version History

Introduced: 5.3.

STRICTARRSUBS option added: 5.6

LOGICAL_PREDICATE option added: 6.0

# COMPLEX

The COMPLEX function returns complex scalars or arrays given one or two scalars or arrays.

## Syntax

*Result* = COMPLEX( *Real [, Imaginary]* [, /DOUBLE])

or

*Result* = COMPLEX(*Expression, Offset, $D_1$ [, ..., $D_8$]* [, /DOUBLE])

## Return Value

Returns complex scalars or arrays given one or two scalars or arrays. If only one parameter is supplied, the imaginary part of the result is zero, otherwise it is set to the value of the *Imaginary* parameter. Parameters are first converted to single-precision floating-point. If either or both of the parameters are arrays, the result is an array, following the same rules as standard IDL operators. If three parameters are supplied, COMPLEX extracts fields of data from *Expression*.

## Arguments

### Real

Scalar or array to be used as the real part of the complex result.

### Imaginary

Scalar or array to be used as the imaginary part of the complex result.

### Expression

The expression from which data is to be extracted.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as complex data. See the

description in Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual for details.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

## Keywords

### DOUBLE

Set this keyword to return a double-precision complex result. Setting this keyword is equivalent to using the DCOMPLEX function, and is provided as a programming convenience.

### Thread Pool Keywords

This routine is written to make use of IDL’s *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

Create a complex array from two integer arrays by entering the following commands:

```
; Create the first integer array:
A = [1,2,3]

; Create the second integer array:
B = [4,5,6]
```

```
; Make A the real parts and B the imaginary parts of the new
; complex array:
C = COMPLEX(A, B)

; See how the two arrays were combined:
PRINT, C
```

IDL prints:

```
( 1.00000, 4.00000)( 2.00000, 5.00000)
( 3.00000, 6.00000)
```

The real and imaginary parts of the complex array can be extracted as follows:

```
; Print the real part of the complex array C:
PRINT, 'Real Part: ', REAL_PART(C)

; Print the imaginary part of the complex array C:
PRINT, 'Imaginary Part: ', IMAGINARY(C)
```

IDL prints:

```
Real Part:         1.00000   2.00000   3.00000
Imaginary Part:    4.00000   5.00000   6.00000
```

## Version History

Introduced: Original

## See Also

BYTE, CONJ, DCOMPLEX, DOUBLE, FIX, FLOAT, IMAGINARY, LONG, LONG64, REAL_PART, STRING, UINT, ULONG, ULONG64

# COMPLEXARR

The COMPLEXARR function returns a complex, single-precision, floating-point vector or array.

## Syntax

*Result* = COMPLEXARR( $D_1$*[*, ..., $D_8$*]* [, /NOZERO] )

## Return Value

Returns a complex, single-precision, floating-point vector or array.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, COMPLEXARR sets every element of the result to zero. If the NOZERO keyword is set, this zeroing is not performed, and COMPLEXARR executes faster.

## Examples

To create an empty, 5-element by 5-element, complex array C, enter:

```
C = COMPLEXARR(5, 5)
```

## Version History

Introduced: Original

## See Also

DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# COMPLEXROUND

The COMPLEXROUND function rounds real and imaginary components of a complex array.

This routine is written in the IDL language. Its source code can be found in the file `complexround.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = COMPLEXROUND(*Input*)

## Return Value

Returns the result of rounding the real and imaginary components of the input array. If the array is double-precision complex, then the result is also double-precision complex.

## Arguments

### Input

The complex array to be rounded.

## Keywords

None.

## Examples

```
X = [COMPLEX(1.245, 3.88), COMPLEX(9.1, 0.3345)]
PRINT, COMPLEXROUND(X)
```

IDL prints:

```
(   1.00000,   4.00000)(   9.00000,   0.00000)
```

## Version History

Introduced: Pre 4.0

## See Also

ROUND

# COMPUTE_MESH_NORMALS

The COMPUTE_MESH_NORMALS function computes normal vectors for a set of polygons described by the input array.

## Syntax

*Result* = COMPUTE_MESH_NORMALS( *fVerts*[, *iConn*] )

## Return Value

Returns a 3 x *M* array containing a unit normal for each vertex in the input array.

## Arguments

### fVerts

A 3 x *M* array of vertices.

### iConn

A connectivity array (see the POLYGONS keyword to IDLgrPolygon::Init). If no *iConn* array is provided, it is assumed that the vertices in *fVerts* constitute a single polygon.

## Keywords

None.

## Version History

Introduced: 5.1

# COND

The COND function returns the condition number of a real or complex two-dimensional array *A*.

By default, COND uses the $L_\infty$ $L_\infty$ For the $L_1$ and $L_\infty$ norms, the condition number is computed form NORM(*A*)·NORM(INVERT(*A*)). If *A* is real and the inverse of A is invalid (due to the singularity of *A* or floating-point errors in the INVERT function), COND returns -1. If *A* is complex and the inverse of A is invalid (due to the singularity of *A*), calling COND results in floating-point errors.

For the $L_2$ norm, the condition number is defined as the ratio of the largest singular value to the smallest. The singular values are computed using SVDC.

This routine is written in the IDL language. Its source code can be found in the file `cond.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = COND( *A* [, /DOUBLE] [, LNORM={0 | 1 | 2}])

## Return Value

Returns the condition number of an *n* by *n* real or complex array *A* by explicitly computing NORM(A)·NORM($A^{-1}$). If *A* is real and $A^{-1}$ is invalid (due to the singularity of *A* or floating-point errors in the INVERT function), COND returns -1. If *A* is complex and $A^{-1}$ is invalid (due to the singularity of *A*), calling COND results in floating-point errors.

## Arguments

### A

The two-dimensional array. For LNORM = 0 or 1, the array *A* must be a square and can be either real or complex. For LNORM = 2, the array *A* may be rectangular and can only be real.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### LNORM

Set this keyword to an integer value to indicate which norm to use for the computation. The possible values of this keyword are:

| Value | Description |
|---|---|
| 0 | Use the $L_\infty$ norm (the maximum absolute row sum norm). This is the default. |
| 1 | Use the $L_1$ norm (the maximum absolute column sum norm). |
| 2 | Use the $L_2$ norm (the spectral norm). For LNORM = 2, *A* cannot be complex. |

*Table 6: LNORM Keyword Values*

## Examples

```
; Define a complex array A:
A = [[COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3, 1)], $
     [COMPLEX(1,-2), COMPLEX(2, 2), COMPLEX(1, 0)], $
     [COMPLEX(1, 1), COMPLEX(0, 1), COMPLEX(1, 5)]]

; Compute the condition number of the array using internal
; double-precision arithmetic:
PRINT, COND(A, /DOUBLE)
```

IDL prints:

```
5.93773
```

## Version History

Introduced: Pre 4.0

## See Also

DETERM, INVERT, NORM, SVDC

# CONGRID

The CONGRID function shrinks or expands the size of an array by an arbitrary amount. CONGRID is similar to REBIN in that it can resize a one, two, or three dimensional array, but where REBIN requires that the new array size must be an integer multiple of the original size, CONGRID will resize an array to any arbitrary size. (REBIN is somewhat faster, however.) REBIN averages multiple points when shrinking an array, while CONGRID just resamples the array.

This routine is written in the IDL language. Its source code can be found in the file `congrid.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CONGRID( *Array, X, Y, Z* [, /CENTER] [, CUBIC=*value*{-1 to 0}] [, /INTERP] [, /MINUS_ONE] )

## Return Value

Returns the resized array. The returned array has the same number of dimensions as the original array and is of the same data type.

## Arguments

### Array

A 1-, 2-, or 3-dimensional array to resize. *Array* can be any type except string or structure.

### X

The new X-dimension of the resized array. *X* must be an integer or a long integer, and must be greater than or equal to 2.

### Y

The new Y-dimension of the resized array. If the original array has only 1 dimension, *Y* is ignored. If the original array has 2 or 3 dimensions *Y* MUST be present.

### Z

The new Z-dimension of the resized array. If the original array has only 1 or 2 dimensions, *Z* is ignored. If the original array has 3 dimensions then *Z* MUST be present.

## Keywords

### CENTER

Set this keyword to shift the interpolation so that points in the input and output arrays are assumed to lie at the midpoint of their coordinates rather than at their lower-left corner.

### CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm. This keyword has no effect when used with 3-dimensional arrays.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than $\omega_0$, and *f* is sampled with spacing less than or equal to $1/(2\omega_0)$, then *f* can be reconstructed by convolving with a sinc function: $\text{sinc}(x) = \sin(\pi x) / (\pi x)$.

In the one-dimensional case, four neighboring points are used, while in the two-dimensional case 16 points are used. Note that cubic convolution interpolation is significantly slower than bilinear interpolation.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

### INTERP

Set this keyword to force CONGRID to use linear interpolation when resizing a 1- or 2-dimensional array. CONGRID automatically uses linear interpolation if the input array is 3-dimensional. When the input array is 1- or 2-dimensional, the default is to employ nearest-neighbor sampling.

### MINUS_ONE

Set this keyword to prevent CONGRID from extrapolating one row or column beyond the bounds of the input array. For example, if the input array has the dimensions (*i*, *j*) and the output array has the dimensions (*x*, *y*), then by default the array is resampled by a factor of (*i*/*x*) in the X direction and (*j*/*y*) in the Y direction. If MINUS_ONE is set, the array will be resampled by the factors (*i*-1)/(*x*-1) and (*j*-1)/(*y*-1).

## Examples

Given `vol` is a 3-D array with the dimensions (80, 100, 57), resize it to be a (90, 90, 80) array

```
vol = CONGRID(vol, 90, 90, 80)
```

## Version History

Introduced: Original

## See Also

REBIN

# CONJ

The CONJ function returns the complex conjugate of *X*. The complex conjugate of the real-imaginary pair (*x*, *y*) is (*x*, -*y*). If *X* is not complex, a complex-valued copy of *X* is used.

## Syntax

*Result* = CONJ(*X*)

## Return Value

Returns the complex conjugate of *X*.

## Arguments

### X

The value for which the complex conjugate is desired. If *X* is an array, the result has the same structure, with each element containing the complex conjugate of the corresponding element of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Print the conjugate of the complex pair (4.0, 5.0) by entering:

```
PRINT, CONJ(COMPLEX(4.0, 5.0))
```

IDL prints:

```
( 4.00000, -5.00000)
```

## Version History

Introduced: Original

## See Also

CINDGEN, COMPLEX, COMPLEXARR, DCINDGEN, DCOMPLEX, DCOMPLEXARR

# CONSTRAINED_MIN

The CONSTRAINED_MIN procedure solves nonlinear optimization problems of the following form:

Minimize or maximize gp(X), subject to:

$$glb_i \le g_i(X) \le gub_i \qquad \text{for } i = 0,...,nfuns-1,\ i \ne p$$

$$xlb_j \le x_j \le xub_j \qquad \text{for } j = 0,...,nvars-1$$

*X* is a vector of *nvars* variables, $x_0$ ,...,$x_{nvars}$-1, and *G* is a vector of *nfuns* functions $g_0$ ,...,$g_{nfuns}$-1, which all depend on *X*. Any of these functions may be nonlinear. Any of the bounds may be infinite and any of the constraints may be absent. If there are no constraints, the problem is solved as an unconstrained optimization problem. The program solves problems of this form by the Generalized Reduced Gradient Method. See References 1-4.

CONSTRAINED_MIN uses first partial derivatives of each function $g_i$ with respect to each variable $x_j$. These are automatically computed by finite difference approximation (either forward or central differences).

CONSTRAINED_MIN is based on an implementation of the GRG algorithm supplied by Windward Technologies, Inc. See Reference 11.

## Syntax

CONSTRAINED_MIN, *X*, *Xbnd*, *Gbnd*, *Nobj*, *Gcomp*, *Inform* [, EPSTOP=*value*] [, LIMSER=*value*] [, /MAXIMIZE] [, NSTOP=*value*] [, REPORT=*filename*] [, TITLE=*string*]

## Arguments

### X

An *nvars*-element vector. On input, *X* contains initial values for the variables. On output, *X* contains final values of the variable settings determined by CONSTRAINED_MIN.

### Xbnd

Bounds on variables. *Xbnd* is an *nvars x 2* element array.

- *Xbnd[j,0]* is the lower bound for variable *x[j]*.

- *Xbnd[j,1]* is the upper bound for variable *x[j]*.
- Use -1.0e30 to denote no lower bound and 1.0e30 for no upper bound.

## Gbnd

Bounds on constraint functions. *Gbnd* is an *nfuns x 2* element array.

- *Gbnd[i,0]* is the lower bound for function *g[i]*.
- *Gbnd[i,1]* is the upper bound for function *g[i]*.
- use -1.0e30 to denote no lower bound and 1.0e30 for no upper bound.

Bounds on the objective function are ignored; set them to 0.

## Nobj

Index of the objective function.

## Gcomp

A scalar string specifying the name of a user-supplied IDL function. This function must accept an *nvars*-element vector argument *x* of variable values and return an *nfuns*-element vector *G* of function values.

## Inform

Termination status returned from CONSTRAINED_MIN.

| ***Inform* value** | **Message** |
|---|---|
| 0 | Kuhn-Tucker conditions satisfied.<br>This is the best possible indicator that an optimal point has been found. |
| 1 | Fractional change in objective less than EPSTOP for NSTOP consecutive iterations. See Keywords below.<br>This is not as good as *Inform*=0, but still indicates the likelihood that an optimal point has been found. |
| 2 | All remedies have failed to find a better point.<br>User should check functions and bounds for consistency and, perhaps, try other starting values. |

*Table 7: Inform Argument Values*

| *Inform* value | Message |
|---|---|
| 3 | Number of completed 1-dimensional searches exceeded LIMSER. See Keywords below.<br>User should check functions and bounds for consistency and, perhaps, try other starting values. It might help to increase LIMSER. Use LIMSER=*larger_value* to do this. |
| 4 | Objective function is unbounded.<br>CONSTRAINED_MIN has observed dramatic change in the objective function over several steps. This is a good indication that the objective function is unbounded. If this is not the case, the user should check functions and bounds for consistency. |
| 5 | Feasible point not found.<br>CONSTRAINED_MIN was not able to find a feasible point. If the problem is believed to be feasible, the user should check functions and bounds for consistency and perhaps try other starting values. |
| 6 | Degeneracy has been encountered.<br>The point returned may be close to optimal. The user should check functions and bounds for consistency and perhaps try other starting values. |
| 7 | Noisy and nonsmooth function values. Possible singularity or error in the function evaluations. |
| 8 | Optimization process terminated by user request. |
| 9 | Maximum number of function evaluations exceeded. |
| –1 | Fatal Error. Some condition, such as *nvar*s < 0, was encountered. CONSTRAINED_MIN documented the condition in the report and terminated. In this case, the user needs to correct the input and rerun CONSTRAINED_MIN. |
| –2 | Fatal Error. The report file could not be opened. Check the filename specified via the REPORT keyword, and make sure you have write privileges to the specified path. |

*Table 7: Inform Argument Values*

| *Inform* value | Message |
|---|---|
| –3 | Fatal Error. Same as *Inform* = –1. In this case, the REPORT keyword was not specified. Specify the REPORT keyword and rerun CONSTRAINED_MIN, then check the report file for more detail on the error. |

*Table 7: Inform Argument Values*

# Keywords

## EPSTOP

Set this keyword to specify the CONSTRAINED_MIN convergence criteria. If the fractional change in the objective function is less than EPSTOP for NSTOP consecutive iterations, the program will accept the current point as optimal. CONSTRAINED_MIN will accept the current point as optimal if the Kuhn-Tucker optimality conditions are satisfied to EPSTOP. By default, EPSTOP = 1.0e-4.

## LIMSER

If the number of completed one dimensional searches exceeds LIMSER, CONSTRAINED_MIN terminates and returns inform = 3. By default: LIMSER = 10000.

## MAXIMIZE

By default, the CONSTRAINED_MIN procedure performs a minimization. Set the MAXIMIZE keyword to perform a maximization instead.

## NSTOP

Set this keyword to specify the CONSTRAINED_MIN convergence criteria. If the fractional change in the objective function is less than EPSTOP for NSTOP consecutive iterations, CONSTRAINED_MIN will accept the current point as optimal. By default, NSTOP = 3.

## REPORT

Set this keyword to specify a name for the CONSTRAINED_MIN report file. If the specified file does not exist, it will be created. Note that if the file cannot be created, no error message will be generated. If the specified file already exists, it will be overwritten. By default, CONSTRAINED_MIN does not create a report file.

### TITLE

Set this keyword to specify a title for the problem in the CONSTRAINED_MIN report.

## Examples

This example has 5 variables {X0, X1, ..., X4}, bounded above and below, a quadratic objective function {G3}, and three quadratic constraints {G0, G1, G2}, with both upper and lower bounds. See the Himmelblau text [7], problem 11.

Minimize:

```
G3 = 5.3578547X2X2 + 0.8356891X0X4 + 37.293239X0 - 40792.141
```

Subject to:

$0 < G0 = 85.334407 + 0.0056858X1X4 + 0.0006262X0X3 - 0.0022053X2X4 < 92$

$90 < G1 = 80.51249 + 0.0071317X1X4 + 0.0029955X0X1 + 0.0021813X2X2 < 110$

$20 < G2 = 9.300961 + 0.0047026X2X4 + 0.0012547X0X2 + 0.0019085X2X3 < 25$

and,

```
78 < X0 < 102
33 < X1 < 45
27 < X2 < 45
27 < X3 < 45
27 < X4 < 45
```

This problem is solved starting from X = {78, 33, 27, 27, 27} which is infeasible because constraint G2 is not satisfied at this point.

The constraint functions and objective function are evaluated by HMBL11:

```
; Himmelblau Problem 11
; 5 variables and 4 functions
FUNCTION HMBL11, x

g = DBLARR(4)
g[0] = 85.334407 + 0.0056858*x[1]*x[4] + 0.0006262*x[0] $
   *x[3] - 0.0022053*x[2]*x[4]
g[1] = 80.51249 + 0.0071317*x[1]*x[4] + 0.0029955*x[0] $
   *x[1] + 0.0021813*x[2]*x[2]
g[2] = 9.300961 + 0.0047026*x[2]*x[4] + 0.0012547*x[0]* $
   x[2] + 0.0019085*x[2]*x[3]
g[3] = 5.3578547*x[2]*x[2] + 0.8356891*x[0]*x[4] $
   + 37.293239*x[0] - 40792.141
RETURN, g
END
```

```
; Example problem for CONSTRAINED_MIN
; Himmelblau Problem 11
; 5 variables and 3 constraints
; Constraints and objective defined in HMBL11
xbnd   = [[78, 33, 27, 27, 27], [102, 45, 45, 45, 45]]
gbnd   = [[0, 90, 20, 0], [92, 110, 25, 0 ]]
nobj   = 3
gcomp  = 'HMBL11'
title  = 'IDL:  Himmelblau 11'
report = 'hmbl11.txt'
x      = [78, 33, 27, 27, 27]
CONSTRAINED_MIN, x, xbnd, gbnd, nobj, gcomp, inform, $
   REPORT = report, TITLE = title
g = HMBL11(x)
; Print minimized objective function for HMBL11 problem:
PRINT, g[nobj]
```

## References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3. Abadie, J. and Carpentier, J. “Generalization of the Wolfe Reduced Gradient Method to the Case of Nonlinear Constraints”, in Optimization, R. Fletcher (ed.), Academic Press London; 1969, pp. 37-47.

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7. Himmelblau, D.M., Applied Nonlinear Programming, McGraw-Hill Book Co., New York, 1972.

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9. Smith, S. and Lasdon, L.S., Solving Large Sparse Nonlinear Programs Using GRG, ORSA Journal on Computing, Vol. 4, No. 1,Winter 1992, pp. 1-15.

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11. Windward Technologies, GRG2 Users's Guide, 1997.

## Version History

Introduced: 5.1

# CONTINUE

The CONTINUE statement provides a convenient way to immediately start the next iteration of the enclosing FOR, WHILE, or REPEAT loop.

**Note**

Do not confuse the CONTINUE statement described here with the .CONTINUE executive command. The two constructs are not related, and serve completely different purposes.

**Note**

CONTINUE is not allowed within CASE or SWITCH statements. This is in contrast with the C language, which does allow this.

For more information on using CONTINUE and other IDL program control statements, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

CONTINUE

## Examples

This example presents one way (not necessarily the best) to print the even numbers between 1 and 10.

```
FOR I = 1,10 DO BEGIN
   ; If odd, start next iteration:
   IF (I AND 1) THEN CONTINUE
   PRINT, I
ENDFOR
```

## Version History

Introduced: 5.4

# CONTOUR

The CONTOUR procedure draws a contour plot from data stored in a rectangular array or from a set of unstructured points. Both line contours and filled contour plots can be created. Note that outline and fill contours cannot be drawn at the same time. To create a contour plot with both filled contours and outlines, first create the filled contour plot, then add the outline contours by calling CONTOUR a second time with the OVERPLOT keyword.

Contours can be smoothed by using the MIN_CURVE_SURF function on the contour data before contouring.

Using various keywords, described below, it is possible to specify contour levels, labeling, colors, line styles, and other options. CONTOUR draws contours by searching for each contour line and then following the line until it reaches a boundary or closes.

### Smoothing Contours

The MIN_CURVE_SURF function can be used to smoothly interpolate both regularly and irregularly sampled surfaces before contouring. This function replaces the older SPLINE keyword to CONTOUR, which was inaccurate and is no longer supported. MIN_CURVE_SURF interpolates the entire surface to a relatively fine grid before drawing the contours.

## Syntax

CONTOUR, *Z* [, *X*, *Y*] [, C_ANNOTATION=*vector_of_strings*]
[, C_CHARSIZE=*value*] [, C_CHARTHICK=*integer*] [, C_COLORS=*vector*]
[, C_LABELS=*vector*{each element 0 or 1}] [, C_LINESTYLE=*vector*] [{, /FILL |
, /CELL_FILL} | [, C_ORIENTATION=*degrees*] [, C_SPACING=*value*]]
[, C_THICK=*vector*] [, /CLOSED] [, /DOWNHILL] [, /FOLLOW]
[, /IRREGULAR] [, /ISOTROPIC] [, LEVELS=*vector*] [, NLEVELS=*integer*{1 to
60}] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, /OVERPLOT]
[{, /PATH_DATA_COORDS, PATH_FILENAME=*string*, PATH_INFO=*variable*,
PATH_XY=*variable*} | , TRIANGULATION=*variable*] [, /PATH_DOUBLE]
[, /XLOG] [, /YLOG] [, ZAXIS={0 | 1 | 2 | 3 | 4}]

**Graphics Keywords:** Accepts all graphics keywords accepted by PLOT except for: LINESTYLE, PSYM, SYMSIZE. See “Graphics Keywords Accepted” on page 302.

# Arguments

## Z

A one- or two-dimensional array containing the values that make up the contour surface. If arguments *X* and *Y* are provided, the contour is plotted as a function of the (X, Y) locations specified by their contents. Otherwise, the contour is generated as a function of the two-dimensional array index of each element of *Z*.

If the IRREGULAR keyword is set, X, Y, Z are all required, and are treated as vectors. Each point has a value of Z[i] and a location of (X[i], Y[i]).

This argument is converted to double-precision floating-point before plotting. Plots created with CONTOUR are limited to the range and precision of double-precision floating-point values.

## X

A vector or two-dimensional array specifying the X coordinates for the contour surface. If *X* is a vector, each element of *X* specifies the X coordinate for a column of *Z* (e.g., X[0] specifies the X coordinate for Z[0,*]). If X is a two-dimensional array, each element of X specifies the X coordinate of the corresponding point in Z (i.e., $X_{ij}$ specifies the X coordinate for $Z_{ij}$).

## Y

A vector or two-dimensional array specifying the Y coordinates for the contour surface. If *Y* a vector, each element of *Y* specifies the Y coordinate for a row of Z (e.g., Y[0] specifies the Y coordinate for Z[*,0]). If *Y* is a two-dimensional array, each element of *Y* specifies the Y coordinate of the corresponding point in Z ($Y_{ij}$ specifies the Y coordinate for $Z_{ij}$).

# Keywords

## C_ANNOTATION

The label to be drawn on each contour. Usually, contours are labeled with their value. This parameter, a vector of strings, allows any text to be specified. The first label is used for the first contour drawn, and so forth. If the LEVELS keyword is specified, the elements of C_ANNOTATION correspond directly to the levels specified, otherwise, they correspond to the default levels chosen by the CONTOUR procedure. If there are more contour levels than elements in C_ANNOTATION, the remaining levels are labeled with their values.

Use of this keyword implies use of the FOLLOW keyword.

**Note**

This keyword has no effect if the FILL or CELL_FILL keyword is set (i.e., if the contours are drawn with solid-filled or line-filled polygons).

### Example

To produce a contour plot with three levels labeled “low”, “medium”, and “high”:

```
CONTOUR, Z, LEVELS = [0.0, 0.5, 1.0], $
   C_ANNOTATION = ['low', 'medium', 'high']
```

## C_CHARSIZE

The size of the characters used to annotate contour labels. Normally, contour labels are drawn at 3/4 of the size used for the axis labels (specified by the CHARSIZE keyword or !P.CHARSIZE system variable. This keyword allows the contour label size to be specified directly. Use of this keyword implies use of the FOLLOW keyword.

## C_CHARTHICK

The thickness of the characters used to annotate contour labels. Set this keyword equal to an integer value specifying the line thickness of the vector drawn font characters. This keyword has no effect when used with the hardware drawn fonts. The default value is 1. Use of this keyword implies use of the FOLLOW keyword.

## C_COLORS

The color index used to draw each contour. This parameter is a vector, converted to integer type if necessary. If there are more contour levels than elements in C_COLORS, the elements of the color vector are cyclically repeated.

### Example

If C_COLORS contains three elements, and there are seven contour levels to be drawn, the colors $c_0$, $c_1$, $c_2$, $c_0$, $c_1$, $c_2$, $c_0$ will be used for the seven levels. To call CONTOUR and set the colors to [100,150,200], use the command:

```
CONTOUR, Z, C_COLORS = [100,150,200]
```

## C_LABELS

Specifies which contour levels should be labeled. By default, every other contour level is labeled. C_LABELS allows you to override this default and explicitly specify

the levels to label. This parameter is a vector, converted to integer type if necessary. If the LEVELS keyword is specified, the elements of C_LABELS correspond directly to the levels specified, otherwise, they correspond to the default levels chosen by the CONTOUR procedure. Setting an element of the vector to zero causes that contour label to not be labeled. A nonzero value forces labeling.

Use of this keyword implies use of the FOLLOW keyword.

### Example

To produce a contour plot with four levels where all but the third level is labeled:

```
CONTOUR, Z, LEVELS = [0.0, 0.25, 0.75, 1.0], $
   C_LABELS = [1, 1, 0, 1]
```

## C_LINESTYLE

The line style used to draw each contour. As with C_COLORS, C_LINESTYLE is a vector of line style indices. If there are more contour levels than line styles, the line styles are cyclically repeated. See “LINESTYLE” on page 3875 for a list of available styles.

**Note**

The cell drawing contouring algorithm draws all the contours in each cell, rather than following contours. Since an entire contour is not drawn as a single operation, the appearance of the more complicated linestyles will suffer. Use of the contour following method (selected with the FOLLOW keyword) will give better looking results in such cases.

### Example

To produce a contour plot, with the contour levels directly specified in a vector V, with all negative contours drawn with dotted lines, and with positive levels in solid lines:

```
CONTOUR, Z, LEVELS = V, C_LINESTYLE = (V LT 0.0)
```

## C_ORIENTATION

If the FILL keyword is set, this keyword can be set to the angle, in degrees counterclockwise from the horizontal, of the lines used to fill contours. If neither C_ORIENTATION nor C_SPACING are specified, the contours are solid filled.

## C_SPACING

If the FILL keyword is set, this keyword can be used to control the distance, in centimeters, between the lines used to fill the contours.

## C_THICK

The line used to draw each contour level. As with C_COLORS, C_THICK is a vector of line thickness values, although the values are floating point. If there are more contours than thickness elements, elements are repeated. If omitted, the overall line thickness specified by the THICK keyword parameter or !P.THICK is used for all contours.

## CELL_FILL

Set this keyword to produce a filled contour plot using a “cell filling” algorithm. Use this keyword instead of FILL when you are drawing filled contours over a map, when you have missing data, or when contours that extend off the edges of the contour plot. CELL_FILL is less efficient than FILL because it makes one or more polygons for each data cell. It also gives poor results when used with patterned (line) fills, because each cell is assigned its own pattern. Otherwise, this keyword operates identically to the FILL keyword, described below.

**Tip**

In order for CONTOUR to fill the contours properly when using a map projection, the X and Y arrays (if supplied) must be arranged in increasing order. This ensures that the polygons generated will be in counterclockwise order, as required by the mapping graphics pipeline.

**Warning**

Do not draw filled contours over the poles on Cylindrical map projections. In this case, the polar points map to lines on the map, and the interpolation becomes ambiguous, causing errors in filling. One possible work-around is to limit the latitudes to the range of -89.9 degrees to + 89.9 degrees, avoiding the poles.

## CLOSED

Set this keyword to a nonzero value to close contours that intersect the plot boundaries. After a contour hits a boundary, it follows the plot boundary until it connects with its other boundary intersection. Set CLOSED=0 along with PATH_INFO and/or PATH_XY to return path information for contours that are not closed.

## DOWNHILL

Set this keyword to label each contour with short, perpendicular tick marks that point in the “downhill” direction, making the direction of the grade readily apparent. If this keyword is set, the contour following method is used in drawing the contours.

## FILL

Set this keyword to produce a filled contour plot. The contours are filled with solid or line-filled polygons. For solid polygons, use the C_COLOR keyword to specify the color index of the polygons for each contour level. For line fills, use C_ORIENTATION, C_SPACING, C_COLOR, C_LINESTYLE, and/or C_THICK to specify attributes for the lines.

If the current device is not a pen plotter, each polygon is erased to the background color before the fill lines are drawn, to avoid superimposing one pattern over another.

Contours that are not closed can not be filled because their interior and exterior are undefined. Contours created from data sets with missing data may not be closed; many map projections can also produce contours that are not closed. Filled contours should not be used in these cases.

**Note**

If the current graphics device is the Z-buffer, the algorithm used when the FILL keyword is specified will not work when a Z value is also specified with the graphics keyword ZVALUE. In this situation, use the CELL_FILL keyword instead of the FILL keyword.

## FOLLOW

In IDL version 5, CONTOUR always uses a line-following method. The FOLLOW keyword remains available for compatibility with existing code, but is no longer necessary. As in previous versions of IDL, setting FOLLOW will cause CONTOUR to draw contour labels.

## IRREGULAR

Set this keyword to indicate that the input data is irregularly gridded. Setting IRREGULAR is the same as performing an explicit triangulation. That is:

```
CONTOUR, Z, X, Y, /IRREGULAR
```

is the same as

```
TRIANGULATE, X, Y, tri   ;Get triangulation
CONTOUR, Z, X, Y, TRIANGULATION=tri
```

## ISOTROPIC

Set this keyword to force the scaling of the X and Y axes to be equal.

**Note**

The X and Y axes will be scaled isotropically and then fit within the rectangle defined by the POSITION keyword; one of the axes may be shortened. See "POSITION" on page 3877 for more information.

## LEVELS

Specifies a vector containing the contour levels drawn by the CONTOUR procedure. A contour is drawn at each level in LEVELS.

### Example

To draw a contour plot with levels at 1, 100, 1000, and 10000:

```
CONTOUR, Z, LEVELS = [1, 100, 1000, 10000]
```

To draw a contour plot with levels at 50, 60, ..., 90, 100:

```
CONTOUR, Z, LEVELS = FINDGEN(6) * 10 + 50
```

## MAX_VALUE

Data points with values above this value are ignored (i.e., treated as missing data) when contouring. Cells containing one or more corners with values above MAX_VALUE will have no contours drawn through them. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## MIN_VALUE

Data points with values less than this value are ignored (i.e., treated as missing data) when contouring. Cells containing one or more corners with values below MIN_VALUE will have no contours drawn through them. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## NLEVELS

The number of equally spaced contour levels that are produced by CONTOUR. If the LEVELS parameter, which explicitly specifies the value of the contour levels, is

present, this keyword has no effect. If neither parameter is present, approximately six levels are drawn. NLEVELS should be a positive integer.

## OVERPLOT

Set this keyword to make CONTOUR “overplot”. That is, the current graphics screen is not erased, no axes are drawn and the previously established scaling remains in effect. You must explicitly specify either the values of the contour levels or the number of levels (via the NLEVELS keyword) when using this option, unless geographic mapping coordinates are in effect.

## PATH_DATA_COORDS

Set this keyword to cause the output contour positions to be measured in data units rather than the default normalized units. This keyword is useful only if the PATH_XY or PATH_FILENAME keywords are set.

## PATH_DOUBLE

Set this keyword to indicate that the PATH_FILENAME, PATH_INFO, and PATH_XY keywords should return vertex and contour value information as double-precision floating-point values. The default is to return this information as single-precision floating-point values.

## PATH_FILENAME

Specifies the name of a file to contain the contour positions. If PATH_FILENAME is present, CONTOUR does not draw the contours, but rather, opens the specified file and writes the coordinates of the contours, into it. The file consists of a series of logical records containing binary data. Each record is preceded with a header structure defining the contour as follows:

If the PATH_DOUBLE keyword is not set:

```
{CONTOUR_HEADER, TYPE:0B, HIGH:0B, LEVEL:0, NUM:0L, VALUE:0.0}
```

If the PATH_DOUBLE keyword is set:

```
{CONTOUR_DBL_HEADER, TYPE:0B, HIGH:0B, LEVEL:0, NUM:0L,
VALUE:0.0D}
```

The fields are:

| Field | Description |
|---|---|
| TYPE | A byte that is zero if the contour is open, and one if it is closed. |
| HIGH | A byte that is 1 if the contour is closed and above its surroundings, and is 0 if the contour is below. This field is meaningless if the contour is not closed. |
| LEVEL | A short integer with value greater or equal to zero (It is an index into the LEVELS array). |
| NUM | The longword number of data points in the contour. |
| VALUE | The contour value. If the PATH_DOUBLE keyword is not set, this is a single-precision floating-point value; if the PATH_DOUBLE keyword is set, this is a double-precision floating-point value. |

*Table 8: CONTOUR Fields*

Following the header in each record are NUM X-coordinate values followed by NUM Y-coordinate values. By default, these values are specified in normalized coordinates unless the PATH_DATA_COORDS keyword is set.

## PATH_INFO

Set this keyword to a named variable that will return path information for the contours. This information can be used, along with data stored in a variable named by the PATH_XY keyword, to trace closed contours. To get PATH_INFO and PATH_XY with contours that are not closed, set the CLOSED keyword to 0. If PATH_INFO is present, CONTOUR does not draw the contours, but rather records the path information in an array of structures of the following type:

If the PATH_DOUBLE keyword is not set:

```
{CONTOUR_PATH_STRUCTURE, TYPE:0B, HIGH_LOW:0B, $
   LEVEL:0, N:0L, OFFSET:0L, VALUE:0.0}
```

If the PATH_DOUBLE keyword is set:

```
{COUNTOUR_DBL_PATH_STRUCTURE, TYPE:0B, HIGH_LOW:0B, LEVEL:0,
   N: 0L, OFFSET:0L, VALUE:0.0D}
```

The fields are:

| Field | Description |
|---|---|
| TYPE | A byte that is zero if the contour is open, and one if it is closed.<br>**Note -** If the CLOSE keyword is not explicitly set equal to zero, all contours will be closed. |
| HIGH_LOW | A byte that is 1 if the contour is above its surroundings, and is 0 if the contour is below. |
| LEVEL | A short integer indicating the index of the contour level, from zero to the number of levels minus one. |
| N | A long integer indicating the number of XY pairs in the contour's path. |
| OFFSET | A long integer that is the offset into the array defined by PATH_XY, representing the first XY coordinate for this contour. |
| VALUE | The contour value. If the PATH_DOUBLE keyword is not set, this is a single-precision floating-point value; if the PATH_DOUBLE keyword is set, this is a double-precision floating-point value. |

*Table 9: PATH_INFO Fields*

See the examples section below for an example using the PATH_INFO and PATH_XY keywords to return contour path information.

## PATH_XY

Set this keyword to a named variable that returns the coordinates of a set of closed polygons defining the closed paths of the contours. This information can be used, along with data stored in a variable named by the PATH_INFO keyword, to trace closed contours. To get PATH_XY and PATH_INFO with contours that are not closed, set the CLOSED keyword to 0. If PATH_XY is present, CONTOUR does not draw the contours, but rather records the path coordinates in the named array. If the PATH_DOUBLE keyword is not set, the array will contain single-precision floating point values; if the PATH_DOUBLE keyword is set, the array will contain double-precision floating point values. By default, the values in the array are specified in normalized coordinates unless the PATH_DATA_COORDS keyword is set.

See the examples section below for an example using the PATH_INFO and PATH_XY keywords to return contour path information.

### TRIANGULATION

Set this keyword to a variable that contains an array of triangles returned from the TRIANGULATE procedure. Providing triangulation data allows you to contour irregularly gridded data directly, without gridding.

### XLOG

Set this keyword to specify a logarithmic X axis.

### YLOG

Set this keyword to specify a logarithmic Y axis.

### ZAXIS

Set this keyword to an integer value to draw a Z axis for the CONTOUR plot. CONTOUR draws no Z axis by default. This keyword is of use only if a three-dimensional transformation is established. Possible values are:

- 1 - Draws Z axis from the lower right-hand corner of the plot
- 2 - Draws Z axis from the lower left-hand corner of the plot
- 3 - Draws Z axis from the upper left-hand corner of the plot
- 4 - Draws Z axis from the upper right-hand corner of the plot

## Graphics Keywords Accepted

See Appendix B, “Graphics Keywords” for the description of graphics and plotting keywords not listed above.

BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, FONT, NOCLIP, NODATA, NOERASE, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

# Examples

## Example 1

This example creates a contour plot with 10 contour levels where every other contour is labeled:

```
;Create a simple dataset to plot:
Z = DIST(100)

;Draw the plot:
CONTOUR, Z, NLEVELS=10, /FOLLOW, TITLE='Simple Contour Plot'
```

## Example 2

This example shows the use of polygon filling and smoothing.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Create a surface to contour (2D array of random numbers):
A = RANDOMU(seed, 5, 6)

;Smooth the dataset before contouring:
B = MIN_CURVE_SURF(A)

;Load discrete colors for contours:
TEK_COLOR

;Draw filled contours:
CONTOUR, B, /FILL, NLEVELS=5, C_COLOR=INDGEN(5)+2

;Overplot the contour lines with tickmarks:
CONTOUR, B, NLEVELS=5, /DOWNHILL, /OVERPLOT
```

Alternatively, we could draw line-filled contours by replacing the last two commands with:

```
CONTOUR, B, C_ORIENTATION=[0, 22, 45]

CONTOUR, B, /OVERPLOT, NLEVELS=5
```

## Example 3

The following example saves the closed path information of a set of contours and plots the result:

```
; Create a 2D array of random numbers:
A = RANDOMU(seed, 8, 10)

; Smooth the dataset before contouring:
B = MIN_CURVE_SURF(A)

; Compute contour paths:
CONTOUR, B, PATH_XY=xy, PATH_INFO=info
FOR I = 0, (N_ELEMENTS(info) - 1 ) DO BEGIN
   S = [INDGEN(info(I).N), 0]

; Plot the closed paths:
   PLOTS, xy(*,INFO(I).OFFSET + S ), /NORM
ENDFOR
```

### Example 4

This example contours irregularly-gridded data without having to call TRIGRID. First, use the TRIANGULATE procedure to get the Delaunay triangulation of your data, then pass the triangulation array to CONTOUR:

```
;Make 50 normal X, Y points:
x = RANDOMN(seed, 50)
y = RANDOMN(seed, 50)

;Make the Gaussian:
Z = EXP(-(x^2 + y^2))

;Get triangulation:
TRIANGULATE, X, Y, tri

;Draw the contours:
CONTOUR, Z, X, Y, TRIANGULATION = tri
```

## Version History

Introduced: Original

## See Also

ICONTOUR, IMAGE_CONT, SHADE_SURF, SHOW3, SURFACE

# CONVERT_COORD

The CONVERT_COORD function transforms one or more sets of coordinates to and from the coordinate systems supported by IDL.

The input coordinates *X* and, optionally, *Y* and/or *Z* can be given in data, device, or normalized form by using the DATA, DEVICE, or NORMAL keywords. The default input coordinate system is DATA. The keywords TO_DATA, TO_DEVICE, and TO_NORMAL specify the output coordinate system.

If the input points are in 3D data coordinates, be sure to set the T3D keyword.

**Warning**

For devices that support windows, CONVERT_COORD can only provide valid results if a window is open and current. Also, CONVERT_COORD only applies to Direct Graphics devices.

## Syntax

*Result* = CONVERT_COORD( *X* [, *Y* [, *Z*]] [, /DATA | , /DEVICE | , /NORMAL] [, /DOUBLE][, /T3D] [, /TO_DATA | , /TO_DEVICE | , /TO_NORMAL] )

## Return Value

The result of the function is a (3, *n*) vector containing the (*x*, *y*, *z*) components of the n output coordinates.

## Arguments

### X

A vector or scalar argument providing the X components of the input coordinates. If only one argument is specified, *X* must be an array of either two or three vectors (i.e., `(2,*)` or `(3,*)`). In this special case, `X[0,*]` are taken as the X values, `X[1,*]` are taken as the Y values, and, if present, `X[2,*]` are taken as the Z values.

### Y

An optional argument providing the Y input coordinate(s).

### Z

An optional argument providing the Z input coordinate(s).

## Keywords

### DATA

Set this keyword if the input coordinates are in data space (the default).

### DEVICE

Set this keyword if the input coordinates are in device space.

### DOUBLE

Set this keyword to indicate that the returned coordinates should be double-precision. If this keyword is not set, the default is to return single-precision coordinates (unless double-precision arguments are input, in which case the returned coordinates will be double-precision).

### NORMAL

Set this keyword if the input coordinates are in normalized space.

### T3D

Set this keyword if the 3D transformation !P.T is to be applied.

### TO_DATA

Set this keyword if the output coordinates are to be in data space.

### TO_DEVICE

Set this keyword if the output coordinates are to be in device space.

### TO_NORMAL

Set this keyword if the output coordinates are to be in normalized space.

## Examples

Convert, using the currently established viewing transformation, 11 points along the parametric line $x = t$, $y = 2t$, $z = t^2$, along the interval [0, 1] from data coordinates to device coordinates:

```
; Establish a valid transformation matrix:
SURFACE, DIST(20), /SAVE

; Make a vector of X values:
X = FINDGEN(11)/10.

; Convert the coordinates. D will be a (3,11) element array:
D = CONVERT_COORD(X, 2*X, X^2, /T3D, /TO_DEVICE)
```

## Version History

Introduced: Pre 4.0

## See Also

CV_COORD

# CONVOL

The CONVOL function convolves an array with a kernel, and returns the result. Convolution is a general process that can be used for various types of smoothing, signal processing, shifting, differentiation, edge detection, etc. The CENTER keyword controls the alignment of the kernel with the array and the ordering of the kernel elements. If CENTER is explicitly set to 0, convolution is performed in the strict mathematical sense, otherwise the kernel is centered over each data point.

## Using CONVOL

Assume R = CONVOL(A, K, S), where *A* is an *n*-element vector, *K* is an *m*-element vector (*m* < *n*), and *S* is the scale factor. If the CENTER keyword is omitted or set to 1:

$$R_t = \begin{cases} \frac{1}{S}\sum_{i=0}^{m-1} A_{t+i-m/2} K_i & \text{if} \quad m/2 \le t < n - m/2 \\ 0 & \text{otherwise} \end{cases}$$

where the value *m*/2 is determined by *integer division*. This means that the result of the division is the largest *integer* value less than or equal to the fractional number.

If CENTER is explicitly set to 0:

$$R_t = \begin{cases} \frac{1}{S}\sum_{i=0}^{m-1} A_{t-i} K_i & \text{if} \quad t \ge m - 1 \\ 0 & \text{otherwise} \end{cases}$$

In the two-dimensional, zero CENTER case where *A* is an *m* by *n*-element array, and *K* is the *l* by *l* element kernel; the result *R* is an *m* by *n*-element array:

$$R_{t,u} = \begin{cases} \frac{1}{S}\sum_{i=0}^{l-1}\sum_{j=0}^{l-1} A_{t-i,u-j} K_{i,j} & \text{if} \quad t \ge l-1 \quad \text{and} \quad u \ge l-1 \\ 0 & \text{otherwise} \end{cases}$$

The centered case is similar, except the *t-i* and *u-j* subscripts are replaced by *t+i-l*/2 and *u+j-l*/2.

# Syntax

*Result* = CONVOL( *Array, Kernel* [, *Scale_Factor*] [, /CENTER] [, /EDGE_WRAP] [, /EDGE_TRUNCATE] [, MISSING=*value*] [, /NAN] )

# Return Value

Returns the result of the array convolution.

# Arguments

## Array

An array of any basic type except string. The result of CONVOL has the same type and dimensions as *Array.*

If the *Array* parameter is of byte type, the result is clipped to the range of 0 to 255. Negative results are set to 0, and values greater than 255 are set to 255.

## Kernel

An array of any type except string. If the type of *Kernel* is not the same as *Array*, a copy of *Kernel* is made and converted to the appropriate type before use. The size of the kernel dimensions must be smaller than those of *Array.*

**Note**

CONVOL accepts non-square kernels including one-dimensional kernels.

## Scale_Factor

A scale factor that is divided into each resulting value. This argument allows the use of fractional kernel values and avoids overflow with byte or integer arguments. If omitted, a scale factor of 1 is used.

# Keywords

## CENTER

Set or omit this keyword to center the kernel over each array point. If CENTER is explicitly set to zero, the CONVOL function works in the conventional mathematical

sense. In many signal and image processing applications, it is useful to center a symmetric kernel over the data, thereby aligning the result with the original array.

Note that for the kernel to be centered, it must be symmetric about the point K(FLOOR(*m*/2)), where *m* is the number of elements in the kernel.

## EDGE_WRAP

Set this keyword to make CONVOL compute the values of elements at the edge of *Array* by "wrapping" the subscripts of *Array* at the edge. For example, if CENTER is set to zero:

$$R_t = \left\{ \frac{1}{S} \left[ \sum_{i=0}^{m-1} A_{((t-i) \bmod (n))} K_i \right] \right.$$

where *n* is the number of elements in *Array*. The mod operator in the formula above is defined as `a mod b = a - b * floor(a/b)`. For example, -1 mod 5 is 4. If neither EDGE_WRAP nor EDGE_TRUNCATE is set, CONVOL sets the values of elements at the edges of *Array* to zero.

## EDGE_TRUNCATE

Set this keyword to make CONVOL compute the values of elements at the edge of *Array* by repeating the subscripts of *Array* at the edge. For example, if CENTER is set to zero:

$$R_t = \left\{ \frac{1}{S} \sum_{i=0}^{m} A_{((t-i) > 0 < (n-1))} K_i \right.$$

where *n* is the number of elements in *Array*. The "<" and ">" operators in the above formula return the smaller and larger of their operands, respectively. If neither EDGE_WRAP nor EDGE_TRUNCATE is set, CONVOL sets the values of elements at the edges of *Array* to zero.

## MISSING

Set this keyword to the numeric value to return for elements that contain no valid points within the kernel. The default is the IEEE floating-point value NaN. This keyword is only used if the NAN keyword is set.

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.) Elements with the value NaN are treated as missing data, and are ignored when computing the convolution for neighboring elements. In the *Result*, missing elements are replaced by the convolution of all other valid points within the kernel. If all points within the kernel are missing, then the result at that point is given by the MISSING keyword.

**Note**

CONVOL should never be called without the NAN keyword if the input array may possibly contain NaN values.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Convolve a vector of random noise and a one-dimensional triangular kernel and plot the result. Create a simple vector as the original dataset and plot it by entering:

```
A = RANDOMN(SEED, 100) & PLOT, A
```

Create a simple kernel by entering:

```
K = [1, 2, 3, 2, 1]
```

Convolve the two and overplot the result by entering:

```
OPLOT, CONVOL(A, K, TOTAL(K))
```

## Version History

Introduced: Original

## See Also

BLK_CON

# COORD2TO3

The COORD2TO3 function converts normalized X and Y screen coordinates to 3D data coordinates.

**Note**

A valid 3D transform must exist in !P.T or be specified by the PTI keyword. The axis scaling variables, !X.S, !Y.S and !Z.S must be valid.

This routine is written in the IDL language. Its source code can be found in the file `coord2to3.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = COORD2TO3( *Mx*, *My*, *Dim*, *D0* [, *PTI*] )

## Return Value

Returns a three-element vector containing 3D data coordinates given the normalized X and Y screen coordinates and one of the three data coordinates.

## Arguments

### Mx, My

The normalized X and Y screen coordinates.

### Dim

A parameter used to specify which data coordinate is fixed. Use 0 for a fixed X data coordinate, 1 for a fixed Y data coordinate, or 2 for a fixed Z data coordinate.

### D0

The value of the fixed data coordinate.

### PTI

The inverse of !P.T. If this parameter is not supplied, or set to 0, COORD2TO3 computes the inverse. If this routine is to be used in a loop, the caller should supply PTI for highest efficiency.

## Keywords

None.

## Examples

To return the data coordinates of the mouse, fixing the data Z value at 10, enter the commands:

```
;Make sure a transformation matrix exists.
CREATE_VIEW

;Get the normalized mouse coords.
CURSOR, X, Y, /NORM

;Print the 3D coordinates.
PRINT, COORD2TO3(X, Y, 2, 10.0)
```

## See Also

CONVERT_COORD, CREATE_VIEW, CV_COORD, SCALE3, T3D

# COPY_LUN

The COPY_LUN procedure copies data between two open files. It allows you to transfer a known amount of data from one file to another without needing to have the data available in an IDL variable. COPY_LUN can copy a fixed amount of data, specified in bytes or lines of text, or it can copy from the current position of the file pointer in the input file to the end of that file.

COPY_LUN copies data between open files. To copy entire files based on their names, see the FILE_COPY procedure. To read and discard a known amount of data from a file, see the SKIP_LUN.

## Syntax

COPY_LUN, *FromUnit*, *ToUnit* [, *Num*] [, /EOF] [, /LINES]
[, /TRANSFER_COUNT]

## Arguments

### FromUnit

An integer that specifies the file unit for the file from which data is to be taken (the *source* file). Data is copied from *FromUnit*, starting at the current position of the file pointer. The file pointer is advanced as data is read. The file specified by *FromUnit* must be open, and must not have been opened with the RAWIO keyword to OPEN.

### ToUnit

An integer that specifies the file unit for the file to which data is to be written (the *destination* file). Data is written to *ToUnit*, starting at the current position of the file pointer. The file pointer is advanced as data is written. The file specified by *ToUnit* must be open for output (OPENW or OPENU), and must not have been opened with the RAWIO keyword to OPEN.

### Num

The amount of data to transfer between the two files. This value is specified in bytes, unless the LINES keyword is specified, in which case it is taken to be the number of text lines. If *Num* is not specified, COPY_LUN acts as if the EOF keyword has been set, and copies all data in *FromUnit* (the source file) from the current position of the file pointer to the end of the file.

If *Num* is specified and the source file comes to end of file before the specified amount of data is transferred, COPY_LUN issues an end-of-file error. The EOF keyword alters this behavior.

# Keywords

## EOF

Set this keyword to ignore the value given by *Num* (if present) and instead transfer all data between the current position of the file pointer in *FromUnit* and the end of the file.

**Note**

If EOF is set, no end-of-file error is issued even if the amount of data transferred does not match the amount specified by *Num*. The TRANSFER_COUNT keyword can be used with EOF to determine how much data was transferred.

## LINES

Set this keyword to indicate that the *Num* argument specifies the number of lines of text to be transferred. By default, the *Num* argument specifies the number of bytes of data to transfer.

## TRANSFER_COUNT

Set this keyword equal to a named variable that will contain the amount of data transferred. If LINES is specified, this value is the number of lines of text. Otherwise, it is the number of bytes. TRANSFER_COUNT is primarily useful when the *Num* argument is not specified or the EOF keyword is present. If *Num* is specified and the EOF keyword is not present, TRANSFER_COUNT will be the same as the value specified for *Num*.

# Examples

Copy the next 100000 bytes of data between two files:

```
COPY_LUN, FromUnit, ToUnit, 100000
```

Copy the next 8 lines of text between two files:

```
COPY_LUN, FromUnit, ToUnit, 8, /LINES
```

Copy the remainder of the data in one file to another, and use the TRANSFER_COUNT keyword to determine how much data was copied:

```
COPY_LUN, FromUnit, ToUnit, /EOF, TRANSFER_COUNT=n
```

Copy the remaining lines of text from one file to another, and use the TRANSFER_COUNT keyword to determine how many lines were transferred.

```
COPY_LUN, FromUnit, ToUnit, /EOF, /LINES, TRANSFER_COUNT=n
```

## Version History

Introduced: 5.6

## See Also

CLOSE, EOF, FILE_COPY, FILE_LINK, FILE_MOVE, OPEN, READ/READF, SKIP_LUN, WRITEU

# CORRELATE

The CORRELATE function computes the linear Pearson correlation coefficient of two vectors or the correlation matrix of an *m* x *n* array. Alternatively, this function computes the covariance of two vectors or the covariance matrix of an *m* x *n* array.

This routine is written in the IDL language. Its source code can be found in the file `correlate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CORRELATE( *X* [, *Y*] [, /COVARIANCE] [, /DOUBLE] )

## Return Value

If vectors of unequal lengths are specified, the longer vector is truncated to the length of the shorter vector and a single correlation coefficient is returned. If an *m* x *n* array is specified, the result will be an *m* x *m* array of linear Pearson correlation coefficients, with the element *i*,*j* corresponding to correlation of the *i*th and *j*th columns of the input array.

## Arguments

### X

A vector or an *m* x *n* array. *X* can be integer, single-, or double-precision floating-point.

### Y

An integer, single-, or double-precision floating-point vector. If *X* is an *m* x *n* array, *Y* should not be supplied.

## Keywords

### COVARIANCE

Set this keyword to compute the sample covariance rather than the correlation coefficient.

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

Define the data vectors.

```
X = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71]
Y = [68, 66, 68, 65, 69, 66, 68, 65, 71, 67, 68, 70]
```

Compute the linear Pearson correlation coefficient of x and y. The result should be 0.702652:

```
PRINT, CORRELATE(X, Y)
```

IDL prints:

```
0.702652
```

Compute the covariance of x and y. The result should be 3.66667.

```
PRINT, CORRELATE(X, Y, /COVARIANCE)
```

IDL prints:

```
3.66667
```

Define an array with x and y as its columns.

```
A = TRANSPOSE([[X],[Y]])
```

Compute the correlation matrix.

```
PRINT, CORRELATE(A)
```

IDL prints:

```
  1.00000    0.702652
  0.702652   1.00000
```

## Version History

Introduced: Pre 4.0

## See Also

A_CORRELATE, C_CORRELATE, M_CORRELATE, P_CORRELATE, R_CORRELATE

# COS

The periodic function COS returns the trigonometric cosine of X.

## Syntax

*Result* = COS(*X*)

## Return Value

Returns the trigonometric cosine of X.

## Arguments

### X

The angle for which the cosine is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. When applied to complex numbers:

COS(*x*) = (EXP(*I**x) + EXP(-*I**x))/2

where *I* is defined as COMPLEX(0, 1).

If *X* is an array, the result has the same structure, with each element containing the cosine of the corresponding element of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Find the cosine of 0.5 radians and print the result by entering:

```
PRINT, COS(.5)
```

IDL prints:

```
0.877583
```

## Version History

Introduced: Original

## See Also

ACOS, COSH

# COSH

The COSH function returns the hyperbolic cosine of *X*.

## Syntax

*Result* = COSH(*X*)

## Return Value

Returns the hyperbolic cosine of *X*.

## Arguments

### X

The value for which the hyperbolic cosine is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. COSH is defined as:

$\mathrm{COSH}(u) = (e^{u} + e^{-u}) / 2$

If *X* is an array, the result has the same structure, with each element containing the hyperbolic cosine of the corresponding element of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Find the hyperbolic cosine of 0.5 radians and print the result by entering:

```
PRINT, COSH(.5)
```

IDL prints:

```
1.12763
```

## Version History

Introduced: Original

## See Also

ACOS, COS

# CPU

The CPU procedure is used to change the values stored in the read-only !CPU system variable, which in turn controls the way IDL uses the system processor or processors.

**Note**

Not all routines are affected by changes to the !CPU system variable. Those routines that *are* affected can override some of the values in the !CPU system variable by setting *thread pool keywords*, which change the way IDL uses the system processor(s) during a single invocation of the routine. A list of thread pool keywords appears at the end of the keywords list for each routine that is affected by the state of the !CPU system variable.

## Syntax

CPU [,TPOOL_MAX_ELTS = *NumMaxElts*] [,TPOOL_MIN_ELTS = *NumMinElts*] [,TPOOL_NTHREADS = *NumThreads*] [,/VECTOR_ENABLE]

## Arguments

None.

## Keywords

### TPOOL_MAX_ELTS

This keyword changes the value returned by !CPU.TPOOL_MAX_ELTS.

Set this keyword to a non-zero value to set the maximum number of data elements involved in a computation that uses the thread pool. If the number of elements in the computation exceeds the number contained in !CPU.TPOOL_MAX_ELTS, IDL will not use the thread pool for the computation. Setting this value to 0 removes any limit on maximum number of elements, and any computation with at least !CPU.TPOOL_MIN_ELTS will use the thread pool.

See "Possible Drawbacks to the Use of the IDL Thread Pool" in Chapter 14 of the *Building IDL Applications* manual for discussion of the circumstances under which it may be useful to specify a maximum number of elements for computations that use the thread pool.

## TPOOL_MIN_ELTS

This keyword changes the value returned by !CPU.TPOOL_MIN_ELTS.

Set this keyword to a non-zero value to set the minimum number of data elements involved in a computation that uses the thread pool. If the number of elements in the computation is less than the number contained in !CPU.TPOOL_MIN_ELTS, IDL will not use the thread pool for the computation. Use this keyword to prevent IDL from using the thread pool on tasks that are too small to benefit from it.

See "Possible Drawbacks to the Use of the IDL Thread Pool" in Chapter 14 of the *Building IDL Applications* manual for discussion of the circumstances under which it may be useful to specify a minimum number of elements for computations that use the thread pool.

## TPOOL_NTHREADS

This keyword changes the value returned by !CPU.TPOOL.NTHREADS.

Set this keyword to the number of threads IDL should use when performing computations that take advantage of the thread pool. By default, IDL will use !CPU.HW_NCPU threads, so that each thread will have the potential to run in parallel with the others. Set this keyword equal to 0 (zero) to ensure that !CPU.HW_NCPU threads will be used. Set this keyword equal to 1 (one) to disable use of the thread pool.

**Note**

For numerical computation, there is no benefit to using more threads than your system has CPUs. However, depending on the size of the problem and the number of other programs running on the system, there may be a performance advantage to using *fewer* CPUs. See "Possible Drawbacks to the Use of the IDL Thread Pool" in Chapter 14 of the *Building IDL Applications* manual for a discussion of the circumstances under which using fewer than the maximum number of CPUs makes sense.

## VECTOR_ENABLE

This keyword changes the value returned by !CPU.VECTOR_ENABLE.

Set this keyword to enable use of the system's vector unit (e.g. Macintosh Altivec/Velocity Engine) if one is present. Set this keyword equal to 0 (zero) explicitly disable such use. This keyword is ignored if the current system does not support a vector unit (that is, if !CPU.HW_VECTOR =0).

## Examples

Configure !CPU so that by default, IDL will use two threads for computations that involve more than 5000 data values.

```
CPU, TPOOL_MIN_ELTS=5000, TPOOL_NTHREADS=2
```

## Version History

Introduced: 5.5

## See Also

!CPU, Chapter 14, “Multithreading in IDL” in the *Building IDL Applications* manual.

# CRAMER

The CRAMER function solves an *n* by *n* linear system of equations using Cramer's rule.

This routine is written in the IDL language. Its source code can be found in the file `cramer.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CRAMER( *A*, *B* [, /DOUBLE] [, ZERO=*value*] )

## Return Value

Returns the solution of an *n* by *n* linear system of equations using Cramer's rule.

## Arguments

### A

An *n* by *n* single- or double-precision floating-point array.

### B

An *n*-element single- or double-precision floating-point vector.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### ZERO

Use this keyword to set the value of the floating-point zero. A floating-point zero on the main diagonal of a triangular array results in a zero determinant. A zero determinant results in a "Singular matrix" error and stops the execution of CRAMER. For single-precision inputs, the default value is $1.0 \times 10^{-6}$. For double-precision inputs, the default value is $1.0 \times 10^{-12}$.

## Examples

Define an array A and right-hand side vector B.

```
A = [[ 2.0,  1.0,  1.0], $
     [ 4.0, -6.0,  0.0], $
     [-2.0,  7.0,  2.0]]
B = [3.0, 10.0, -5.0]

;Compute the solution and print.
PRINT, CRAMER(A,B)
```

IDL prints:

```
1.00000     -1.00000      2.00000
```

## Version History

Introduced: Pre 4.0

## See Also

CHOLSOL, GS_ITER, LU_COMPLEX, LUSOL, SVSOL, TRISOL

# CREATE_STRUCT

The CREATE_STRUCT function creates a structure given pairs of tag names and values. CREATE_STRUCT can also be used to concatenate structures.

## Syntax

*Result* = CREATE_STRUCT( *[*$Tag_1$*, Values*$_1$*, ..., Tag*$_n$*, Values*$_n$*] [, Structures*$_n$*]* [, NAME=*string*])

or

*Result* = CREATE_STRUCT( *[Tags, Values*$_1$*, ..., Values*$_n$*] [, Structures*$_n$*]* [, NAME=*string*])

## Return Value

Returns a structure composed of given pairs of tag names and values.

## Arguments

### Tags

The structure tag names. Tag names may be specified either as scalar strings or a single string array. If scalar strings are specified, values alternate with the tag names. If a string array is provided, values must still be specified individually. Tag names must be enclosed in quotes. Tag names may not be IDL Reserved Words, and must be unique within a given structure, although the same tag name can be used in more than one structure.

**Note**

If a tag name contains spaces, CREATE_STRUCT will replace the spaces with underscores. For example, if you specify a tag name of `'my tag'`, the tag will be created with the name `'my_tag'`.

### Values

The values for the structure fields. The number of *Values* arguments must match the number of *Tags* arguments (if tags are specified as scalar strings) or the number of elements of the *Tags* array (if tags are specified as a single array.)

### Structures

One or more existing structure variables whose tags and values will be inserted into the new structure. When concatenating structures in this manner, the following rules apply:

- All tag names, whether specified via the *Tags* argument or in an existing structure variable, must be unique.
- Names of named structures included via the *Structures* arguments are not used in the newly-created structure.
- *Structures* arguments can be interspersed with groups of *Tags* and *Values* arguments in the call to CREATE_STRUCT. Use caution, however, to ensure that the number of *Tags* and *Values* in each group are equal, to avoid inserting a structure variable as the value of a single tag when you mean to include the structure's data as individual tags and values.

## Keywords

### NAME

To create a named structure, set this keyword equal to a string specifying the structure name. If this keyword is not present, an anonymous structure is created.

## Examples

To create the anonymous structure { A: 1, B: 'xxx'} in the variable *P*, enter:

```
p = CREATE_STRUCT('A', 1, 'B', 'xxx')
```

To add the fields "FIRST" and "LAST" to the structure, enter the following:

```
p = CREATE_STRUCT('FIRST', 0, p, 'LAST', 3)
```

The resulting structure contains { FIRST: 0, A: 1, B: 'xxx', LAST: 3}.

Finally, consider the following statements:

```
s1 = {Struct1, Tag1:'AAA', Tag2:'BBB'}
s2 = {Struct2, TagA:100, TagB:200}
s3 = CREATE_STRUCT(NAME='Struct3', ['A','B','C'], 1, 2, s1, s2)
```

Here, the variable `s3` contains the following named structure:

{ Struct3, A: 1, B: 2, C: {Struct1, Tag1: 'AAA', Tag2: 'BBB'}, TagA: 100, TagB: 200 }

Note that the value of `s3.C` is itself a “Struct1” structure, since the structure variable `s1` was interpreted as a *Values* argument, whereas the structure variable `s2` was interpreted as a *Structures* argument, thus including the tags from the “Struct2” structure directly in the new structure.

## Version History

Introduced: Pre 4.0

## See Also

IDL_VALIDNAME, N_TAGS, TAG_NAMES, Chapter 7, “Structures” in the *Building IDL Applications* manual.

# CREATE_VIEW

The CREATE_VIEW procedure sets the various system variables required to define a coordinate system and a 3-D view. This procedure builds the system viewing matrix (!P.T) in such a way that the correct aspect ratio of the data is maintained even if the display window is not square. CREATE_VIEW also sets the “Data” to “Normal” coordinate conversion factors (!X.S, !Y.S, and !Z.S) so that center of the unit cube will be located at the center of the display window.

CREATE_VIEW sets the following IDL system variables:

| | | | |
|---|---|---|---|
| !P.T | !X.S | !Y.S | !Z.S |
| !P.T3D | !X.Style | !Y.Style | !Z.Style |
| !P.Position | !X.Range | !Y.Range | !Z.Range |
| !P.Clip | !X.Margin | !Y.Margin | !Z.Margin |
| !P.Region | | | |

This routine is written in the IDL language. Its source code can be found in the file `create_view.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

CREATE_VIEW [, AX=*value*] [, AY=*value*] [, AZ=*value*] [, PERSP=*value*] [, /RADIANS] [, WINX=*pixels*] [, WINY=*pixels*] [, XMAX=*scalar*] [, XMIN=*scalar*] [, YMAX=*scalar*] [, YMIN=*scalar*] [, ZFAC=*value*] [, ZMAX=*scalar*] [, ZMIN=*scalar*] [, ZOOM=*scalar or 3-element vector*]

## Arguments

This procedure has no required arguments.

## Keywords

### AX

A floating-point value specifying the orientation (X rotation) of the view. The default is 0.0.

### AY

A floating-point value specifying the orientation (Y rotation) of the view. The default is 0.0.

### AZ

A floating-point value specifying the orientation (Z rotation) of the view. The default is 0.0.

### PERSP

A floating-point value specifying the perspective projection distance. A value of 0.0 indicates an isometric projection (NO perspective). The default is 0.0.

### RADIANS

Set this keyword if AX, AY, and AZ are specified in radians. The default is degrees.

### WINX

A long integer specifying the X size, in pixels, of the window that the view is being set up for. The default is 640.

### WINY

A long integer specifying the Y size, in pixels, of the window that the view is being set up for. The default is 512.

### XMAX

A scalar specifying the maximum data value on the X axis. The default is 1.0.

### XMIN

A scalar specifying the minimum data value on the X axis. The default is 0.0.

### YMAX

A scalar specifying the maximum data value on the Y axis. The default is 1.0.

### YMIN

A scalar specifying the minimum data value on the Y axis. The default is 0.0.

### ZFAC

Set this keyword to a floating-point value to expand or contract the view in the Z dimension. The default is 1.0.

### ZMAX

A scalar specifying the maximum data value on the Z axis. The default is 1.0.

### ZMIN

A scalar specifying the minimum data value on the Z axis. The default is 0.0.

### ZOOM

A floating-point number or 3-element vector specifying the view zoom factor. If zoom is a single value then the view will be zoomed equally in all 3 dimensions. If zoom is a 3-element vector then the view will be scaled zoom[0] in X, zoom[1] in Y, and zoom[2] in Z. The default is 1.0.

## Examples

Set up a view to display an iso-surface from volumetric data. First, create some data:

```
vol = FLTARR(40, 50, 30)
vol(3:36, 3:46, 3:26) = RANDOMU(S, 34, 44, 24)
FOR I = 0, 10 DO vol = SMOOTH(vol, 3)
```

Generate the iso-surface.

```
SHADE_VOLUME, vol, 0.2, polygon_list, vertex_list, /LOW
```

Set up the view. Note that the subscripts into the Vol array range from 0 to 39 in X, 0 to 49 in Y, and 0 to 29 in Z. As such, the 3-D coordinates of the iso-surface (vertex_list) may have the same range. Set XMIN, YMIN, and ZMIN to zero (the default), and set XMAX=39, YMAX=49, and ZMAX=29.

```
WINDOW, XSIZE = 600, YSIZE = 400
CREATE_VIEW, XMAX = 39, YMAX = 49, ZMAX = 29, $
  AX = (-60.0), AZ = (30.0), WINX = 600, WINY = 400, $
  ZOOM = (0.7), PERSP = (1.0)
```

Display the iso-surface in the specified view.

```
img = POLYSHADE(polygon_list, vertex_list, /DATA, /T3D)
TVSCL, img
```

## Version History

Introduced: Pre 4.0

## See Also

SCALE3, T3D

# CROSSP

The CROSSP function returns a vector that is the cross-product of two input vectors, *V1* and *V2*.

## Syntax

*Result* = CROSSP(*V1*, *V2*)

## Return Value

Returns a floating-point vector that is the cross-product of two 3-element vectors, *V1* and *V2*.

## Arguments

### V1, V2

Three-element vectors.

## Version History

Introduced: Original

## See Also

"Matrix Multiplication" in Chapter 2 of the *Building IDL Applications* manual.

# CRVLENGTH

The CRVLENGTH function computes the length of a curve with a tabular representation, *Y*[*i*] = F(*X*[*i*]).

**Warning**

Data that is highly oscillatory requires a sufficient number of samples for an accurate curve length computation.

This routine is written in the IDL language. Its source code can be found in the file `crvlength.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CRVLENGTH( *X*, *Y* [, /DOUBLE] )

## Return Value

Returns the curve length.

## Arguments

### X

An *n*-element single- or double-precision floating-point vector. *X* must contain at least three elements, and values must be specified in ascending order. Duplicate *X* values will result in a warning message.

### Y

An *n*-element single- or double-precision floating-point vector.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Example

```
;Define a 21-element vector of X-values:
x = [-2.00, -1.50, -1.00, -0.50, 0.00, 0.50, 1.00, 1.50, 2.00, $
```

```
2.50,  3.00,  3.50,  4.00, 4.50, 5.00, 5.50, 6.00, 6.50, $
7.00,  7.50,  8.00]

;Define a 21-element vector of Y-values:
y = [-2.99, -2.37, -1.64, -0.84, 0.00, 0.84, 1.64, 2.37, 2.99, $
3.48,  3.86,  4.14,  4.33, 4.49, 4.65, 4.85, 5.13, 5.51, $
6.02,  6.64,  7.37]

;Compute the length of the curve:
result = CRVLENGTH(x, y)

Print, result
```

IDL prints:

```
14.8115
```

## Version History

Introduced: 5.0

## See Also

INT_TABULATED, PNT_LINE

# CT_LUMINANCE

The CT_LUMINANCE function calculates the luminance of colors.

This routine is written in the IDL language. Its source code can be found in the file `ct_luminance.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CT_LUMINANCE( [*R*, *G*, *B*] [, BRIGHT=*variable*] [, DARK=*variable*] [, /READ_TABLES] )

## Return Value

The function returns an array containing the luminance values of the specified colors. If the *R*, *G*, and *B* parameters are not specified, or if *R* is of integer, byte or long type, the result is a longword array with the same number of elements as the input arguments. Otherwise, the result is a floating-point array with the same number of elements as the input arguments.

## Arguments

### R

An array representing the red color table. If omitted, the color values from either the COLORS common block, or the current color table are used.

### G

An array representing the green color table. This parameter is optional.

### B

An array representing the blue color table. This parameter is optional.

## Keywords

### BRIGHT

Set this keyword to a named variable in which the array index of the brightest color is returned.

### DARK

Set this keyword to a named variable in which the array index of the darkest color is returned.

### READ_TABLES

Set this keyword, and don't specify the *R*, *G*, and *B* arguments, to read colors directly from the current colortable (using TVLCT, /GET) instead of using the COLORS common block.

## Version History

Introduced: Pre 4.0

## See Also

GAMMA_CT, STRETCH

# CTI_TEST

The CTI_TEST function constructs a “contingency table” from an array of observed frequencies and tests the hypothesis that the rows and columns are independent using an extension of the chi-square goodness-of-fit test.

This routine is written in the IDL language. Its source code can be found in the file `cti_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CTI_TEST( *Obfreq* [, COEFF=*variable*] [, /CORRECTED] [, CRAMV=*variable*] [, DF=*variable*] [, EXFREQ=*variable*] [, RESIDUAL=*variable*] )

## Return Value

Returns a two-element vector containing the chi-square test statistic X2 and the one-tailed probability of obtaining a value of X2 or greater.

## Arguments

### Obfreq

An *m* x *n* array containing observed frequencies. *Obfreq* can contain either integer, single-, double-precision floating-point values.

## Keywords

### COEFF

Set this keyword to a named variable that will contain the Coefficient of Contingency. The Coefficient of Contingency is a non-negative scalar, in the interval [0.0, 1.0], which measures the degree of dependence within a contingency table. The larger the value of COEFF, the greater the degree of dependence.

### CORRECTED

Set this keyword to use the “Yate’s Correction for Continuity” when computing the Chi-squared test statistic, X2. The Yate’s correction always decreases the magnitude of X2. In general, this keyword should be set for small sample sizes.

### CRAMV

Set this keyword to a named variable that will contain Cramer's V. Cramer's V is a non-negative scalar, in the interval [0.0, 1.0], which measures the degree of dependence within a contingency table.

### DF

Set this keyword to a named variable that will contain the number of degrees of freedom used to compute the probability of obtaining the value of the Chi-squared test statistic or greater. DF = (*n* - 1) * (*m* - 1) where *m* and *n* are the number of columns and rows of the contingency table, respectively.

### EXFREQ

Set this keyword to a named variable that will contain an array of *m*-columns and *n*-rows containing expected frequencies. The elements of this array are often referred to as the "cells" of the expected frequencies. The expected frequency of each cell is computed as the product of row and column marginal frequencies divided by the overall total of observed frequencies.

### RESIDUAL

Set this keyword to a named variable that will contain an array of *m*-columns and *n*-rows containing signed differences between corresponding cells of observed frequencies and expected frequencies.

## Examples

Define a 5-column and 4-row array of observed frequencies.

```
obfreq = [[748, 821, 786, 720, 672], $
          [ 74,  60,  51,  66,  50], $
          [ 31,  25,  22,  16,  15], $
          [  9,  10,   6,   5,   7]]
```

Test the hypothesis that the rows and columns of "obfreq" contain independent data at the 0.05 significance level.

```
result = CTI_TEST(obfreq, COEFF = coeff)
```

The result should be the two-element vector [14.3953, 0.276181].

The computed value of 0.276181 indicates that there is no reason to reject the proposed hypothesis at the 0.05 significance level. The Coefficient of Contingency returned in the parameter "coeff" (coeff = 0.0584860) also indicates the lack of

dependence between the rows and columns of the observed frequencies. Setting the CORRECTED keyword returns the two-element vector [12.0032, 0.445420] and (coeff = 0.0534213) resulting in the same conclusion of independence.

## Version History

Introduced: Pre 4.0

## See Also

CORRELATE, M_CORRELATE, XSQ_TEST

# CURSOR

The CURSOR procedure is used to read the position of the interactive graphics cursor from the current graphics device. Note that not all graphics devices have interactive cursors. CURSOR enables the graphic cursor on the device and optionally waits for the operator to position it. On devices that have a mouse, CURSOR normally waits until a mouse button is pressed (or already down). If no mouse buttons are present, CURSOR waits for a key on the keyboard to be pressed.

The system variable !MOUSE is set to the button status. Each mouse button is assigned a bit in !MOUSE, bit 0 is the left most button, bit 1 the next, etc. See "!MOUSE" on page 3899 for details.

### Using CURSOR with Draw Widgets

Note that the CURSOR procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain the cursor position and button state information from a draw widget, examine the X, Y, PRESS, and RELEASE fields in the structures returned by the draw widget in response to cursor events.

### Using CURSOR with the TEK Device

Note that for the CURSOR procedure to work properly with Tektronix terminals, you may need to execute the command, `DEVICE, GIN_CHARS=6`.

## Syntax

CURSOR, *X*, *Y* [, *Wait* | [, /CHANGE | , /DOWN | , /NOWAIT | , /UP | , /WAIT]] [, /DATA | , /DEVICE, | , /NORMAL]

## Arguments

### X

A named variable to receive the cursor's current column position.

### Y

A named variable to receive the cursor's current row position.

### Wait

An integer that specifies the conditions under which CURSOR returns. This parameter can be used interchangeably with the keyword parameters listed below that specify the type of wait. The default value is 1. The table below describes each type of wait.

Note that not all modes of waiting work with all display devices.

| Wait Value | Corresponding Keyword | Action |
|---|---|---|
| 0 | NOWAIT | Return immediately. |
| 1 | WAIT | Return if a button is down. |
| 2 | CHANGE | Return if a button is pressed, released, or the pointer is moved. |
| 3 | DOWN | Return when a button down transition is detected. |
| 4 | UP | Return when a button up transition is detected. |

*Table 10: Values for CURSOR Wait Parameter*

## Keywords

### CHANGE

Set this keyword to wait for pointer movement or button transition within the currently selected window.

### DATA

Set this keyword to return *X* and *Y* in data coordinates.

### DOWN

Set this keyword to wait for a button down transition within the currently selected window.

### DEVICE

Set this keyword to return *X* and *Y* in device coordinates.

### NORMAL

Set this keyword to return *X* and *Y* in normalized coordinates.

### NOWAIT

Set this keyword to read the pointer position and button status and return immediately. If the pointer is not within the currently selected window, the device coordinates -1, -1 are returned.

### UP

Set this keyword to wait for a button up transition within the current window.

### WAIT

Set this keyword to wait for a button to be depressed within the currently selected window. If a button is already pressed, return immediately.

## Examples

Activate the graphics cursor, select a point in the graphics window, and return the position of the cursor in device coordinates. Enter:

```
CURSOR, X, Y, /DEVICE
```

Move the cursor over the graphics window and press the mouse button. The position of the cursor in device coordinates is stored in the variables X and Y. To label the location, enter:

```
XYOUTS, X, Y, 'X marks the spot.', /DEVICE
```

## Version History

Introduced: Original

## See Also

RDPIX, TVCRS, CURSOR_CROSSHAIR (and other CURSOR_ keywords), WIDGET_DRAW, “!MOUSE” on page 3899

# CURVEFIT

The CURVEFIT function uses a gradient-expansion algorithm to compute a non-linear least squares fit to a user-supplied function with an arbitrary number of parameters. The user-supplied function may be any non-linear function where the partial derivatives are known or can be approximated. Iterations are performed until the chi square changes by a specified amount, or until a maximum number of iterations have been performed.

This routine is written in the IDL language. Its source code can be found in the file `curvefit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CURVEFIT( *X*, *Y*, *Weights*, *A* [, *Sigma*] [, CHISQ=*variable*] [, /DOUBLE] [, FITA=*vector*] [, FUNCTION_NAME=*string*] [, ITER=*variable*] [, ITMAX=*value*] [, /NODERIVATIVE] [, STATUS={0 | 1 | 2}] [, TOL=*value*] [, YERROR=*variable*] )

## Return Value

Returns a vector of values for the dependent variables, as fitted by the function fit. If *A* is double-precision or if the DOUBLE keyword is set, calculations are performed in double-precision arithmetic, otherwise they are performed in single-precision arithmetic.

## Arguments

### X

An *n*-element vector of independent variables.

### Y

A vector of dependent variables. *Y* must have the same number of elements as *F* returned by the user-defined function.

### Weights

For instrumental (Gaussian) weighting, set $Weights_i = 1.0/\text{standard\_deviation}(Y_i)^2$. For statistical (Poisson) weighting, $Weights_i = 1.0/Y_i$. For no weighting, set $Weights_i = 1.0$. If *Weights* is set to an undefined variable then no weighting will be used.

### A

A vector with as many elements as the number of terms in the user-supplied function, containing the initial estimate for each parameter. On return, the vector *A* contains the fitted model parameters.

### Sigma

A named variable that will contain a vector of standard deviations for the elements of the output vector *A*.

**Note**

If *Weights* is omitted, then you are assuming that your supplied model is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned for the *Sigma* argument are multiplied by SQRT(CHISQ/(*N***M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See Section 15.2 of *Numerical Recipes in C (Second Edition)* for details.

## Keywords

### CHISQ

Set this keyword equal to a named variable that will contain the value of the reduced chi-squared.

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### FITA

Set this keyword to a vector, with as many elements as *A*, which contains a zero for each fixed parameter, and a non-zero value for elements of *A* to fit. If not supplied, all parameters are taken to be non-fixed.

### FUNCTION_NAME

Use this keyword to specify the name of the function to fit. If this keyword is omitted, CURVEFIT assumes that the IDL procedure `FUNCT` is to be used. If `FUNCT` is not already compiled, IDL compiles the function from the file `funct.pro`, located in the `lib` subdirectory of the IDL distribution. `FUNCT` evaluates the sum of a Gaussian and a second-order polynomial.

The function to be fit must be written as an IDL procedure and compiled prior to calling CURVEFIT. The procedure must accept values of *X* (the independent variable), and *A* (the fitted function's initial parameter values). It must return values for *F* (the function's value at *X*), and optionally *PDER* (a 2D array of partial derivatives).

The return value for *F* must have the same number of elements as *Y*. The return value for *PDER* (if supplied) must be a 2D array with dimensions [N_ELEMENTS(*Y*), N_ELEMENTS(*A*)].

See the *Example* section below for an example function.

## ITER

Set this keyword equal to a named variable that will contain the actual number of iterations performed.

## ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 20.

## NODERIVATIVE

If this keyword is set, the routine specified by the FUNCTION_NAME keyword will not be requested to provide partial derivatives. The partial derivatives will be estimated by CURVEFIT using forward differences. If analytical derivatives are available they should always be used.

## STATUS

Set this keyword to a named variable that will contain an integer indicating the status of the computation. Possible return values are:

| | |
|---|---|
| 0 | The computation was successful. |
| 1 | The computation failed. Chi-square was increasing without bounds. |
| 2 | The computation failed to converge in ITMAX iterations. |

### TOL

Use this keyword to specify the desired convergence tolerance. The routine returns when the relative decrease in chi-squared is less than TOL in one iteration. The default value is $1.0 \times 10^{-3}$.

### YERROR

Set this keyword to a named variable that will contain the standard error between YFIT and Y.

## Examples

Fit a function of the form `F(x) = a * exp(b*x) + c` to sample pairs contained in arrays *X* and *Y*. The partial derivatives are easily computed symbolically:

```
df/da = EXP(b*x)
df/db = a * x * EXP(b*x)
df/dc = 1.0
```

First, define a procedure to return `F(x)` and the partial derivatives, given *X*. Note that A is an array containing the values `a`, `b`, and `c`.

```
PRO gfunct, X, A, F, pder
  bx = EXP(A[1] * X)
  F = A[0] * bx + A[2]
```

```
;If the procedure is called with four parameters, calculate the
;partial derivatives.
  IF N_PARAMS() GE 4 THEN $
    pder = [[bx], [A[0] * X * bx], [replicate(1.0, N_ELEMENTS(X))]]
END
```

Compute the fit to the function we have just defined. First, define the independent and dependent variables:

```
X = FLOAT(INDGEN(10))
Y = [12.0, 11.0, 10.2, 9.4, 8.7, 8.1, 7.5, 6.9, 6.5, 6.1]

;Define a vector of weights.
weights = 1.0/Y

;Provide an initial guess of the function’s parameters.
A = [10.0,-0.1,2.0]

;Compute the parameters.
yfit = CURVEFIT(X, Y, weights, A, SIGMA, FUNCTION_NAME='gfunct')

;Print the parameters returned in A.
PRINT, 'Function parameters: ', A
```

IDL prints:

```
Function parameters:       9.91120    -0.100883      2.07773
```

Thus, the function that best fits the data is:

$$f(x) = 9.91120(e^{-0.100883x}) + 2.07773$$

## Version History

Introduced: Original

YERROR keyword added: 5.6

## See Also

COMFIT, GAUSS2DFIT, GAUSSFIT, LMFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

# CV_COORD

The CV_COORD function converts 2D and 3D coordinates between the rectangular, polar, cylindrical, and spherical coordinate systems.

This routine is written in the IDL language. Its source code can be found in the file `cv_coord.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CV_COORD( [, /DEGREES] [, /DOUBLE] [, FROM_CYLIN=*cyl_coords* | , FROM_POLAR=*pol_coords* | , FROM_RECT=*rect_coords* | , FROM_SPHERE=*sph_coords*] [, /TO_CYLIN | , /TO_POLAR | , /TO_RECT | , /TO_SPHERE] )

## Return Value

If the value specified in the “FROM_” keyword is double precision, or if the DOUBLE keyword is set, then all calculations are performed in double precision and the returned value is double precision. Otherwise, single precision is used. If none of the “FROM_” keyword are specified, 0 is returned. If none of the “TO_” keywords are specified, the input coordinates are returned.

## Arguments

This function has no required arguments. All data is passed in via keywords.

## Keywords

### DEGREES

If set, then the input and output coordinates are in degrees (where applicable). Otherwise, the angles are in radians.

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### FROM_CYLIN

A vector of the form [*angle*, *radius*, *z*], or a (3, *n*) array of cylindrical coordinates to convert.

### FROM_POLAR

A vector of the form [*angle*, *radius*], or a (2, *n*) array of polar coordinates to convert.

### FROM_RECT

A vector of the form [*x*, *y*] or [*x*, *y*, *z*], or a (2, *n*) or (3, *n*) array containing rectangular coordinates to convert.

### FROM_SPHERE

A vector of the form [*longitude*, *latitude*, *radius*], or a (3, *n*) array of spherical coordinates to convert.

### TO_CYLIN

If set, cylindrical coordinates are returned in a vector of the form [*angle*, *radius*, *z*], or a (3, *n*) array.

### TO_POLAR

If set, polar coordinates are returned in a vector of the form [*angle*, *radius*], or a (2, n) array.

### TO_RECT

If set, rectangular coordinates are returned in a vector of the form [*x*, *y*] or [*x*, *y*, *z*], or a (2, *n*) or (3, *n*) array.

### TO_SPHERE

If set, spherical coordinates are returned in a vector of the form [*longitude*, *latitude*, *radius*], or a (3, *n*) array.

## Examples

Convert from spherical to cylindrical coordinates:

```
sph_coord = [[45.0, -60.0, 10.0], [0.0, 0.0, 0.0]]
rect_coord = CV_COORD(FROM_SPHERE=sph_coord, /TO_CYLIN, /DEGREES)
```

Convert from rectangular to polar coordinates:

```
rect_coord = [10.0, 10.0]
polar_coord = CV_COORD(FROM_RECT=rect_coord, /TO_POLAR)
```

## Version History

Introduced: Pre 4.0

## See Also

CONVERT_COORD, COORD2TO3, CREATE_VIEW, SCALE3, T3D

# CVTTOBM

The CVTTOBM function converts a byte array in which each byte represents one pixel into a “bitmap byte array” in which each bit represents one pixel. This is useful when creating bitmap labels for buttons created with the WIDGET_BUTTON function.

Most of IDL’s image file format reading functions (READ_BMP, READ_PICT, etc.) return a byte array which must be converted before use as a button label. Note that there is one exception to this rule; the READ_X11_BITMAP routine returns a bitmap byte array that needs no conversion before use.

This routine is written in the IDL language. Its source code can be found in the file `cvttobm.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

IDL supports color bitmaps for button labels. The IDL GUIBuilder has a Bitmap Editor that allows you to create color bitmaps for button labels. The BITMAP keyword to WIDGET_BUTTON specifies that the button label is a color bitmap.

## Syntax

*Result* = CVTTOBM( *Array* [, THRESHOLD=*value*{0 to 255}] )

## Return Value

Returns a bitmap byte array. Bitmap byte arrays are monochrome; by default, CVTTOBM converts pixels that are darker than the median value to black and pixels that are lighter than the median value to white. You can supply a different threshold value via the THRESHOLD keyword.

## Arguments

### Array

A 2-dimensional pixel array, one byte per pixel.

# Keywords

## THRESHOLD

A byte value (or an integer value between 0 and 255) to be used as a threshold value when determining if a particular pixel is black or white. If THRESHOLD is not specified, the threshold is calculated to be the average of the input array.

# Examples

The following example creates a bitmap button label from a byte array:

```
; Create a byte array:
image = BYTSCL(DIST(100))
; Create a widget base:
base = WIDGET_BASE(/COLUMN)

; Use CVTTOBM to create a bitmap byte array for a button label:
button = WIDGET_BUTTON(base, VALUE = CVTTOBM(image))

; Realize the widget:
WIDGET_CONTROL, base, /REALIZE
```

# Version History

Introduced: 5.0

# See Also

WIDGET_BUTTON, XBM_EDIT, “Using the Bitmap Editor” in Chapter 24 of the *Building IDL Applications* manual.

# CW_ANIMATE

The CW_ANIMATE function creates a compound widget that displays an animated sequence of images using off-screen windows knows as *pixmaps*. The speed and direction of the display can be adjusted using the widget interface.

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

## Using CW_ANIMATE

Unlike XINTERANIMATE, using the CW_ANIMATE widget requires calls to two separate procedures, CW_ANIMATE_LOAD and CW_ANIMATE_RUN, to load the images to be animated and to run the animation. Alternatively, you can supply a vector of pre-existing pixmap window IDs, eliminating the need to use CW_ANIMATE_LOAD. The vector of pixmaps is commonly obtained from a call to CW_ANIMATE_GETP applied to a previous animation widget. Once the images are loaded, they are displayed by copying the images from the pixmap or buffer to the visible draw widget.

See the documentation for CW_ANIMATE_LOAD, CW_ANIMATE_RUN, and CW_ANIMATE_GETP for more information.

The only event returned by CW_ANIMATE indicates that the user has clicked on the “End Animation” button. The parent application should use this as a signal to kill the animation widget via WIDGET_CONTROL. When the widget is destroyed, the pixmaps used in the animation are destroyed as well, unless they were saved by a call to CW_ANIMATE_GETP.

See the animation widget’s help file (available by clicking the “Help” button on the widget) for more information about the widget’s controls.

# Syntax

*Result* = CW_ANIMATE( *Parent*, *Sizex*, *Sizey*, *Nframes* [, /NO_KILL] [, OPEN_FUNC=*string*] [, PIXMAPS=*vector*] [, /TRACK] [, UNAME=*string*] [, UVALUE=*value*] )

# Return Value

This function returns the widget ID of the newly-created animation widget.

# Arguments

## Parent

The widget ID of the parent widget.

## Sizex

The width of the displayed image, in pixels.

## Sizey

The height of the displayed image, in pixels

## Nframes

The number of frames in the animation sequence.

# Keywords

## NO_KILL

Set this keyword to omit the “End Animation” button from the animation widget.

## OPEN_FUNC

Set this keyword equal to a scalar string specifying the name of a user-written function that loads animation data. If a function is specified, an “Open ...” button is added to the animation widget.

## PIXMAPS

Use this keyword to provide the animation widget with a vector of pre-existing pixmap (off screen window) IDs. This vector is usually obtained from a call to CW_ANIMATE_GETP applied to a previous animation widget.

## TRACK

Set this keyword to cause the frame slider to track the frame number of the currently-displayed frame.

### UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

### UVALUE

The “user value” to be assigned to the widget.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See “Compound Widgets” in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_ANIMATE Widget

The only event returned by this widget indicates that the user has pressed the DONE button. The parent application should use this as a signal to kill the animation widget via WIDGET_CONTROL.

## Examples

Assume the following event handler procedure exists:

```
PRO EHANDLER, EV
WIDGET_CONTROL, /DESTROY, EV.TOP
end
```

**Tip**

If you wish to create this event handler starting from the IDL command prompt, remember to begin with the `.RUN` command.

Enter the following commands to open the file ABNORM.DAT (a series of images of a human heart) and load the images it contains into an array H.

```
OPENR, 1, FILEPATH('abnorm.dat', SUBDIR = ['examples','data'])
H = BYTARR(64, 64, 16)
READU, 1, H
CLOSE, 1
H = REBIN(H, 128, 128, 16)
```

Create an instance of the animation widget and load the frames. Note that because the animation widget is realized before the call to CW_ANIMATE_LOAD, the frames are displayed as they are loaded. This provides the user with an indication of how things are progressing.

```
base = WIDGET_BASE(TITLE = 'Animation Widget')
animate = CW_ANIMATE(base, 128, 128, 16)
WIDGET_CONTROL, /REALIZE, base
FOR I=0,15 DO CW_ANIMATE_LOAD, animate, FRAME=I, IMAGE=H[*,*,I]
```

Save the pixmap window IDs for future use:

```
CW_ANIMATE_GETP, animate, pixmap_vect
```

Start the animation:

```
CW_ANIMATE_RUN, animate
XMANAGER, 'CW_ANIMATE Demo', base, EVENT_HANDLER = 'EHANDLER'
```

Pressing the “End Animation” button kills the application.

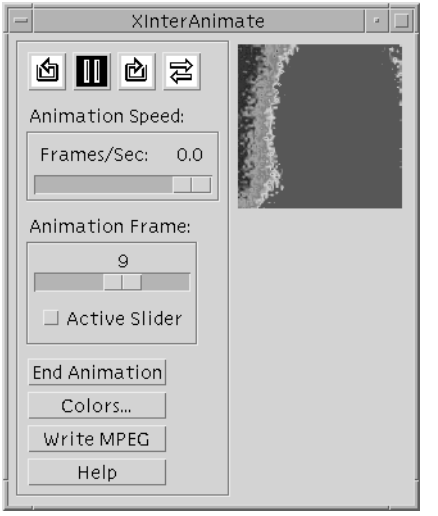


*Figure 6: The animation interface created by CW_ANIMATE*

## Version History

Introduced: Pre 4.0

## See Also

CW_ANIMATE_LOAD, CW_ANIMATE_RUN, CW_ANIMATE_GETP, XINTERANIMATE

# CW_ANIMATE_GETP

The CW_ANIMATE_GETP procedure gets a copy of the vector of pixmap window IDs being used by a CW_ANIMATE animation widget. If this routine is called, CW_ANIMATE does not destroy the pixmaps when it is destroyed. You can then provide the pixmaps to a later instance of CW_ANIMATE to re-use them, skipping the pixmap creation and rendering step (CW_ANIMATE_LOAD).

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

CW_ANIMATE_GETP, *Widget*, *Pixmaps* [, /KILL_ANYWAY]

## Arguments

### Widget

The widget ID of the animation widget (created with CW_ANIMATE) that contains the pixmaps.

### Pixmaps

A named variable that will contain a vector of the window IDs of the pixmap windows.

## Keywords

### KILL_ANYWAY

Set this keyword to ensure that the pixmaps are destroyed anyway when CW_ANIMATE exits, despite the fact that CW_ANIMATE_GETP has been called.

## Example

See “CW_ANIMATE” on page 357.

## Version History

Introduced: Pre 4.0

## See Also

CW_ANIMATE, CW_ANIMATE_LOAD, CW_ANIMATE_RUN, XINTERANIMATE

# CW_ANIMATE_LOAD

The CW_ANIMATE_LOAD procedure creates an array of pixmaps which are loaded into a CW_ANIMATE compound widget.

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

CW_ANIMATE_LOAD, *Widget* [, /CYCLE] [, FRAME=*value*{0 to *NFRAMES*}] [, IMAGE=*value*] [, /ORDER] [, WINDOW=*[window_num* [, *X0*, *Y0*, *Sx*, *Sy*]*]*] [, XOFFSET=*pixels*] [, YOFFSET=*pixels*]

## Arguments

### Widget

The widget ID of the animation widget (created with CW_ANIMATE) into which the image should be loaded.

## Keywords

### CYCLE

Set this keyword to cause the animation to cycle. Normally, frames are displayed going either forward or backward. If CYCLE is set, the animation reverses direction after the last frame in either direction is displayed.

### FRAME

The frame number to be loaded. This is a value between 0 and NFRAMES. If not supplied, frame 0 is loaded.

### IMAGE

The image to be loaded. IMAGE can either be a 2D or a 3D (24-bit) image.

### ORDER

Set this keyword to display images from the top down instead of the default bottom up. This keyword is only used when loading images with the IMAGE keyword.

### WINDOW

When this keyword is specified, an image is copied from an existing window to the animation pixmap. Under some windowing systems, this technique is much faster than reading from the display and then loading with the IMAGE keyword.

The value of this parameter is either an IDL window number (in which case the entire window is copied), or a vector containing the window index and the rectangular bounds of the area to be copied. For example:

```
WINDOW = [Window_Number, X0, Y0, Sx, Sy]
```

### XOFFSET

The horizontal offset, in pixels from the left of the frame, of the image in the destination window.

### YOFFSET

The vertical offset, in pixels from the bottom of the frame, of the image in the destination window.

## Example

See the documentation for CW_ANIMATE for an example using this procedure. Note that if the widget is realized before calls to CW_ANIMATE_LOAD, the frames are displayed as they are loaded. This provides the user with an indication of how things are progressing.

## Version History

Introduced: Pre 4.0

## See Also

CW_ANIMATE, CW_ANIMATE_GETP, CW_ANIMATE_RUN, XINTERANIMATE

# CW_ANIMATE_RUN

The CW_ANIMATE_RUN procedure displays a series of images that have been loaded into a CW_ANIMATE compound widget by a call to CW_ANIMATE_LOAD.

CW_ANIMATE provides the graphical interface used by the XINTERANIMATE procedure, which is the preferred routine for displaying animation sequences in most situations. Use this widget instead of XINTERANIMATE when you need to run multiple instances of the animation widget simultaneously. Note that if more than one animation widget is running, they will have to share resources and will display images more slowly than a single instance of the widget.

This routine is written in the IDL language. Its source code can be found in the file `cw_animate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

CW_ANIMATE_RUN, *Widget* [, *Rate*{0 to 100}] [, NFRAMES=*value*] [, /STOP]

## Arguments

### Widget

The widget ID of the animation widget (created with CW_ANIMATE) that will display the animation.

### Rate

A value between 0 and 100 that represents the speed of the animation as a percentage of the maximum display rate. The fastest animation has a value of 100 and the slowest has a value of 0. The default animation rate is 100.

The animation rate can also be adjusted after the animation has begun by changing the value of the “Animation Speed” slider.

## Keywords

### NFRAMES

Set this keyword equal to the number of frames to animate. This number must be less than or equal to the *Nframes* argument to CW_ANIMATE.

### STOP

If this keyword is set, the animation is stopped.

## Example

See “CW_ANIMATE” on page 357.

## Version History

Introduced: Pre 4.0

## See Also

CW_ANIMATE, CW_ANIMATE_GETP, CW_ANIMATE_LOAD, XINTERANIMATE

# CW_ARCBALL

The CW_ARCBALL function creates a compound widget for intuitively specifying three-dimensional orientations.

The user drags a simulated track-ball with the mouse to interactively obtain arbitrary rotations. Sequences of rotations may be cascaded. The rotations may be unconstrained (about any axis), constrained to the view X, Y, or Z axes, or constrained to the object's X, Y, or Z axis.

This widget is based on "ARCBALL: A User Interface for Specifying Three-Dimensional Orientation Using a Mouse," by Ken Shoemake, Computer Graphics Laboratory, University of Pennsylvania, Philadelphia, PA 19104.

This widget can generate any rotation about any axis. Note, however, that not all rotations are compatible with the IDL SURFACE procedure, which is restricted to rotations that project the object Z axis parallel to the view Y axis.

This routine is written in the IDL language. Its source code can be found in the file `cw_arcball.pro` in the `lib` subdirectory of the IDL distribution.

### Using CW_ARCBALL

Use the command:

```
WIDGET_CONTROL, id, GET_VALUE = matrix
```

to return the current 3x3 rotation matrix in the variable `matrix`.

You can set the arcball to new rotation matrix using the command:

```
WIDGET_CONTROL, id, SET_VALUE = matrix
```

after the widget is initially realized.

## Syntax

*Result* = CW_ARCBALL( *Parent* [, COLORS=*array*] [, /FRAME] [, LABEL=*string*] [, RETAIN={0 | 1 | 2}] [, SIZE=*pixels*] [, /UPDATE] [, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*array*] )

## Return Value

This function returns the widget ID of the newly-created ARCBALL widget.

# Arguments

## Parent

The widget ID of the parent widget.

# Keywords

## COLORS

A 6-element array containing the color indices to be used.

- Colors[0] = view axis color,
- Colors[1] = object axis color,
- Colors[2] = XZ plane +Y side (body top) color,
- Colors[3] = YZ plane (fin) color,
- Colors[4] = XZ plane -Y side (body bottom),
- Colors[5] = background color.

For devices that are using indexed color (i.e., DECOMPOSED=0), the default value for COLORS is `[1,7,2,3,7,0]`, which yields good colors with the TEK_COLOR table: (white, yellow, red, green, yellow, black). For devices that are using decomposed color (i.e., DECOMPOSED=1), the default value is an array of corresponding decomposed (rather than indexed) colors: (white, yellow, red, green, yellow, black).

For more information on decomposed color, refer to the DECOMPOSED keyword to the DEVICE routine.

## FRAME

Set this keyword to draw a frame around the widget.

## LABEL

Set this keyword to a string containing the widget's label.

## RETAIN

Set this keyword to zero, one, or two to specify how backing store should be handled for the draw widget. RETAIN=0 specifies no backing store. RETAIN=1 requests that

the server or window system provide backing store. RETAIN=2 specifies that IDL provide backing store directly. See “Backing Store” on page 3824 for details.

## SIZE

The size of the square drawable area containing the arcball, in pixels. The default is 192.

## UPDATE

Set this keyword to cause the widget will send an event each time the mouse button is released after a drag operation. By default, events are only sent when the “Update” button is pressed.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

## VALUE

Set this keyword to a 3 x 3 array that will be the initial value for the rotation matrix. VALUE must be a valid rotation matrix (no translation or perspective) where TRANSPOSE(VALUE) = INVERSE(VALUE). This can be the upper-left corner of !P.T after executing the command

```
T3D, /RESET, ROTATE = [x,y,z].
```

The default is the identity matrix.

## Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the 3 x 3 rotation matrix in the arcball widget.

See "Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_ARCBALL Widget

Arcball widgets generate event structures with the following definition:

```
event = {ID:0L, TOP:0L, HANDLER:0L, VALUE:fltarr(3,3) }
```

The VALUE field contains the 3 x 3 array representing the new rotation matrix.

## Examples

See the procedure `ARCBALL_TEST`, contained in the `cw_arcball.pro` file. To test CW_ARCBALL, enter the following commands:

```
.RUN cw_arcball
ARCBALL_TEST
```

This results in the following:

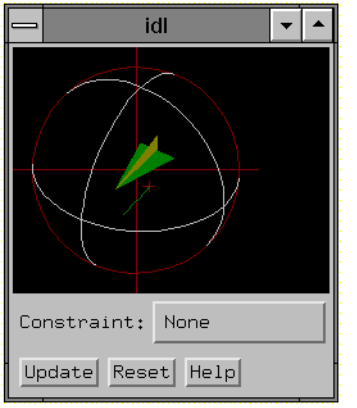


*Figure 7: The CW_ARCBALL widget.*

## Version History

Introduced: Pre 4.0

## See Also

CREATE_VIEW, SCALE3, T3D

# CW_BGROUP

The CW_BGROUP function creates a widget base of buttons. It handles the details of creating the proper base (standard, exclusive, or non-exclusive) and filling in the desired buttons. Events for the individual buttons are handled transparently, and a CW_BGROUP event returned. This event can return any one of the following:

- the index of the button within the base,
- the widget ID of the button,
- the name of the button,
- an arbitrary value taken from an array of user values.

Only buttons with textual names are handled by this widget. Bitmaps are not understood.

This routine is written in the IDL language. Its source code can be found in the file `cw_bgroup.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_BGROUP( *Parent*, *Names* [, BUTTON_UVALUE=*array*] [, COLUMN=*value*] [, EVENT_FUNC=*string*] [{, /EXCLUSIVE | , /NONEXCLUSIVE} | [, SPACE=*pixels*] [, XPAD=*pixels*] [, YPAD=*pixels*]] [, FONT=*font*] [, FRAME=*width*] [, IDS=*variable*] [, /LABEL_LEFT=*string* | , /LABEL_TOP=*string*] [, /MAP] [, /NO_RELEASE] [, /RETURN_ID | , /RETURN_INDEX | , /RETURN_NAME] [, ROW=*value*] [, /SCROLL] [, X_SCROLL_SIZE=*width*] [, Y_SCROLL_SIZE=*height*] [, SET_VALUE=*value*] [, UNAME=*string*] [, UVALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*width*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

This function returns the widget ID of the newly-created button group widget.

## Arguments

### Parent

The widget ID of the parent widget.

### Names

A string array, one string per button, giving the name of each button.

## Keywords

### BUTTON_UVALUE

An array of user values to be associated with each button and returned in the event structure. If this keyword is set, the user values are always returned, even if the any of the RETURN_ID, RETURN_INDEX, or RETURN_NAME keywords are set.

### COLUMN

Buttons will be arranged in the number of columns specified by this keyword.

### EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget. This function is called with the return value structure whenever a button is pressed, and follows the conventions for user-written event functions.

### EXCLUSIVE

Set this keyword to cause buttons to be placed in an exclusive base, in which only one button can be selected at a time.

### FONT

The name of the font to be used for the button titles. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

### FRAME

Specifies the width of the frame to be drawn around the base.

### IDS

A named variable in which the button IDs will be stored, as a longword vector.

## LABEL_LEFT

Set this keyword to a string creating a text label to the left of the buttons.

## LABEL_TOP

Set this keyword to a string creating a text label above the buttons.

## MAP

Set this keyword to cause the base to be mapped when the widget is realized (the default).

## NONEXCLUSIVE

Set this keyword to cause buttons to be placed in an non-exclusive base, in which any number of buttons can be selected at once.

## NO_RELEASE

If set, button release events will not be returned.

## RETURN_ID

Set this keyword to return the widget ID of the button in the VALUE field of returned events. This keyword is ignored if the BUTTON_UVALUE keyword is set.

## RETURN_INDEX

Set this keyword to return the zero-based index of the button within the base in the VALUE field of returned events. This keyword is ignored if the BUTTON_UVALUE keyword is set. THIS IS THE DEFAULT.

## RETURN_NAME

Set this keyword to return the name of the button within the base in the VALUE field of returned events. This keyword is ignored if the BUTTON_UVALUE keyword is set.

## ROW

Buttons will be arranged in the number of rows specified by this keyword.

## SCROLL

If set, the base will include scroll bars to allow viewing a large base through a smaller viewport.

## SET_VALUE

Allows changing the current state of toggle buttons (i.e., exclusive and nonexclusive groups of buttons). The behavior of SET_VALUE differs between EXCLUSIVE and NONEXCLUSIVE CW_BGROUP widgets. With EXCLUSIVE CW_BGROUP widgets, the argument to SET_VALUE is the id of the widget to be turned on. With NONEXCLUSIVE CW_BGROUP widgets the argument to SET_VALUE should be an array of on/off flags for the array of buttons.

## SPACE

The space, in pixels, to be left around the edges of a row or column major base.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

## XOFFSET

The X offset of the widget relative to its parent.

## XPAD

The horizontal space, in pixels, between children of a row or column major base.

## XSIZE

The width of the base.

### X_SCROLL_SIZE

The width of the viewport if SCROLL is specified.

### YOFFSET

The Y offset of the widget relative to its parent.

### YPAD

The vertical space, in pixels, between children of a row or column major base.

### YSIZE

The height of the base.

### Y_SCROLL_SIZE

The height of the viewport if SCROLL is specified.

## Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the button group. The values for different types of CW_BGROUP widgets is shown in the table below:

| Type | Value |
|---|---|
| normal | None |
| exclusive | Index of currently set button |
| non-exclusive | Vector indicating the position of each button (1-set, 0-unset) |

*Table 11: Button Group Values*

See "Writing Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_BGROUP Widget

Button Group widgets generates event structures with the following definition:

```
event = {ID:0L, TOP:0L, HANDLER:0L, SELECT:0, VALUE:0 }
```

The SELECT field is passed through from the button event. VALUE is either the INDEX, ID, NAME, or BUTTON_UVALUE of the button, depending on how the widget was created.

## Version History

Introduced: Pre 4.0

## See Also

CW_PDMENU, WIDGET_BUTTON

# CW_CLR_INDEX

The CW_CLR_INDEX function creates a compound widget for the selection of a color index. A horizontal color bar is displayed. Clicking on the bar sets the color index.

This routine is written in the IDL language. Its source code can be found in the file `cw_clr_index.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_CLR_INDEX( *Parent* [, COLOR_VALUES=*vector* |
[, NCOLORS=*value*] [, START_COLOR=*value*]]
[, EVENT_FUNC='*function_name*'] [, /FRAME] [, LABEL=*string*]
[, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*value*] [, XSIZE=*pixels*]
[, YSIZE=*pixels*] )

## Return Value

This function returns the widget ID of the newly-created color index widget.

## Arguments

### Parent

The widget ID of the parent widget.

## Keywords

### COLOR_VALUES

A vector of color indices containing the colors to be displayed in the color bar. If omitted, NCOLORS and START_COLOR specify the range of color indices.

### EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget. This function is called with the return value structure whenever a button is pressed, and follows the conventions for user-written event functions.

## FRAME

If set, a frame will be drawn around the widget.

## LABEL

A text label that appears to the left of the color bar.

## NCOLORS

The number of colors to place in the color bar. The default is !D.N_COLORS.

## START_COLOR

Set this keyword to the starting color index, placed at the left of the bar.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

## VALUE

Set this keyword to the index of the color that is to be initially selected. The default is the START_COLOR.

## XSIZE

The width of the color bar in pixels. The default is 192.

## YSIZE

The height of the color bar in pixels. The default is 12.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the color selection widget. The value of a CW_CLR_INDEX widget is the index of the color selected.

See "Writing Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_CLR_INDEX Widget

This widget generates event structures with the following definition:

```
Event = {CW_COLOR_INDEX, ID: base, TOP: ev.top, HANDLER: 0L,
VALUE:c}
```

The VALUE field is the color index selected.

## Version History

Introduced: Pre 4.0

## See Also

CW_COLORSEL, XLOADCT, XPALETTE

# CW_COLORSEL

The CW_COLORSEL function creates a compound widget that displays all the colors in the current colormap in a 16 x 16 (320 x 320 pixels) grid. To select a color index, the user moves the mouse pointer over the desired color square and presses any mouse button. Alternatively, the color index can be selected by moving one of the three sliders provided around the grid.

This routine is written in the IDL language. Its source code can be found in the file `cw_colorsel.pro` in the `lib` subdirectory of the IDL distribution.

### Using CW_COLORSEL

The command:

```
WIDGET_CONTROL, widgetID, SET_VALUE = -1
```

informs the widget to initialize itself and redraw. It should be called when any of the following happen:

- the widget is realized,
- the widget needs redrawing,
- the brightest or darkest color has changed.

To set the current color index, use the command:

```
WIDGET_CONTROL, widgetID, SET_VALUE = index
```

To retrieve the current color index and store it in the variable `var`, use the command:

```
WIDGET_CONTROL, widgetID, GET_VALUE = var
```

## Syntax

*Result* = CW_COLORSEL( *Parent* [, /FRAME] [, UNAME=*string*] [, UVALUE=*value*] [, XOFFSET=*value*] [, YOFFSET=*value*] )

## Return Value

This function returns the widget ID of the newly-created color index widget.

# Arguments

## Parent

The widget ID of the parent widget.

# Keywords

## FRAME

If set, a frame is drawn around the widget.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

## XOFFSET

The X offset position

## YOFFSET

The Y offset position

# Widget Events Returned by the CW_COLORSEL Widget

This widget generates event structures with the following definition:

```
Event = {COLORSEL_EVENT, ID: base, TOP: ev.top, HANDLER: 0L, VALUE:c}
```

The VALUE field is the color index selected.

## Version History

Introduced: Pre 4.0

## See Also

CW_CLR_INDEX, XLOADCT, XPALETTE

# CW_DEFROI

The CW_DEFROI function creates a compound widget that allows the user to define a region of interest within a widget draw window.

**Warning**

This is a *modal* widget. No other widget applications will be responsive while this widget is in use. Also, since CW_DEFROI has its own event-handling loop, it should not be created as a child of a modal base.

This routine is written in the IDL language. Its source code can be found in the file `cw_defroi.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_DEFROI( *Draw* [, IMAGE_SIZE=*vector*] [, OFFSET=*vector*] [, /ORDER] [, /RESTORE] [, ZOOM=*vector*] )

## Return Value

The is function returns an array of subscripts defining the region. If no region is defined, the scalar -1 is returned.

## Arguments

### Draw

The widget ID of draw window in which to draw the region. Note that the draw window must have both BUTTON and MOTION events enabled (see WIDGET_DRAW for more information).

## Keywords

### IMAGE_SIZE

The size of the underlying array, expressed as a two element vector: [*columns*, *rows*]. Default is the size of the draw window divided by the value of ZOOM.

### OFFSET

The offset of lower left corner of image within the draw window. Default = [0,0].

### ORDER

Set this keyword to return inverted subscripts, as if the array were output from top to bottom.

### RESTORE

Set this keyword to restore the draw window to its previous appearance on exit. Otherwise, the regions remain on the drawable.

### ZOOM

If the image array was expanded (using REBIN, for example) specify this two element vector containing the expansion factor in X and Y. Default = [1,1]. Both elements of ZOOM must be integers.

## Widget Events Returned by the CW_DEFROI Widget

Region definition widgets do not return an event structure.

## Examples

The following two procedures create a region-of-interest widget and its event handler. Create a file containing the program code using a text editor and compile using the .RUN command, or type .RUN at the IDL prompt and enter the lines interactively.

First, create the event handler:

```
PRO test_event, ev

; The common block holds variables that are shared between the
; routine and its event handler:
COMMON T, draw, dbutt, done, image

; Define what happens when you click the "Draw ROI" button:
IF ev.id EQ dbutt THEN BEGIN
   ; The ROI definition will be stored in the variable Q:
   Q = CW_DEFROI(draw)
   IF (Q[0] NE -1) then BEGIN
      ; Show the size of the ROI definition array:
      HELP, Q
      ; Duplicate the original image.
      image2 = image

      ; Set the points in the ROI array Q equal to a single
      ; color value:
```

```
      image2(Q)=!P.COLOR-1

      ; Get the window ID of the draw widget:
      WIDGET_CONTROL, draw, GET_VALUE=W

      ; Set the draw widget as the current graphics window:
      WSET, W

      ; Load the image plus the ROI into the draw widget:
      TV, image2
   ENDIF
ENDIF

; Define what happens when you click the "Done" button:
IF ev.id EQ done THEN WIDGET_CONTROL, ev.top, /DESTROY

END
```

Next, create a draw widget that can call CW_DEFROI. Note that you *must* specify both button events and motion events when creating the draw widget, if it is to be used with CW_DEFROI.

```
PRO test
COMMON T, draw, dbutt, done, image

; Create a base to hold the draw widget and buttons:
base = WIDGET_BASE(/COLUMN)

; Create a draw widget that will return both button and
; motion events:
draw = WIDGET_DRAW(base, XSIZE=256, YSIZE=256, /BUTTON, /MOTION)
dbutt = WIDGET_BUTTON(base, VALUE='Draw ROI')
done = WIDGET_BUTTON(base, VALUE='Done')
WIDGET_CONTROL, base, /REALIZE

; Get the widget ID of the draw widget:
WIDGET_CONTROL, draw, GET_VALUE=W

; Set the draw widget as the current graphics window:
WSET, W

; Create an original image:
image = BYTSCL(SIN(DIST(256)))

; Display the image in the draw widget:
TV, image
```

```
; Start XMANAGER:
XMANAGER, "test", base

END
```

This results in the following:

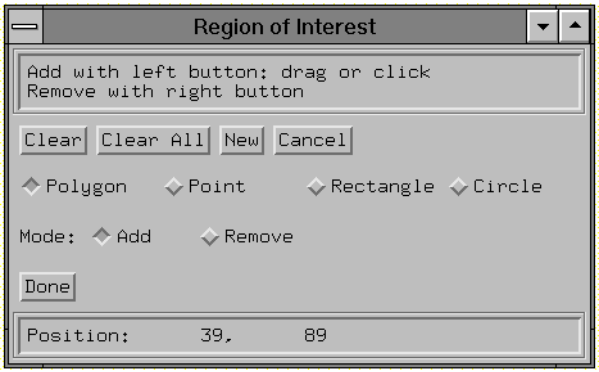


*Figure 8: The Region of Interest Definition Widget*

## Version History

Introduced: Pre 4.0

## See Also

DEFROI

# CW_FIELD

The CW_FIELD function creates a widget data entry field. The field consists of a label and a text widget. CW_FIELD can create string, integer, or floating-point fields. The default is an editable string field.

This routine is written in the IDL language. Its source code can be found in the file `cw_field.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_FIELD( *Parent* [, /ALL_EVENTS] [, /COLUMN]
[, FIELDFONT=*font*] [, /FLOATING | , /INTEGER | , /LONG | , /STRING]
[, FONT=*string*] [, FRAME=*pixels*] [, /NOEDIT] [, /RETURN_EVENTS] [, /ROW]
[, TEXT_FRAME=*pixels*] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*]
[, VALUE=*value*] [, XSIZE=*characters*] [, YSIZE=*lines*] )

## Return Value

This function returns the widget ID of the newly-created field widget.

## Arguments

### Parent

The widget ID of the parent widget.

## Keywords

### ALL_EVENTS

Like RETURN_EVENTS but return an event whenever the contents of a text field have changed.

### COLUMN

Set this keyword to center the label above the text field. The default is to position the label to the left of the text field.

### FIELDFONT

A string containing the name of the font to use for the TEXT part of the field.

## FLOATING

Set this keyword to have the field accept only floating-point values. Any number or string entered is converted to its floating-point equivalent.

## FONT

A string containing the name of the font to use for the TITLE of the field. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

## FRAME

The width, in pixels, of a frame to be drawn around the entire field cluster. The default is no frame.

## INTEGER

Set this keyword to have the field accept only integer values. Any number or string entered is converted to its integer equivalent (using FIX). For example, if 12.5 is entered in this type of field, it is converted to 12.

## LONG

Set this keyword to have the field accept only long integer values. Any number or string entered is converted to its long integer equivalent (using LONG).

## NOEDIT

Normally, the value in the text field can be edited. Set this keyword to make the field non-editable.

## RETURN_EVENTS

Set this keyword to make CW_FIELD return an event when a carriage return is pressed in a text field. The default is not to return events. Note that the value of the text field is always returned when the following command is used:

```
WIDGET_CONTROL, field, GET_VALUE = X
```

## ROW

Set this keyword to position the label to the left of the text field. This is the default.

## STRING

Set this keyword to have the field accept only string values. Numbers entered in the field are converted to their string equivalents. This is the default.

## TEXT_FRAME

Set this keyword to the width in pixels of a frame to be drawn around the text field. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances. Under Microsoft Windows, text widgets always have a frame of width 1 pixel.

## TITLE

A string containing the text to be used as the label for the field. The default is “Input Field”.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

## VALUE

The initial value in the text widget. This value is automatically converted to the type set by the STRING, INTEGER, and FLOATING keywords described below.

## XSIZE

An explicit horizontal size (in characters) for the text input area. The default is to let the window manager size the widget. Using the XSIZE keyword is not recommended.

## YSIZE

An explicit vertical size (in lines) for the text input area. The default is 1.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the field. If one of the FLOATING, INTEGER, LONG, or STRING keywords to CW_FIELD is set, values set with the SET_VALUE keyword to WIDGET_CONTROL will be forced to the appropriate type. Values returned by the GET_VALUE keyword to WIDGET_CONTROL will be of the type specified when the field widget is created. Note that if the field contains string information, returned values will be contained in a string *array* even if the field contains only a single string.

See "Writing Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_FIELD Widget

This widget generates event structures with the following definition:

```
event = { ID:0L, TOP:0L, HANDLER: 0L, VALUE:'', TYPE:0 , UPDATE:0}
```

The VALUE field is the value of the field. TYPE specifies the type of data contained in the field and can be any of the following: 0=string, 1=floating-point, 2=integer, 3=long integer (the value of TYPE is determined by setting one of the STRING, FLOAT, INTETER, or LONG keywords). UPDATE contains a zero if the field has not been altered or a one if it has.

## Examples

The code below creates a main base with a field cluster attached to it. The cluster accepts string input, has the title "Name", and has a frame around it:

```
base = WIDGET_BASE()
field = CW_FIELD(base, TITLE = "Name", /FRAME)
WIDGET_CONTROL, base, /REALIZE
```

## Version History

Introduced: Pre 4.0

## See Also

WIDGET_LABEL, WIDGET_TEXT

# CW_FILESEL

The CW_FILESEL function is a compound widget for file selection.

This routine is written in the IDL language. Its source code can be found in the file `cw_filesel.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_FILESEL ( *Parent* [, /FILENAME] [, FILTER=*string array*] [, /FIX_FILTER] [, /FRAME] [, /IMAGE_FILTER] [, /MULTIPLE | , /SAVE] [, PATH=*string*] [, UNAME=*string*] [, UVALUE=*value*] [, /WARN_EXIST] )

## Return Value

This function returns the widget ID of the newly-created file selection widget.

## Arguments

### Parent

The widget ID of the parent.

## Keywords

### FILENAME

Set this keyword to have the initial filename filled in the filename text area.

### FILTER

Set this keyword to an array of strings determining the filter types. If not set, the default is “All Files”. All files containing the chosen filter string will be displayed as possible selections. “All Files” is a special filter which returns all files in the current directory.

Example:

```
FILTER=["All Files", ".txt"]
```

Multiple filter types may be used per filter entry, using a comma as the separator.

Example:

```
FILTER=[".jpg, .jpeg", ".txt, .text"]
```

## FIX_FILTER

If set, the user can not change the file filter.

## FRAME

If set, a frame is drawn around the widget.

## IMAGE_FILTER

If set, the filter “Image Files” will be added to the end of the list of filters. If set, and FILTER is not set, “Image Files” will be the only filter displayed. Valid image files are determined from QUERY_IMAGE.

## MULTIPLE

If set, the file selection list will allow multiple filenames to be selected. The filename text area will not be editable in this case. It is illegal to specify both /SAVE and /MULTIPLE.

## PATH

Set this keyword to the initial path the widget is to start in. The default is the current directory.

## SAVE

Set this keyword to create a widget with a “Save” button instead of an “Open” button. It is illegal to specify both /SAVE and /MULTIPLE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

### WARN_EXIST

Set this keyword to produce a question dialog if the user selects a file that already exists. This keyword is useful when creating a “write” dialog. The default is to allow any filename to be quietly accepted, whether it exists or not.

### Keywords to WIDGET_CONTROL

You can use the GET_UVALUE and SET_UVALUE keywords to WIDGET_CONTROL to obtain or set the user value of this widget. Use the command to read the currently selected filename (or filenames if MULTIPLE is set) including the full path:

```
WIDGET_CONTROL, id, GET_VALUE=filenames
```

To set the value of the filename, use the following command:

```
WIDGET_CONTROL, id, SET_VALUE=value
```

where *value* is a scalar string (or string array) containing the filenames, including the full path.

See “Compound Widgets” in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by CW_FILESEL

This widget generates event structures with the following definition:

```
Event = {FILESEL_EVENT, ID:0L, TOP:0L, HANDLER:0L,VALUE:'',
   DONE:0L, FILTER:''}
```

The ID field is the widget ID of the CW_FILESEL widget. The TOP field contains the widget ID of the top-level widget. The HANDLER field is always set to zero. The VALUE field is a string containing the most recent filename selected, if any.

**Note**

Even if MULTIPLE is set, VALUE will only contain the most recently selected filename. To retrieve all of the currently selected filenames, use the GET_VALUE keyword to WIDGET_CONTROL.

The DONE field can be any of the following:

- 0 = User selected a file but didn’t double-click, or the user changed filters (in this case the VALUE field will be an empty string.)

- 1 = User pressed “Open”/“Save” or double-clicked on a file.
- 2 = User pressed “Cancel”.

The FILTER field is a string containing the current filter.

## Examples

This example creates a CW_FILESEL widget that is used to select image files for display. Note how the DONE tag of the event structure returned by CW_FILESEL is used to determine which button was pressed, and how the VALUE tag is used to obtain the file that was selected:

```
PRO image_opener_event, event

   WIDGET_CONTROL, event.top, GET_UVALUE=state, /NO_COPY

   CASE event.DONE OF
      0: BEGIN
            state.file = event.VALUE
            WIDGET_CONTROL, event.top, SET_UVALUE=state, /NO_COPY
         END
      1: BEGIN
            IF (state.file NE '') THEN BEGIN
               img = READ_IMAGE(state.file)
               TV, img
            ENDIF
            WIDGET_CONTROL, event.top, SET_UVALUE=state, /NO_COPY
         END
      2: WIDGET_CONTROL, event.top, /DESTROY
   ENDCASE

END

PRO image_opener

   DEVICE, DECOMPOSED=0, RETAIN=2

   base = WIDGET_BASE(TITLE ='Open Image', /COLUMN)
   filesel = CW_FILESEL(base, /IMAGE_FILTER, FILTER='All Files')
   file=''
   state = {file:file}

   WIDGET_CONTROL, base, /REALIZE
   WIDGET_CONTROL, base, SET_UVALUE=state, /NO_COPY
   XMANAGER, 'image_opener', base

END
```

## Version History

Introduced: 5.3

## See Also

DIALOG_PICKFILE, FILEPATH

# CW_FORM

The CW_FORM function is a compound widget that simplifies creating small forms which contain text, numeric fields, buttons, lists, and droplists. Event handling is also simplified.

This routine is written in the IDL language. Its source code can be found in the file `cw_form.pro` in the `lib` subdirectory of the IDL distribution.

### Using CW_FORM

The form has a value that is a structure with a tag/value pair for each field in the form. Use the command

```
WIDGET_CONTROL, id, GET_VALUE=v
```

to read the current value of the form. To set the value of one or more tags, use the command

```
WIDGET_CONTROL, id, SET_VALUE={ Tag:value, ..., Tag:value}
```

## Syntax

*Result* = CW_FORM( [*Parent*,] *Desc* [, /COLUMN] [, IDS=*variable*] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*] )

## Return Value

If the argument *Parent* is present, the returned value of this function is the widget ID of the newly-created form widget. If *Parent* is omitted, the form realizes itself as a modal, top-level widget and CW_FORM returns a structure containing the value of each field in the form when the user finishes.

## Arguments

### Parent

The widget ID of the parent widget. Omit this argument to created a modal, top-level widget.

### Desc

A string array describing the form. Each element of the string array contains two or more comma-delimited fields. Each string has the following format:

'*Depth*, *Item*, *Initial value*, *Settings*'

Use the backslash character (“\”) to escape commas that appear within fields. To include the backslash character, escape it with another backslash.

The fields are defined as follows:

- **Depth**

  A digit defining the level at which the element will be placed on the form. Nesting is used primarily for layout, with row or column bases.

  This field must contain the digit 0, 1, or 2, with the following effects:

  - 0 = continue the current nesting level.
  - 1 = begin a new level under the current level.
  - 2 = last element at the current level.

- **Item**

  A label defining the type of element to be placed in the form. *Item* must be one of the following: BASE, BUTTON, DROPLIST, FLOAT, INTEGER, LABEL, LIST, or TEXT.

  BASEs and LABELs do not return a value in the widget value structure. The other items return the following value types:

| Item | Description |
|---|---|
| BUTTON | An integer or integer array. For single buttons, the value is 1 if the button is set, or 0 if it is not set. For exclusive button groups, the value is the index of the currently set button. For non-exclusive button groups, the value is an array containing an element for each button. Array elements are set to 1 if the corresponding button is set, or 0 if it is not set. |
| DROPLIST | An integer. The value set in the widget value structure is the zero-based index of the item is selected. |
| FLOAT | A floating-point value. The value set in the widget value structure is the floating-point value of the field. |
| INTEGER | An integer. The value set in the widget value structure is the integer value of the field. |

*Table 12: Values for the Item field*

| Item | Description |
|---|---|
| LIST | An integer. The value set in the widget value structure is the zero-based index of the item is selected. |
| TEXT | A string. The value set in the widget value structure is the string value of the field. |

*Table 12: Values for the Item field*

- **Initial value**

  The initial value of the field. The *Initial value* field is left empty for BASEs.

  For BUTTON, DROPLIST, and LIST items, the value field contains one or more item names, separated by the | character. Strings do not need to be enclosed in quotes. For example, the following line defines an exclusive button group with buttons labeled “one,” “two,” and “three.”

  ```
  '0, BUTTON, one|two|three, EXCLUSIVE'
  ```

  For FLOAT, INTEGER, LABEL, and TEXT items, the value field contains the initial value of the field.

- **Settings**

  The *Settings* field contains one of the following keywords or keyword=*value* pairs. Keywords are used to specify optional attributes or options. Any number of keywords may be included in the description string.

  Note that preceding keywords with a “/” character has no effect. Simply including a keyword in the *Settings* field enables that option.

| Keyword | Description |
|---|---|
| CENTER | Specifies alignment of LABEL items. |
| COLUMN | If present, specifies column layout in BASES or for BUTTON groups. |
| EXCLUSIVE | If present, makes an exclusive set of BUTTONs. The default is nonexclusive. |

*Table 13: Values for the Settings Field*

| Keyword | Description |
|---|---|
| FONT=*font name* | If present, the font for the item is specified. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used. |
| EVENT=*function* | Specifies the name of a user-written event function that is called whenever the element is changed. The event function is called with the widget event structure as a parameter. It may return an event structure or zero to indicate that no further event processing is desired. |
| FRAME | If present, a frame is drawn around the item. Valid only for BASEs. |
| LABEL_LEFT=*label* | Place a label to the left of the item. This keyword is valid with BUTTON, DROPLIST, FLOAT, INTEGER and TEXT items. |
| LABEL_TOP=*label* | Place a label above the item. This keyword is valid with BUTTON, DROPLIST, FLOAT, INTEGER and TEXT items. |
| LEFT | Specifies alignment of LABEL items. |
| NO_RELEASE | If present, exclusive and non-exclusive buttons generate only select events. This keyword has no effect on regular buttons. |
| QUIT | If the form widget is created as a top-level, modal widget, when the user activates an item defined with this keyword, the form is destroyed and its widget value returned in the widget value structure of CW_FORM. For non-modal form widgets, events generated by changing this item have their QUIT field set to 1. |
| RIGHT | Specifies alignment of LABEL items. |

*Table 13: Values for the Settings Field (Continued)*

| Keyword | Description |
|---|---|
| ROW | If present, specifies row layout in BASES or for BUTTON groups. |
| SET_VALUE=*value* | Sets the initial value of BUTTON groups or DROPLISTs. For droplists and exclusive button groups, *value* should be the zero-based index of the item selected. |
| TAG=*name* | The tag name of this element in the widget's value structure. If not specified, the tag name is TAG*nnn*, where *nnn* is the zero-based index of the item in the *Desc* array. |
| WIDTH=*n* | Specifies the width, in characters, of a TEXT, INTEGER, or FLOAT item. |

*Table 13: Values for the Settings Field (Continued)*

# Keywords

## COLUMN

Set this keyword to make the orientation of the form vertical. If COLUMN is not set, the form is laid out in a horizontal row.

## IDS

Set this keyword equal to a named variable into which the widget id of each widget corresponding to an element in the *Desc* array is stored.

## TITLE

Set this keyword equal to a scalar string containing the title of the top level base. TITLE is not used if the form widget has a parent widget.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget

hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

### UVALUE

Set this keyword equal to the user value associated with the form widget.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the form. The form has a value that is a structure with a tag/value pair for each field in the form. Use the command

```
WIDGET_CONTROL, id, GET_VALUE=v
```

to read the current value of the form. To set the value of one or more tags, use the command

```
WIDGET_CONTROL, id, SET_VALUE={ Tag:value, ..., Tag:value}
```

See "Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_FORM Widget

This widget generates event structures each time the value of the form is changed. The event structure has the following definition:

```
Event = { ID:0L, TOP:0L, HANDLER:0L, TAG:'', VALUE:0, QUIT:0}
```

The ID field is the widget ID of the CW_FORM widget. The TOP field is the widget ID of the top-level widget. The TAG field contains the tag name of the field that changed. The VALUE field contains the new value of the changed field. The QUIT field contains a zero if the quit flag is not set, or one if it is set.

## Examples

Define a form with a label, two groups of vertical buttons (one non-exclusive and the other exclusive), a text field, an integer field, and "OK" and "Done" buttons. If either the "OK" or "Done" buttons are pressed, the form exits.

Begin by defining a string array describing the form:

```
desc = [ $
   '0, LABEL, Centered Label, CENTER', $
   '1, BASE,, ROW, FRAME', $
   '0, BUTTON, B1|B2|B3, LABEL_TOP=Nonexclusive:,' $
   + 'COLUMN, TAG=bg1', $
   '2, BUTTON, E1|E2|E2, EXCLUSIVE,LABEL_TOP=Exclusive:,' $
   + 'COLUMN,TAG=bg2', $
   '0, TEXT, , LABEL_LEFT=Enter File name:, WIDTH=12,' $
   + 'TAG=fname', $
   '0, INTEGER, 0, LABEL_LEFT=File size:, WIDTH=6, TAG=fsize', $
   '1, BASE,, ROW', $
   '0, BUTTON, OK, QUIT,' $
   +  'TAG=OK', $
   '2, BUTTON, Cancel, QUIT']
```

To use the form as a modal widget:

```
a = CW_FORM(desc, /COLUMN)
```

When the form is exited, (when the user presses the OK or Cancel buttons), a structure is returned as the function's value. We can examine the structure by entering:

```
HELP, /STRUCTURE, a
```

| IDL Output | | | Meaning |
|---|---|---|---|
| BG1 | INT | Array[3] | Set buttons = 1, unset = 0. |
| BG2 | INT | 1 | Second button of exclusive button group was set. |
| FNAME | STRING | 'test.dat' | Value of the text field |
| FSIZE | LONG | 120 | Value of the integer field |
| OK | LONG | 1 | This button was pressed |
| TAG8 | LONG | 0 | This button wasn't pressed |

*Table 14: Output from HELP, /STRUCTURE*

**Note**

If the "Cancel" button is pressed, the "OK" field is set to 0.

To use CW_FORM inside another widget:

```
a = WIDGET_BASE(TITLE='Testing')
b = CW_FORM(a, desc, /COLUMN)
WIDGET_CONTROL, a, /REALIZE
XMANAGER, 'Test', a
```

The event handling procedure (in this example, called TEST_EVENT), may use the TAG field of the event structure to determine which field changed and perform any data validation or special actions required. It can also get and set the value of the widget by calling WIDGET_CONTROL.

## Version History

Introduced: 4.0

# CW_FSLIDER

The CW_FSLIDER function creates a slider that selects floating-point values.

This routine is written in the IDL language. Its source code can be found in the file `cw_fslider.pro` in the `lib` subdirectory of the IDL distribution.

### Using CW_FSLIDER

To get or set the value of a CW_FSLIDER widget, use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL.

**Note**

The CW_FSLIDER widget is based on the WIDGET_SLIDER routine, which accepts only integer values. Because conversion between integers and floating-point numbers necessarily involves round-off errors, the slider value returned by CW_FSLIDER may not exactly match the input value, even when a floating-point number is entered in the slider's text field as an ASCII value. For more information on floating-point issues, see "Accuracy & Floating-Point Operations" in Chapter 22 of the *Using IDL* manual.

## Syntax

*Result* = CW_FSLIDER( *Parent* [, /DOUBLE] [, /DRAG] [, /EDIT] [, FORMAT=*string*] [, /FRAME] [, MAXIMUM=*value*] [, MINIMUM=*value*] [, SCROLL=*units*] [, /SUPPRESS_VALUE] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*initial_value*] [, XSIZE=*length* | {, /VERTICAL [, YSIZE=*height*]}] )

## Return Value

This function returns the widget ID of the newly-created slider widget.

## Arguments

### Parent

The widget ID of the parent widget.

# Keywords

## DOUBLE

Set this keyword to return double-precision values in the VALUE field of widget events generated by CW_FSLIDER. Explicitly set DOUBLE=0 to ensure that values returned in the VALUE field are single-precision. By default, CW_FSLIDER will return double-precision values if any of the values specified by the MINIMUM, MAXIMUM, or VALUE keywords is double-precision, or single-precision otherwise.

**Note**

The value returned by the GET_VALUE keyword to WIDGET_CONTROL is the value contained in the VALUE field of the widget event structure.

## DRAG

Set this keyword to cause events to be generated continuously when the slider is adjusted. The default is DRAG=0, in which case events are generated only when the mouse is released. Note that on slow systems, /DRAG performance can be inadequate.

## EDIT

Set this keyword to make the slider label editable. The default is EDIT=0. If EDIT is set, the GET_VALUE keyword to WIDGET_CONTROL will return the value of the slider label if it has been changed.

**Note**

If the user edits the slider label but does not press Enter, the slider position will not be updated to the new value. In this case, the widget programmer is responsible for using GET_VALUE to retrieve the new value of the slider label, followed by SET_VALUE to set the new value and update the slider position.

## FORMAT

Provides the format in which the slider value is displayed. This should be a format as accepted by the STRING procedure. The default FORMAT is `'(G13.6)'`

## FRAME

Set this keyword to have a frame drawn around the widget. The default is FRAME=0.

## MAXIMUM

The maximum value of the slider. The default is MAXIMUM=100.

## MINIMUM

The minimum value of the slider. The default is MINIMUM=0.

## SCROLL

Set the SCROLL keyword to a floating-point value specifying the number of floating-point units the scroll bar should move when the user clicks the left mouse button inside the slider area (Motif) or on the slider arrows (Windows), but not on the slider itself. The default on both platforms is 0.01 x (MAXIMUM - MINIMUM), which is 1% of the slider range.

## SUPPRESS_VALUE

If this keyword is set, the current slider value is not displayed.

## TITLE

Set this keyword to a string defining the title of slider.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

## VALUE

The initial value of the slider.

## VERTICAL

If set, the slider will be oriented vertically. The default is horizontal.

### XSIZE

The length of horizontal sliders.

### YSIZE

The height of vertical sliders.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

You can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the slider. In addition, you can use the SET_VALUE keyword to change the minimum and maximum values of the slider by setting the keyword equal to a three-element vector [*value*, *min*, *max*].

**Note**

The SET_SLIDER_MAX and SET_SLIDER_MIN keywords to WIDGET_CONTROL and the SLIDER_MIN_MAX keyword to WIDGET_INFO *do not* work with floating point sliders created with CW_FSLIDER.

See "Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_FSLIDER Widget

This widget generates event structures with the following definition:

```
Event = { ID:0L, TOP:0L, HANDLER:0L, VALUE:0.0, DRAG:0}
```

The VALUE field is the floating-point value selected by the slider. The DRAG field reports on whether events are generated continuously (when the DRAG keyword is set) or only when the mouse button is released (the default).

## Version History

Introduced: Pre 4.0

## See Also

WIDGET_SLIDER

# CW_LIGHT_EDITOR

The CW_LIGHT_EDITOR function creates a compound widget to edit properties of existing IDLgrLight objects in a view. Lights cannot be added or removed from a view using this widget. However, lights can be “turned off or on” by hiding or showing them (i.e., HIDE property).

## Syntax

*Result* = CW_LIGHT_EDITOR (*Parent* [, /DIRECTION_DISABLED] [, /DRAG_EVENTS] [, FRAME=*width*] [, /HIDE_DISABLED] [, LIGHT=*objref(s)*] [, /LOCATION_DISABLED] [, /TYPE_DISABLED] [, /UNAME=*string*] [, UVALUE=*value*] [, XSIZE=*pixels*] [, YSIZE=*pixels*] [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*] )

## Return Value

This function returns the widget ID of a newly-created light editor.

## Arguments

### Parent

The widget ID of the parent widget for the new light editor.

## Keywords

### DIRECTION_DISABLED

Set this keyword to make the direction widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

### DRAG_EVENTS

Set this keyword to cause events to be generated continuously while a slider in the compound widget is being dragged or when the mouse cursor is being dragged across the draw widget portion of the compound widget. By default, events are only generated when the mouse comes to rest at its final position and the mouse button is released.

When this keyword is set, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

**Note**

Under Microsoft Windows, sliders do not generate these events, but behave just like regular sliders.

## FRAME

The value of this keyword specifies the width of a frame (in pixels) to be drawn around the borders of the widget. Note that this keyword is only a ‘hint’ to the toolkit, and may be ignored in some instances. The default is no frame.

## HIDE_DISABLED

Set this keyword to make the hide widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

## LIGHT

Set this keyword to one or more object references to IDLgrLight to edit. This will replace the current set of lights being edited with the list of lights from this keyword.

## LOCATION_DISABLED

Set this keyword to make the location widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

## TYPE_DISABLED

Set this keyword to make the light type widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event. The default is to allow this property to be changed.

## UNAME

Set this keyword to a string that can be used to identify the widget. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget

hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The ‘user value’ to be assigned to the widget. Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created. If UVALUE is not present, the widget's initial user value is undefined.

## XRANGE

A two-element vector defining the data range in the x direction. This keyword is used to determine the valid range for the light's location and direction properties

## XSIZE

The width of the drawable area in pixels. The default width is 180.

## YRANGE

A two-element vector defining the data range in the y direction. This keyword is used to determine the valid range for the light's location and direction properties.

## YSIZE

The height of the drawable area in pixels. The default height is 180.

## ZRANGE

A two-element vector defining the data range in the z direction. This keyword is used to determine the valid range for the light's location and direction properties

## WIDGET_CONTROL Keywords

The widget ID returned by this compound widget is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with this compound widget (e.g., UNAME, UVALUE).

## GET_VALUE

Set this keyword to a named variable to contain the current value of the widget. An IDLgrLight object reference of the currently selected light is returned. The value of a widget can be set with the SET_VALUE keyword to this routine.

### SET_VALUE

Sets the value of the specified light editor compound widget. This widget accepts an IDLgrLight object reference of the light in the list of lights to make as the current selection. The property values are retrieved from the light object and the light editor controls are updated to reflect those properties.

## Widget Events Returned by the CW_LIGHT_EDITOR Widget

There are variations of the light editor event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER). The different light editor event structures are described below.

### Light Selected

This is the type of structure returned when the light selected in the light list box is modified by a user.

```
{ CW_LIGHT_EDITOR_LS, ID:0L, TOP:0L, HANDLER:0L, LIGHT:OBJ_NEW()}
```

LIGHT specifies the object ID of the new light selection.

### Light Modified

This is the type of structure returned when the user has modified a light property. This event maybe generated continuously if the DRAG_EVENTS keyword was set. See DRAG_EVENTS above.

```
{ CW_LIGHT_EDITOR_LM, ID:0L, TOP:0L, HANDLER:0L}
```

The value of the light editor will need to be retrieved (i.e., CW_LIGHT_EDITOR_GET) in order to determine the extent of the actual user modification.

## Version History

Introduced: 5.3

## See Also

CW_LIGHT_EDITOR_GET, CW_LIGHT_EDITOR_SET, IDLgrLight

# CW_LIGHT_EDITOR_GET

The CW_LIGHT_EDITOR_GET procedure gets the CW_LIGHT_EDITOR properties.

## Syntax

CW_LIGHT_EDITOR_GET, *WidgetID* [, DIRECTION_DISABLED=*variable*] [, DRAG_ EVENTS=*variable*] [, HIDE_DISABLED=*variable*] [, LIGHT=*variable*] [, LOCATION_DISABLED=*variable*] [, TYPE_DISABLED=*variable*] [, XSIZE=*variable*] [, YSIZE=*variable*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

## Arguments

### WidgetID

The widget ID of the CW_ LIGHT_EDITOR compound widget.

## Keywords

### DIRECTION_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the direction widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

### DRAG_ EVENTS

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to cause events to be generated continuously while a slider in the compound widget is being dragged or when the mouse cursor is being dragged across the draw widget portion of the compound widget.

When this keyword is set, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

**Note**

Under Microsoft Windows, sliders do not generate these events, but behave just like regular sliders.

## HIDE_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the hide widget portion of the compound widget unchangeable by the user.

## LIGHT

Set this keyword to a named variable that will contain one or more object references to IDLgrLight.

## LOCATION_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the location widget portion of the compound widget unchangeable by the user.

## TYPE_DISABLED

Set this keyword to a named variable that will contain a boolean value indicating whether this option has been set to make the light type widget portion of the compound widget unchangeable by the user.

## XRANGE

Set this keyword to a named variable that will contain a two-element vector defining the data range in the x direction.

## XSIZE

Set this keyword to a named variable that will contain the width of the drawable area in pixels.

## YRANGE

Set this keyword to a named variable that will contain a two-element vector defining the data range in the y direction.

### YSIZE

Set this keyword to a named variable that will contain the height of the drawable area in pixels.

### ZRANGE

Set this keyword to a named variable that will contain a two-element vector defining the data range in the z direction.

## Version History

Introduced: 5.3

## See Also

CW_LIGHT_EDITOR, CW_LIGHT_EDITOR_SET, IDLgrLight

# CW_LIGHT_EDITOR_SET

The CW_LIGHT_EDITOR procedure sets the CW_LIGHT_EDITOR properties.

## Syntax

CW_LIGHT_EDITOR_SET, *WidgetID* [, /DIRECTION_DISABLED]
[, /DRAG_EVENTS] [, /HIDE_DISABLED] [, LIGHT=*objref(s)*]
[, /LOCATION_DISABLED] [, /TYPE_DISABLED] [, XSIZE=*pixels*]
[, YSIZE=*pixels*] [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*]

## Arguments

### WidgetID

The widget ID of the CW_ LIGHT_EDITOR compound widget.

## Keywords

### DIRECTION_DISABLED

Set this keyword to make the direction widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

### DRAG_EVENTS

Set this keyword to cause events to be generated continuously while a slider in the compound widget is being dragged or when the mouse cursor is being dragged across the draw widget portion of the compound widget.

When this keyword is set, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

**Note**

Under Microsoft Windows, sliders do not generate these events, but behave just like regular sliders.

### HIDE_DISABLED

Set this keyword to make the hide widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

### LIGHT

Set this keyword to one or more object references to IDLgrLight to edit. This will replace the current set of lights being edited with the list of lights from this keyword.

### LOCATION_DISABLED

Set this keyword to make the location widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

### TYPE_DISABLED

Set this keyword to make the light type widget portion of the compound widget unchangeable by the user. It will appear insensitive and will not generate an event.

### XRANGE

A two-element vector defining the data range in the x direction. This keyword is used to determine the valid range for the light's location and direction properties.

### XSIZE

The width of the drawable area in pixels.

### YRANGE

A two-element vector defining the data range in the y direction. This keyword is used to determine the valid range for the light's location and direction properties.

### YSIZE

The height of the drawable area in pixels.

### ZRANGE

A two-element vector defining the data range in the z direction. This keyword is used to determine the valid range for the light's location and direction properties.

## Version History

Introduced: 5.3

## See Also

CW_LIGHT_EDITOR, CW_LIGHT_EDITOR_GET, IDLgrLight

# CW_ORIENT

The CW_ORIENT function creates a compound widget that provides a means to interactively adjust the three-dimensional drawing transformation and resets the !P.T system variable field to reflect the changed orientation.

This routine is written in the IDL language. Its source code can be found in the file `cw_orient.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_ORIENT( *Parent* [, AX=*degrees*] [, AZ=*degrees*] [, /FRAME] [, TITLE=*string*] [, UNAME=*string*] [, UVALUE=*value*] [, XSIZE=*width*] [, YSIZE=*height*] )

## Return Value

This function returns the widget ID of the newly-created orientation-adjustment widget.

## Arguments

### Parent

The widget ID of the parent widget.

## Keywords

### AX

The initial rotation in the X direction. The default is 30 degrees.

### AZ

The initial rotation in the Z direction. The default is 30 degrees.

### FRAME

Set this keyword to draw a frame around the widget.

### TITLE

The title of the widget.

### UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

### UVALUE

The “user value” to be assigned to the widget.

### XSIZE

Determines the width of the widget. The default is 100.

### YSIZE

Determines the height of the widget. The default is 100.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See “Compound Widgets” in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_ORIENT Widget

CW_ORIENT only returns events when the three dimensional drawing transformation has been altered. The !P.T system variable field is automatically updated to reflect the new orientation.

## Version History

Introduced: Pre 4.0

## See Also

CW_ARCBALL, T3D

# CW_PALETTE_EDITOR

The CW_PALETTE_EDITOR function creates a compound widget to display and edit color palettes. The palette editor is a base that contains a drawable area to display the color palette, a set of vectors that represent the palette and an optional histogram.

## Graphics Area Components

### Reference Color bar

A gray scale color bar is displayed at the top of the graphics area for reference purposes.

### Palette Colorbar

A color bar containing a display of the current palette is displayed below the reference color bar.

### Channel and Histogram Display

The palette channel vectors are displayed below the palette colorbar. The Red channel is displayed in red, the Green channel in green, the Blue channel in blue, and the optional Alpha channel in purple. The optional Histogram vector is displayed in Cyan.

An area with a white background represents the current selection, with gray background representing the area outside of the current selection. Yellow drag handles are an additional indicator of the selection endpoints. These selection endpoints represent the range for some editing operations. In addition, cursor X,Y values and channel pixel values at the cursor location are displayed in a status area below the graphics area.

## Interactive Capabilities

### Color Space

A droplist allows selection of RGB, HSV or HLS color spaces. RGB is the default color space.

**Note**

Regardless of the color space in use, the color vectors retrieved with the GET_VALUE keyword to widget control are always in the RGB color space.

### Editing Mode

A droplist allows selection of the editing mode. Freehand is the default editing mode.

Unless noted below, editing operations apply only to the channel vectors currently selected for editing and apply only to the portion of the vectors within the selection indicators.

| Editing Mode | Description |
|---|---|
| Freehand | The user can click and drag in the graphics area to draw a new curve. Editable channel vectors will be modified to use the new curve for that part of the X range within the selection that was drawn in Freehand mode. |
| Line Segment | A click, drag and release operation defines the start point and end point of a line segment. Editable channel vectors will be modified to use the new curve for that part of the X range within the selection that was drawn in Line Segment mode. |
| Barrel Shift | Click and drag operations in the horizontal direction cause the editable curves to be shifted right or left, with the portion which is shifted off the end of selection area wrapping around to appear on the other side of the selection area. Only the horizontal component of drag movement is used. |
| Slide | Click and drag operations in the horizontal direction cause the editable curves to be shifted right or left. Unlike the Barrel Shift mode, the portion of the curves shifted off the end of the selection area does not wrap around. Only the horizontal component of drag movement is used. |
| Stretch | Click and drag operations in the horizontal direction cause the editable curves to be compressed or expanded. Only the horizontal component of drag movement is used. |

*Table 15:* CW_PALETTE_EDITOR Editing Mode Options

The following table describes the buttons that provide editing operations but do not require cursor input:

| Button | Operation |
|---|---|
| Ramp | Causes the selected part of the editable curves to be replaced with a linear ramp from 0 to 255. |
| Smooth | Causes the selected part of the editable curves to be smoothed. |
| Posterize | Causes the selected part of the editable curves to be replaced with a series of steps. |
| Reverse | Causes the selected part of the editable curves to be reversed in the horizontal direction. |
| Invert | Causes the selected part of the editable curves to be flipped in the vertical direction. |
| Duplicate | Causes the selected part of the editable curves to be compressed by 50% and duplicated to produce two contiguous copies of the channel vectors within the initial selection. |
| Load PreDefined | Leads to additional choices of pre-defined palettes. Loading a pre-defined palette replaces only the selected portion of the editable color channels, respecting of the settings of the selection endpoints and editable checkboxes. This allows loading only a single channel or only a portion of a pre-defined palette. |

*Table 16: CW_PALETTE_EDITOR Button Operations*

### Channel Display and Edit

A row of checkboxes allows the user to indicate which channels of Red, Green, Blue and the optional Alpha channel should be displayed. A second row of checkboxes allows the user to indicate which channels should be edited by the current editing operation. The checkboxes for the Alpha channel will be sensitive only if an Alpha channel is loaded.

### Zoom

Four buttons allow the user to zoom the display of the palette:

| Button | Description |
|---|---|
| \| \| | Zooms to show the current selection. |
| + | Zooms in 50% |
| - | Zooms out 100% |
| 1:1 | Returns the display to the full palette |

*Table 17: Palette Zoom Options*

### Scrolling of the Palette Window

When the palette is zoomed to a scale greater than 1:1 the scroll bar at the bottom of the graphics area can be used to view a different part of the palette.

## Syntax

*Result* = CW_PALETTE_EDITOR (*Parent* [, DATA=*array*] [, FRAME=*width*] [, HISTOGRAM=*vector*] [, /HORIZONTAL] [, SELECTION=*[start, end]*] [, UNAME=*string*] [, UVALUE=*value*] [, XSIZE=*width*] [, YSIZE=*height*] )

## Return Value

This function returns the widget ID of the newly created palette editor.

## Arguments

### Parent

The widget ID of the parent widget for the new palette editor.

## Keywords

### DATA

A 3x256 byte array containing the initial color values for Red, Green and Blue channels. The value supplied can also be a 4x256 byte array containing the initial color values and the optional Alpha channel. The value supplied can also be an

IDLgrPalette object reference. If an IDLgrPalette object reference is supplied it is used internally and is not destroyed on exit. If an object reference is supplied the ALPHA keyword to the CW_PALETTE_EDITOR_SET routine can be used to supply the data for the optional Alpha channel.

## FRAME

The value of this keyword specifies the width of a frame (in pixels) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances. The default is no frame.

## HISTOGRAM

A 256 element byte vector containing the values for the optional histogram curve.

## HORIZONTAL

Set this keyword for a horizontal layout for the compound widget. This consists of the controls to the right of the display area. The default is a vertical layout with the controls below the display area.

## SELECTION

The selection is a two element vector defining the starting and ending point of the selection region of color indexes. The default is [0,255].

## UNAME

Set this keyword to a string that can be used to identify the widget. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The ‘user value’ to be assigned to the widget. Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created. If UVALUE is not present, the widget's initial user value is undefined.

### XSIZE

The width of the drawable area in pixels. The default width is 256.

### YSIZE

The height of the drawable area in pixels. The default height is 256.

### WIDGET_CONTROL Keywords for Palette Editor

The widget ID returned by this compound widget is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with this compound widget (e.g., UNAME, UVALUE).

### GET_VALUE

Set this keyword to a named variable to contain the current value of the widget. A 3xn (RGB) or 4xn (i.e., RGB and ALPHA) array containing the palette is returned.

The value of a widget can be set with the SET_VALUE keyword to this routine.

### SET_VALUE

Sets the value of the specified palette editor compound widget. This widget accepts a 3xn (RGB) or 4xn (i.e., RGB and ALPHA) array representing the value of the palette to be set. Another type of argument accepted is an IDLgrPalette object reference. If an IDLgrPalette object reference is supplied it is used internally and is not destroyed on exit.

## Widget Events Returned by the CW_PALETTE_EDITOR Widget

There are variations of the palette editor event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER). The different palette editor event structures are described below.

#### Selection Moved

This is the type of structure returned when one of the vertical bars that define the selection region is moved by a user.

```
{ CW_PALETTE_EDITOR_SM, ID:0L, TOP:0L, HANDLER:0L, SELECTION:[0,255]}
```

SELECTION indicates a two element vector defining the starting and ending point of the selection region of color indexes.

### Palette Edited

This is the type of structure returned when the user has modified the color palette.

```
{ CW_PALETTE_EDITOR_PM, ID:0L, TOP:0L, HANDLER:0L}
```

The value of the palette editor will need to be retrieved (i.e., WIDGET_CONTROL, GET_VALUE) in order to determine the extent of the actual user modification.

## Version History

Introduced: 5.3

## See Also

CW_PALETTE_EDITOR_GET, CW_PALETTE_EDITOR_SET, IDLgrPalette

# CW_PALETTE_EDITOR_GET

The CW_PALETTE_EDITOR_GET procedure gets the CW_PALETTE_EDITOR properties.

## Syntax

CW_PALETTE_EDITOR_GET, *WidgetID* [, ALPHA=*variable*]
[, HISTOGRAM=*variable*]

## Arguments

### WidgetID

The widget ID of the CW_PALETTE_EDITOR compound widget.

## Keywords

### ALPHA

Set this keyword to a named variable that will contains the optional alpha curve.

### HISTOGRAM

Set this keyword to a named variable that will contains the optional histogram curve.

## Version History

Introduced: 5.3

## See Also

CW_PALETTE_EDITOR, CW_PALETTE_EDITOR_SET, IDLgrPalette

# CW_PALETTE_EDITOR_SET

The CW_PALETTE_EDITOR_SET procedure sets the CW_PALETTE_EDITOR properties.

## Syntax

CW_PALETTE_EDITOR_SET, *WidgetID* [, ALPHA=*byte_vector*]
[, HISTOGRAM=*byte_vector*]

## Arguments

### WidgetID

The widget ID of the CW_PALETTE_EDITOR compound widget.

## Keywords

### ALPHA

A 256 element byte vector that describes the alpha component of the color palette. The alpha value may also be set to the scalar value zero to remove the alpha curve from the display.

### HISTOGRAM

The histogram is an vector to be plotted below the color palette. This keyword can be used to display a distribution of color index values to facilitate editing the color palette. The histogram value may also be set to the scalar value zero to remove the histogram curve from the display.

## Version History

Introduced: 5.3

## See Also

CW_PALETTE_EDITOR, CW_PALETTE_EDITOR_GET, IDLgrPalette

# CW_PDMENU

The CW_PDMENU function creates widget pulldown menus. It has a simpler interface than the XPDMENU procedure, which it replaces. Events for the individual buttons are handled transparently, and a CW_PDMENU event returned. This event can return any one of the following:

- the Index of the button within the base
- the widget ID of the button
- the name of the button.
- the fully qualified name of the button. This allows different sub-menus to contain buttons with the same name in an unambiguous way.

Only buttons with textual names are handled by this widget. Bitmaps are not understood.

This routine is written in the IDL language. Its source code can be found in the file `cw_pdmenu.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_PDMENU( *Parent*, *Desc* [, /COLUMN] [, /CONTEXT_MENU] [, DELIMITER=*string*] [, FONT=*value*] [, /MBAR [, /HELP]] [, IDS=*variable*] [, /RETURN_ID | , /RETURN_INDEX | , /RETURN_NAME | , /RETURN_FULL_NAME] [, UNAME=*string*] [, UVALUE=*value*] [, XOFFSET=*value*] [, YOFFSET=*value*] )

## Return Value

This function returns the widget ID of the newly-created pulldown menu widget.

## Arguments

### Parent

The widget ID of the parent widget.

### Desc

An array of strings or structures. If *Desc* is an array of strings, each element contains the flag field, followed by a backslash character, followed by the name of the menu

item, optionally followed by another backslash character and the name of an event-processing procedure for that element. A string element of the *Desc* array would look like:

```
'n\item_name'
```

or

```
'n\item_name\event_proc'
```

where n is the flag field and *item_name* is the name of the menu item. The flag field is a bitmask that controls how the button is interpreted; appropriate values for the flag field are shown in the following table. If the *event_proc* field is present, it is the name of an event-handling procedure for the menu element and all of its children.

If *Desc* is an array of structures, each structure has the following definition:

```
{CW_PDMENU_S, flags:0, name:''}
```

The name tag is a string field with the following components:

```
'item_name'
```

or

```
'item_name\event_proc'
```

where *item_name* is the name of the menu item. If the *event_proc* field is present, it is the name of an event-handling procedure for the menu element and all of its children

The flags field is a bitmask that controls how the button is interpreted; appropriate values for the flag field are shown in the following table. Note that if *Desc* is an array of structures, you cannot specify individual event-handling procedures for each element.

| Value | Meaning |
|---|---|
| 0 | This button is neither the beginning nor the end of a pulldown level. |
| 1 | This button is the root of a sub-pulldown menu. The sub-buttons start with the next button. |
| 2 | This button is the last button at the current pulldown level. The next button belongs to the same level as the current parent button. If the name field is not specified (or is an empty string), no button is created, and the next button is created one level up in the hierarchy. |

*Table 18: Button Flag Bit Meanings*

| Value | Meaning |
|---|---|
| 3 | This button is the root of a sub-pulldown menu, but it is also the last entry of the current level. |

*Table 18: Button Flag Bit Meanings (Continued)*

# Keywords

## COLUMN

Set this keyword to create a vertical column of menu buttons. The default is to create a horizontal row of buttons.

## CONTEXT_MENU

Set this new keyword to create the pulldown menu within a in a context-sensitive menu. If CONTEXT_MENU is set, Parent must be the widget ID of a base widget with the CONTEXT_MENU keyword set.

For more on creating context menus, see"Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual and the CONTEXT_MENU keyword to WIDGET_BASE.

## DELIMITER

The character used to separate the parts of a fully qualified name in returned events. The default is to use the "." character.

## FONT

The name of the font to be used for the button titles. The font specified is a "device font" (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See "About Device Fonts" on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

## HELP

If the MBAR keyword is set, and one of the buttons on the menubar has the label "help" (case insensitive) then that button is created with the /HELP keyword to give it any special appearance it is supposed to have on a menubar. For example, Motif expects help buttons to be on the right.

## IDS

A named variable in which the button IDs will be stored as a longword vector.

## MBAR

Set this keyword to create a menubar pulldown. If MBAR is set, *Parent* must be the widget ID of a menubar belonging to a top-level base, and the return value of CW_PDMENU is this widget ID. For an example demonstrating the use of the MBAR keyword, see Example 2 below. Also see the MBAR keyword to WIDGET_BASE.

## RETURN_ID

If this keyword is set, the VALUE field of returned events will contain the widget ID of the button.

## RETURN_INDEX

If this keyword is set, the VALUE field of returned events will contain the zero-based index of the button within the base. THIS IS THE DEFAULT.

## RETURN_NAME

If this keyword is set, the VALUE field of returned events will be the name of the selected button.

## RETURN_FULL_NAME

Set this keyword and the VALUE field of returned events will be the fully qualified name of the selected button. This means that the names of all the buttons from the topmost button of the pulldown menu to the selected one are concatenated with the delimiter specified by the DELIMITER keyword. For example, if the top button was named COLORS, the second level button was named BLUE, and the selected button was named LIGHT, the returned value would be

```
COLORS.BLUE.LIGHT
```

This allows different submenus to have buttons with the same name (e.g., COLORS.RED.LIGHT).

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

### UVALUE

The “user value” to be assigned to the widget. If the MBAR keyword is set, the value specified for UVALUE is also assigned as the UVALUE of the parent menu (i.e., the widget specified by the *Parent* argument in the call to CW_PDMENU).

### XOFFSET

The X offset of the widget relative to its parent.

### YOFFSET

The Y offset of the widget relative to its parent.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See “Compound Widgets” in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_PDMENU Widget

This widget generates event structures with the following definition:

```
event = { ID:0L, TOP:0L, HANDLER:0L, VALUE:0 }
```

VALUE is either the INDEX, ID, NAME, or FULL_NAME of the button, depending on how the widget was created.

## Examples

### Example 1

The following is the description of a menu bar with two buttons: “Colors” and “Quit”. Colors is a pulldown containing the colors “Red”, “Green”, Blue”, “Cyan”, and

“Magenta”. Blue is a sub-pulldown containing “Light”, “Medium”, “Dark”, “Navy”, and “Royal.”

The following small program can be used with the above description to create the specified menu:

```
PRO PD_EXAMPLE
   desc = [ '1\Colors' , $
            '0\Red' , $
            '0\Green' , $
            '1\Blue' , $
            '0\Light' , $
            '0\Medium' , $
            '0\Dark' , $
            '0\Navy' , $
            '2\Royal' , $
            '0\Cyan' , $
            '2\Magenta' , $
            '2\Quit' ]

   ; Create the widget:
   base = WIDGET_BASE()
   menu = CW_PDMENU(base, desc, /RETURN_FULL_NAME)
   WIDGET_CONTROL, /REALIZE, base

   ;Provide a simple event handler:
   REPEAT BEGIN
      ev = WIDGET_EVENT(base)
      PRINT, ev.value
   END UNTIL ev.value EQ 'Quit'
   WIDGET_CONTROL, /DESTROY, base

END
```

The *Desc* array could also have been defined using a structure for each element. The following array of structures creates the same menu as the array of strings shown above. Note, however, that if the *Desc* array is composed of structures, you cannot specify individual event-handling routines.

First, make sure CW_PDMENU_S structure is defined:

```
junk = {CW_PDMENU_S, flags:0, name:'' }
```

Define the menu:

```
desc = [ { CW_PDMENU_S, 1, 'Colors' }, $
         { CW_PDMENU_S, 0, 'Red' }, $
         { CW_PDMENU_S, 0, 'Green' }, $
         { CW_PDMENU_S, 1, 'Blue' }, $
         { CW_PDMENU_S, 0, 'Light' }, $
```

```
          { CW_PDMENU_S, 0, 'Medium' }, $
          { CW_PDMENU_S, 0, 'Dark' }, $
          { CW_PDMENU_S, 0, 'Navy' }, $
          { CW_PDMENU_S, 2, 'Royal' }, $
          { CW_PDMENU_S, 0, 'Cyan' }, $
          { CW_PDMENU_S, 2, 'Magenta' }, $
          { CW_PDMENU_S, 2, 'Quit' } ]
```

## Example 2

This example demonstrates the use of the MBAR keyword to CW_PDMENU to populate the “Colors” menu item on a menu bar created using WIDGET_BASE.

```
PRO mbar_event, event

   WIDGET_CONTROL, event.id, GET_UVALUE=uval

   CASE uval OF
      'Quit': WIDGET_CONTROL, /DESTROY, event.top
   ELSE: PRINT, event.value
   ENDCASE

END

PRO mbar

   ; Create the base widget:
   base = WIDGET_BASE(TITLE = 'Example', MBAR=bar, XSIZE=200, $
      UVALUE='base')

   file_menu = WIDGET_BUTTON(bar, VALUE='File', /MENU)
   file_bttn1=WIDGET_BUTTON(file_menu, VALUE='Quit', $
      UVALUE='Quit')

   colors_menu = WIDGET_BUTTON(bar, VALUE='Colors', /MENU)

   ; Define array for colors menu items:
   desc = [ '0\Red' , $
            '0\Green' , $
            '1\Blue' , $
            '0\Light' , $
            '0\Medium' , $
            '0\Dark' , $
            '0\Navy' , $
            '2\Royal' , $
            '0\Cyan' , $
            '2\Magenta' ]
```

```
    ; Create colors menu items. Note that the Parent argument is
    ; set to the widget ID of the parent menu:
    colors = CW_PDMENU(colors_menu, desc, /MBAR, $
       /RETURN_FULL_NAME, UVALUE='menu')

    WIDGET_CONTROL, /REALIZE, base

    XMANAGER, 'mbar', base, /NO_BLOCK

END
```

## Version History

Introduced: Pre 4.0

## See Also

CW_BGROUP, WIDGET_DROPLIST

# CW_RGBSLIDER

The CW_RGBSLIDER function creates a compound widget that provides three sliders for adjusting color values. The RGB, CMY, HSV, and HLS color systems can all be used. No matter which color system is in use, the resulting color is always supplied in RGB, which is the base system for IDL.

This routine is written in the IDL language. Its source code can be found in the file `cw_rgbslider.pro` in the `lib` subdirectory of the IDL distribution.

### Using CW_RGBSLIDER

The CW_RGBSLIDER widget consists of a pulldown menu which allows the user to change between the supported color systems, and three color adjustment sliders, allowing the user to select a new color value.

## Syntax

*Result* = CW_RGBSLIDER( *Parent* [, /CMY | , /HSV | , /HLS | , /RGB] [, /COLOR_INDEX | , GRAPHICS_LEVEL={1 | 2}] [, /DRAG] [, /FRAME] [, LENGTH=*value*] [, UNAME=*string*] [, UVALUE=*value*] [, VALUE=*[r, g, b]*] [, /VERTICAL] )

## Return Value

This function returns the widget ID of the newly-created color adjustment widget.

## Arguments

### Parent

The widget ID of the parent widget.

## Keywords

### CMY

If set, the initial color system used is CMY.

## COLOR_INDEX

Set this keyword to display a small rectangle with the selected color. The color is updated as the values are changed. The color initially displayed in this rectangle corresponds to the value specified with the VALUE keyword. If using Object Graphics, it is recommended that you set the GRAPHICS_LEVEL keyword to 2, in which case the COLOR_INDEX keyword is ignored.

## DRAG

Set this keyword and events will be generated continuously when the sliders are adjusted. If not set, events will only be generated when the mouse button is released. Note: On slow systems, /DRAG performance can be inadequate. The default is DRAG = 0.

## FRAME

If set, a frame will be drawn around the widget. The default is FRAME = 0.

## GRAPHICS_LEVEL

Set this keyword to 2 to use Object Graphics. Set to 1 for Direct Graphics (the default). If set to 2, a small rectangle is displayed with the selected color. The color is updated as the values are changed. The color initially displayed in this rectangle corresponds to the value specified with the VALUE keyword. If this keyword is set, the COLOR_INDEX keyword is ignored.

## HSV

If set, the initial color system used is HSV.

## HLS

If set, the initial color system used is HLS.

## LENGTH

The length of the sliders. The default = 256.

## RGB

If set, the initial color system used is RGB. This is the default.

### UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

### UVALUE

The “user value” to be assigned to the widget.

### VALUE

Set this keyword to a 3-element [*r, g, b*] vector representing the initial RGB value for the CW_RGBSLIDER widget. If the GRAPHICS_LEVEL keyword is set to 2, the color swatch will also initially display this RGB value.

### VERTICAL

If set, the sliders will be oriented vertically. The default is VERTICAL = 0.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget’s base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

See “Compound Widgets” in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_RGBSLIDER Widget

This widget generates event structures with the following definition:

```
event = {ID:0L, TOP:0L, HANDLER:0L, R:0B, G:0B, B:0B }
```

The ‘R’, ‘G’, and ‘B’ fields contain the Red, Green and Blue components of the selected color. Note that CW_RGBSLIDER reports back the Red, Green, and Blue values no matter which color system is selected.

## Version History

Introduced: Pre 4.0

## See Also

CW_CLR_INDEX, XLOADCT, XPALETTE

# CW_TMPL

The CW_TMPL procedure is a template for compound widgets that use the XMANAGER. Use this template instead of writing your compound widgets from “scratch”. This template can be found in the file `cw_tmpl.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = CW_TMPL( *Parent* [, UNAME=*string*] [, UVALUE=*value*] )

## Arguments

### Parent

The widget ID of the parent widget of the new compound widget.

## Keywords

### UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

### UVALUE

A user-specified value for the compound widget.

## Version History

Introduced: Pre 4.0

## See Also

XMNG_TMPL

# CW_ZOOM

The CW_ZOOM function creates a compound widget that displays two images: an original image in one window and a portion of the original image in another. The user can select the center of the zoom region, the zoom scale, the interpolation style, and the method of indicating the zoom center.

This routine is written in the IDL language. Its source code can be found in the file `cw_zoom.pro` in the `lib` subdirectory of the IDL distribution.

## Using CW_ZOOM

The value of the CW_ZOOM widget is the original, un-zoomed image to be displayed (a two-dimensional array). To change the contents of the CW_ZOOM widget, use the command:

```
WIDGET_CONTROL, id, SET_VALUE = array
```

where `id` is the widget ID of the CW_ZOOM widget and `array` is the image array. The value of CW_ZOOM cannot be set until the widget has been realized. Note that the size of the original window, set with the XSIZE and YSIZE keywords to CW_ZOOM, must be the size of the input array.

To return the current zoomed image as displayed by CW_ZOOM in the variable `array`, use the command:

```
WIDGET_CONTROL, id, GET_VALUE = array
```

# Syntax

*Result* = CW_ZOOM( *Parent* [, /FRAME] [, MAX=*scale*] [, MIN=*scale*] [, RETAIN={0 | 1 | 2}] [, SAMPLE=*value*] [, SCALE=*value*] [, /TRACK] [, UNAME=*string*] [, UVALUE=*value*] [, XSIZE=*width*] [, X_SCROLL_SIZE=*width*] [, X_ZSIZE=*zoom_width*] [, YSIZE=*height*] [, Y_SCROLL_SIZE=*height*] [, Y_ZSIZE=*zoom_height*] )

# Return Value

This function returns the widget ID of the newly-created zoom widget.

# Arguments

## Parent

The widget ID of the parent widget.

# Keywords

## FRAME

If set, a frame will be drawn around the widget. The default is FRAME = 0.

## MAX

The maximum zoom scale, which must be greater than or equal to 1. The default is 20.

## MIN

The minimum zoom scale, which must be greater than or equal to 1. The default is 1.

## RETAIN

Set this keyword to zero, one, or two to specify how backing store should be handled for both windows. RETAIN=0 specifies no backing store. RETAIN=1 requests that the server or window system provide backing store. RETAIN=2 specifies that IDL provide backing store directly. See “Backing Store” on page 3824 for details.

## SAMPLE

Set to zero for bilinear interpolation, or to a non-zero value for nearest neighbor interpolation. Bilinear interpolation gives higher quality results, but requires more time. The default is 0.

## SCALE

The initial integer scale factor to use for the zoomed image. The default is SCALE = 4. The scale must be greater than or equal to 1.

## TRACK

Set this keyword and events will be generated continuously as the cursor is moved across the original image. If not set, events will only be generated when the mouse button is released. Note: On slow systems, /TRACK performance can be inadequate. The default is 0.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UVALUE

The “user value” to be assigned to the widget.

## XSIZE

The width of the window (in pixels) for the original image. The default is XSIZE = 500. Note that XSIZE *must* be set to the width of the original image array for the image to display properly.

## X_SCROLL_SIZE

The width of the visible part of the original image. This may be smaller than the actual width controlled by the XSIZE keyword. The default is 0, for no scroll bar.

## X_ZSIZE

The width of the window for the zoomed image. The default is 250.

## YSIZE

The height of the window (in pixels) for the original image. The default is 500. Note that YSIZE *must* be set to the height of the original image array for the image to display properly.

## Y_SCROLL_SIZE

The height of the visible part of the original image. This may be smaller than the actual height controlled by the YSIZE keyword. The default is 0, for no scroll bar.

## Y_ZSIZE

The height of the window for the zoomed image. The default is 250.

### Keywords to WIDGET_CONTROL and WIDGET_INFO

The widget ID returned by most compound widgets is actually the ID of the compound widget's base widget. This means that many keywords to the WIDGET_CONTROL and WIDGET_INFO routines that affect or return information on base widgets can be used with compound widgets.

In addition, you can use the GET_VALUE and SET_VALUE keywords to WIDGET_CONTROL to obtain or set the value of the zoom widget. The value of the CW_ZOOM widget is the original, un-zoomed image to be displayed (a two-dimensional array). To change the contents of the CW_ZOOM widget, use the command:

```
WIDGET_CONTROL, id, SET_VALUE = array
```

where `id` is the widget ID of the CW_ZOOM widget and `array` is the image array. The value of CW_ZOOM cannot be set until the widget has been realized. Note that the size of the original window, set with the XSIZE and YSIZE keywords to CW_ZOOM, must be the size of the input array.

To return the current zoomed image as displayed by CW_ZOOM in the variable `array`, use the command:

```
WIDGET_CONTROL, id, GET_VALUE = array
```

See "Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual for a more complete discussion of controlling compound widgets using WIDGET_CONTROL and WIDGET_INFO.

## Widget Events Returned by the CW_ZOOM Widget

When the "Report Zoom to Parent" button is pressed, this widget generates event structures with the following definition:

```
event = {ZOOM_EVENT, ID:0L, TOP:0L, HANDLER:0L, $
         XSIZE:0L, YSIZE:0L, X0:0L, Y0:0L, X1:0L, Y1:0L }
```

The XSIZE and YSIZE fields contain the dimensions of the zoomed image. The X0 and Y0 fields contain the coordinates of the lower left corner of the original image, and the X1 and Y1 fields contain the coordinates of the upper right corner of the original image.

## Examples

The following code samples illustrate a use of the CW_ZOOM widget.

First, create an event-handler. Note that clicking on the widget's "Zoom" button displays IDL's help output on the console.

```
PRO widzoom_event, event

   WIDGET_CONTROL, event.id, GET_UVALUE=uvalue
   CASE uvalue OF
      'ZOOM': HELP, /STRUCT, event
      'DONE': WIDGET_CONTROL, event.top, /DESTROY
   ENDCASE

END
```

Next, create the widget program:

```
PRO widzoom

   OPENR, lun, FILEPATH('people.dat', $
      SUBDIR = ['examples','data']), /GET_LUN
   image=BYTARR(192,192)
   READU, lun, image
   FREE_LUN, lun
   sz = SIZE(image)

   base=WIDGET_BASE(/COLUMN)
   zoom=CW_ZOOM(base, XSIZE=sz[1], YSIZE=sz[2], UVALUE='ZOOM')
   done=WIDGET_BUTTON(base, VALUE='Done', UVALUE='DONE')
   WIDGET_CONTROL, base, /REALIZE

   WIDGET_CONTROL, zoom, SET_VALUE=image
   XMANAGER, 'widzoom', base

END
```

Once you have entered these programs, type "widzoom" at the IDL command prompt to run the widget application.

## Version History

Introduced: Pre 4.0

## See Also

ZOOM, ZOOM_24

# DBLARR

The DBLARR function create a double-precision, floating-point vector or array of the specified dimensions.

## Syntax

*Result* = DBLARR( $D_1$[, ..., $D_8$] [, /NOZERO] )

## Return Value

Returns a double-precision, floating-point vector or array.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, DBLARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and DBLARR executes faster.

## Examples

To create D, an 3-element by 3-element, double-precision, floating-point array with every element set to 0.0, enter:

```
D = DBLARR(3, 3)
```

## Version History

Introduced: Original

## See Also

COMPLEXARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# DCINDGEN

The DCINDGEN function creates a complex, double-precision, floating-point array with the specified dimensions. Each element of the array has its real part set to the value of its one-dimensional subscript. The imaginary part is set to zero.

## Syntax

*Result* = DCINDGEN( $D_1$ [, ..., $D_8$ ])

## Return Value

Returns a complex, double-precision, floating-point array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create DC, a 4-element vector of complex values with the real parts set to the value of their subscripts, enter:

```
DC = DCINDGEN(4)
```

## Version History

Introduced: 4.0

## See Also

BINDGEN, CINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# DCOMPLEX

The DCOMPLEX function returns double-precision complex scalars or arrays given one or two scalars or arrays. If only one parameter is supplied, the imaginary part of the result is zero, otherwise it is set to the value of the *Imaginary* parameter. Parameters are first converted to double-precision floating-point. If either or both of the parameters are arrays, the result is an array, following the same rules as standard IDL operators. If three parameters are supplied, DCOMPLEX extracts fields of data from *Expression*.

## Syntax

*Result* = DCOMPLEX( *Real* [, *Imaginary*] )

or

*Result* = DCOMPLEX( *Expression, Offset [, $D_1$ [, ..., $D_8$]]* )

## Return Value

Returns double-precision complex scalars or arrays given one or two scalars or arrays.

## Arguments

### Real

Scalar or array to be used as the real part of the complex result.

### Imaginary

Scalar or array to be used as the imaginary part of the complex result.

### Expression

The expression from which data is to be extracted.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as complex data. See the description in Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual for details.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Create a complex array from two integer arrays by entering the following commands:

```
; Create the first integer array:
A = [1,2,3]

; Create the second integer array:
B = [4,5,6]

; Make A the real parts and B the imaginary parts of the new
; complex array:
C = DCOMPLEX(A, B)

; See how the two arrays were combined:
PRINT, C
```

IDL prints:

```
( 1.0000000, 4.0000000)( 2.0000000, 5.0000000)
( 3.0000000, 6.0000000)
```

The real and imaginary parts of the complex array can be extracted as follows:

```
; Print the real part of the complex array C:
PRINT, 'Real Part: ', REAL_PART(C)

; Print the imaginary part of the complex array C:
PRINT, 'Imaginary Part: ', IMAGINARY(C)
```

IDL prints:

```
Real Part:         1.0000000   2.0000000   3.0000000
Imaginary Part:    4.0000000   5.0000000   6.0000000
```

## Version History

Introduced: 4.0

## See Also

BYTE, COMPLEX, CONJ, DOUBLE, FIX, FLOAT, IMAGINARY, LONG, LONG64, REAL_PART, STRING, UINT, ULONG, ULONG64

# DCOMPLEXARR

The DCOMPLEXARR function returns a complex, double-precision, floating-point vector or array.

## Syntax

*Result* = DCOMPLEXARR( $D_1$ *[, ..., $D_8$]* [, /NOZERO] )

## Return Value

Returns a complex, double-precision, floating-point vector or array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, DCOMPLEXARR sets every element of the result to zero. If the NOZERO keyword is set, this zeroing is not performed, and DCOMPLEXARR executes faster.

## Examples

To create an empty, 5-element by 5-element, complex array DC, enter:

```
DC = DCOMPLEXARR(5, 5)
```

## Version History

Introduced: 4.0

## See Also

COMPLEXARR, DBLARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# DEFINE_KEY

The DEFINE_KEY procedure programs the keyboard function *Key* with the string *Value*, or with one of the actions specified by the available keywords.

DEFINE_KEY is primarily intended for use with IDL's UNIX command line interface, but it has limited applications in the Microsoft Windows environment as well.

**Note**

Key bindings for the UNIX graphical interface (IDLDE) can be created via X Window resources. See IDL's resource file, located in your IDL distribution and described in Chapter 8, "Customizing IDL on Motif Systems" in the *Using IDL* manual, for details on key bindings.

## Syntax

DEFINE_KEY, Key [, Value] [, /MATCH_PREVIOUS] [, /NOECHO] [, /TERMINATE]

**UNIX Keywords:** [, /BACK_CHARACTER] [, /BACK_WORD] [, /CONTROL | , /ESCAPE] [, /DELETE_CHARACTER] [, /DELETE_CURRENT] [, /DELETE_EOL] [, /DELETE_LINE] [, /DELETE_WORD] [, /END_OF_LINE] [, /END_OF_FILE] [, /ENTER_LINE] [, /FORWARD_CHARACTER] [, /FORWARD_WORD] [, /INSERT_OVERSTRIKE_TOGGLE] [, /NEXT_LINE] [, /PREVIOUS_LINE] [, /RECALL] [, /REDRAW] [, /START_OF_LINE]

## Arguments

### Key

A scalar string containing the name of a function key to be programmed. IDL maintains an internal list of function key names and the escape sequences they send. Different keys are available for mapping in the UNIX command-line interface and the Windows IDL Development Environment, as described below.

**UNIX** — Under UNIX, DEFINE_KEY allows you to set the values of two distinctly different types of keys:

- Control characters: Any of the 26 control characters (CTRL+A through CTRL+Z) can be associated with specific actions by specifying the CONTROL keyword. Control characters are the unprintable ASCII characters

at the beginning of the ASCII character set. They are usually entered by holding down the Control key while the corresponding letter key is pressed.

- Function keys: Most terminals (and terminal emulators) send escape sequences when a function key is pressed. An escape sequence is a sequence of characters starting the ASCII Escape character. Escape sequences follow strict rules that allow applications such as IDL to determine when the sequence is complete. For instance, the left arrow key on most machines sends the sequence <ESC>[D. The available function keys and the escape sequences they send vary from keyboard to keyboard; IDL cannot be built to recognize all of the different keyboards in existence. The ESCAPE keyword allows you to program IDL with the escape sequences for your keyboard. When you press the function key, IDL will recognize the sequence and take the appropriate action.

If *Key* is not already on IDL's internal list, you must use the ESCAPE keyword to specify the escape sequence, otherwise, *Key* alone will suffice. The available function keys and the escape sequences they send vary from keyboard to keyboard. The SETUP_KEYS procedure should be used once at the beginning of the session to enter the keys for the current keyboard. The following table describes the standard key definitions.

| Editing Key | Function |
|---|---|
| Ctrl+A | Move cursor to start of line |
| Ctrl+B | Move cursor left one word |
| Ctrl+D | EOF if current line is empty, EOL otherwise |
| Ctrl+E | Move to end of line |
| Ctrl+F | Move cursor right one word |
| Ctrl+K | Erase from the cursor to the end of the line |
| Ctrl+N | Move back one line in the recall buffer |
| Ctrl+R | Retype current line |
| Ctrl+U | Delete from current position to start of line |
| Ctrl+W | Delete previous word |
| Ctrl+X | Delete current character |

*Table 19: Standard Key Definitions for UNIX*

| Editing Key | Function |
|---|---|
| Backspace, Delete | Delete previous character |
| ESC-I | Overstrike/insert toggle |
| ESC-Delete | Delete previous word |
| Up Arrow | Move back one line in the recall buffer |
| Down Arrow | Move forward one line in the recall buffer |
| Left Arrow | Move left one character |
| Right Arrow | Move right one character |
| R13 | Move cursor left one word (Sun keyboards) |
| R15 | Move cursor right one word (Sun keyboards) |
| ^*text* | Recall the first line containing *text*. If *text* is blank, recall the previous line |
| *Other Characters* | Insert character at the current cursor position |

*Table 19: Standard Key Definitions for UNIX (Continued)*

**Windows —** Under Windows, function keys F2, F4, and F12 can be customized.

In IDL for Windows, three special variables can be used to expand the current mouse selection, the current line, or the current filename into the output of defined keys.

| Variable | Expansion |
|---|---|
| %f | filename of the currently-selected IDL Editor window |
| %l | number of the current line in an IDL Editor window |
| %s | Currently-selected text from an IDL Output Log or Editor window |

*Table 20: Variable expansions for defined keys*

For example, to define F2 as a key that executes an IDL PRINT command with the current mouse selection as its argument, use the command:

```
DEFINE_KEY, 'F2', 'PRINT, "%S"'
```

Dragging the mouse over any text in an IDL Editor or Output Log window and pressing F2 causes the selected text to be given as the argument to the IDL PRINT procedure. The `%l` and `%f` variables can be used in a similar fashion.

### Value

The scalar string that will be printed (as if it had been typed manually at the keyboard) when *Key* is pressed. If *Value* is not present, and no function is specified for the key with one of the keywords, the key is cleared so that nothing happens when it is pressed.

## Keywords

### BACK_CHARACTER (UNIX Only)

Set this keyword to program *Key* to move the current cursor position left one character.

### BACK_WORD (UNIX Only)

Set this keyword to program *Key* to move the current cursor position left one word.

### CONTROL (UNIX Only)

Set this keyword to indicate that *Key* is the name of a control key. The default is for *Key* to define a function key escape sequence. To view the names used by IDL for the control keys, type the following at the Command Input Line:

```
HELP, /ALL_KEYS
```

**Warning**

The CONTROL and ESCAPE keywords are mutually exclusive and cannot be specified together.

### DELETE_CHARACTER (UNIX Only)

Set this keyword to program *Key* to delete the character to the left of the cursor.

### DELETE_CURRENT (UNIX Only)

Set this keyword to program *Key* to delete the character directly underneath the cursor.

## DELETE_EOL (UNIX Only)

Set this keyword to program *Key* to delete from the cursor position to the end of the line.

## DELETE_LINE (UNIX Only)

Set this keyword to program *Key* to delete all characters to the left of the cursor.

## DELETE_WORD (UNIX Only)

Set this keyword to programs *Key* to delete the word to the left of the cursor.

## END_OF_LINE (UNIX Only)

Set this keyword to program *Key* to move the cursor to the end of the line.

## END_OF_FILE (UNIX Only)

Set this keyword to program *Key* to exit IDL if the current line is empty, and to end the current input line if the current line is not empty.

## ENTER_LINE (UNIX Only)

Set this keyword to program *Key* to enter the current line (i.e., the action normally performed by the “Return” key).

## ESCAPE (UNIX Only)

A scalar string that specifies the escape sequence that corresponds to *Key.* See “Defining New Function Keys” on page 468 for further details.

**Warning**

The CONTROL and ESCAPE keywords are mutually exclusive and cannot be specified together.

## FORWARD_CHARACTER (UNIX Only)

Set this keyword to program *Key* to move the current cursor position right one character.

## FORWARD_WORD (UNIX Only)

Set this keyword to program *Key* to move the current cursor position right one word.

## INSERT_OVERSTRIKE_TOGGLE (UNIX Only)

Set this keyword to program *Key* to toggle between “insert” and “overstrike” mode. When characters are typed into the middle of a line, insert mode causes the trailing characters to be moved to the right to make room for the new ones. Overstrike mode causes the new characters to overwrite the existing ones.

## MATCH_PREVIOUS

Set this keyword to program *Key* to prompt the user for a string, and then search the saved command buffer for the most recently issued command that contains that string. If a match is found, the matching command becomes the current command, otherwise the last command entered is used. Under UNIX, the default match key is the up caret “^” key when pressed in column 1.

## NEXT_LINE (UNIX Only)

Set this keyword to program *Key* to move forward one command in the saved command buffer and make that command the current one.

## NOECHO

Set this keyword to enter the Value assigned to *Key* when pressed, without echoing the string to the screen. This feature is useful for defining keys that perform such actions as erasing the screen. If NOECHO is set, TERMINATE is also assumed to be set.

## PREVIOUS_LINE (UNIX Only)

Set this keyword to program *Key* to move back one command in the saved command buffer and make that command the current one.

## RECALL (UNIX Only)

Set this keyword to program *Key* to prompt the user for a command number. The saved command corresponding to the entered number becomes the current command. In order to view the currently saved commands and the number currently associated with each, enter the IDL command:

```
HELP, /RECALL COMMANDS
```

### Example

The RECALL operation remembers the last command number entered, and if the user simply presses return, it recalls the command currently associated with that saved number. Since the number associated with a given command increases by one

each time a new command is saved, this feature can be used to quickly replay a sequence of commands.

```
IDL> PRINT, 1
1
IDL> PRINT, 2
2
IDL> HELP, /RECALL_COMMANDS
Recall buffer length: 20
1               PRINT, 2
2               PRINT, 1
```

User presses key tied to RECALL.

```
IDL>
```

Line 2 is requested.

```
Recall Line #: 2
```

Saved command 2 is recalled.

```
IDL> PRINT, 1
1
```

User presses return.

```
Recall Line #:
```

Saved command 2 is recalled again.

```
IDL> PRINT, 2
2
```

## REDRAW (UNIX Only)

Set this keyword to program *Key* to retype the current line.

## START_OF_LINE (UNIX Only)

Set this keyword to program *Key* to move the cursor to the start of the line.

## TERMINATE

If this keyword is set, and *Value* is present, pressing *Key* terminates the current input operation after its assigned value is entered. Essentially, an implicit carriage return is added to the end of *Value*.

# Examples

## Defining New Function Keys

Under UNIX, IDL can handle arbitrary function keys. When adding a definition for a function key that is not built into IDL's default list of recognized keys, you must use the ESCAPE keyword to specify the escape sequence it sends. For example, to add a function key named "HELP" which sends the escape sequence <Escape>[28~, use the command:

```
DEFINE_KEY, 'HELP', ESCAPE = '\033[28~'
```

This command adds the HELP key to the list of keys understood by IDL. Since only the key name and escape sequence were specified, pressing the HELP key will do nothing. The Value argument, or one of the keywords provided to specify command line editing functions, could have been included in the above statement to program it with an action.

Once a key is defined using the ESCAPE keyword, it is contained in the internal list of function keys. It can then be subsequently redefined without specifying the escape sequence.

It is convenient to include commonly used key definitions in a startup file, so that they will always be available. See "Startup Files" in Chapter 1 of the *Using IDL* manual.

Usually, the SETUP_KEYS procedure is used to define the function keys found on the keyboard, so it is not necessary to specify the ESCAPE keyword. For example, to program key "F2" on a Sun keyboard to redraw the current line:

```
SETUP_KEYS
DEFINE_KEY, 'F2', /REDRAW
```

The CONTROL keyword alters the action that IDL takes when it sees the specified characters defining the control keys. IDL may not be able to alter the behavior of some control characters. For example, CTRL+S and CTRL+Q are usually reserved by the operating system for flow control. Similarly, CTRL+Z is usually The UNIX suspend character.

### Example

CTRL+D is the UNIX end-of-file character. It is a common UNIX convention (followed by IDL) for programs to quit upon encountering CTRL+D. However, CTRL+D is also used by some text editors to delete characters. To disable IDL default handling of CTRL+D, type the following:

```
DEFINE_KEY, /CONTROL, '^D'
```

To print a reminder of how to exit IDL properly, type the following:

```
DEFINE_KEY, /CONTROL, '^D', "print, 'Enter EXIT to quit IDL'", $
/NOECHO, /TERMINATE
```

To use CTRL+D to delete characters, type the following:

```
DEFINE_KEY, /CONTROL, '^D', /DELETE_CURRENT
```

## Version History

Introduced: Original

## See Also

GET_KBRD

# DEFINE_MSGBLK

The DEFINE_MSGBLK procedure defines and loads a new message block into the currently running IDL session. Messages are issued from a message block using the MESSAGE procedure, which handles the details of IDL message display, including proper formatting, setting the values of the !ERROR_STATE system variable, and displaying traceback information if execution halts. See MESSAGE for details.

A message block is a collection of messages that are loaded into IDL as a single unit. Each block contains the messages required for a specific application. At startup, IDL contains a single internal message block named IDL_MBLK_CORE, which contains the standard messages required by the IDL system. Dynamically loadable modules (DLMs) usually define additional message blocks for their own needs when they are loaded. At the IDL programming level, the DEFINE_MSGBLK and DEFINE_MSGBLK_FROM_FILE procedures can be used to define and load message blocks. You can use the HELP, /MESSAGES command to see the currently defined message blocks.

## Syntax

DEFINE_MSGBLK, *BlockName*, *ErrorNames*, *ErrorFormats*
[, /IGNORE_DUPLICATE] [, PREFIX = *PrefixStr*]

**Note**

IDL will force the values of the message bock name, the individual message names, and any message prefix string to upper case before installing the message block. Because IDL is generally case-insensitive, you do not need to use upper case when supplying these values to the DEFINE_MSGBLK or MESSAGE procedures. The values stored in the !ERROR_STATE system variable will, however, be upper-case strings. If you do string comparisons with values in !ERROR_STATE, you should take this case-folding into account.

## Arguments

### BlockName

A string giving the name of the message block to be defined. Block names must be unique within the IDL system. We recommend that you follow the advice given in "Advice for Library Authors" in Chapter 4 of the *Building IDL Applications* manual when selecting the message block name in order to avoid name conflicts. Use of the PREFIX keyword is also recommended to enforce a consistent naming convention.

### ErrorNames

An array of strings giving the names of the messages defined by the message block.

### ErrorFormats

An array of strings giving the formats for the messages defined by the message block. Note that the format string can include both static text (displayed every time the error is displayed) and dynamic text (specified when the error is generated by a call to the MESSAGE procedure). Each format is matched with the corresponding name in *ErrorNames*. For this reason, *ErrorFormats* should have the same number of elements as *ErrorNames*. We recommend the use of the PREFIX keyword to enforce a consistent naming scheme for your messages.

Error formats are simplified `printf`-style format strings. For more information on format strings, see "C printf-Style Quoted String Format Code" in Chapter 10 of the *Building IDL Applications* manual.

## Keywords

### IGNORE_DUPLICATE

Attempts to define a given *BlockName* more than once in the same IDL session usually cause DEFINE_MSGBLK to issue an error and stop execution of the IDL program. Specify IGNORE_DUPLICATE to cause DEFINE_MSGBLK to quietly ignore attempts to redefine a message block. In this case, no error is issued and execution continues. The original message block remains installed and available for use.

### PREFIX

It is a common and recommended practice to give each message name defined in *ErrorNames* a common unique prefix that identifies it as an error from a specific message block. However, specifying this prefix in each entry of *ErrorNames* is tedious and error prone. The PREFIX keyword can be used to specify a prefix string that will be added to each element of *ErrorNames*.

## Examples

This example defines a message block called ROADRUNNER that contains 2 messages:

```
name = ['BADPLAN', 'RRNOTCAUGHT']
fmt  = ['Bad plan detected: %s.', 'Road Runner not captured.']
DEFINE_MSGBLK, PREFIX = 'ACME_M_', 'ROADRUNNER', name, fmt
```

Once this message block is loaded, the ACME_M_BADPLAN message can be issued using the following statement:

```
MESSAGE, NAME = 'acme_m_badplan', BLOCK = 'roadrunner', $
   'Exploding bridge while standing underneath'
```

This MESSAGE statement produces the output similar to:

```
% Bad plan detected: Exploding bridge while standing underneath.
% Execution halted at:  $MAIN$
```

The IDL command:

```
HELP, /STRUCTURES, !ERROR_STATE
```

can be used to examine the effect of this message on IDL's error state.

## Version History

Introduced: 5.5

## See Also

DEFINE_MSGBLK_FROM_FILE, MESSAGE

# DEFINE_MSGBLK_FROM_FILE

The DEFINE_MSGBLK_FROM_FILE procedure reads the definition of a message block from a file, and uses DEFINE_MSGBLK to load it into the currently running IDL session. Messages are issued from a message block using the MESSAGE procedure, which handles the details of IDL message display, including proper formatting, setting the values of the !ERROR_STATE system variable, and displaying traceback information if execution halts. See MESSAGE for details.

**Note**

For large message blocks, DEFINE_MSGBLK_FROM_FILE can be more convenient than DEFINE_MSGBLK.

## Format of Message Definition Files

A message definition file has a simple structure designed to ease the specification of message blocks. Any line starting with the character @ specifies information about the message block. Any line not starting with an @ character is ignored, and can be used for comments, documentation, notes, or other human readable information. All such text is ignored by DEFINE_MSGBLK_FROM_FILE.

There are three different types of lines starting with @ allowed in a message definition file:

### @IDENT *name*

Specifies the name of the message block being defined. There should be exactly one such line in every message definition file. If the BLOCK keyword to DEFINE_MSGBLK_FROM_FILE is specified, the @IDENT line is ignored and can be omitted. RSI recommends always specifying an @IDENT line.

**Note**

IDL will force the string specified by the @IDENT line to upper case before installing the message block. You do not need to use upper case when supplying the @IDENT *name* string, but !ERROR_STATE.BLOCK will always contain an upper-case string.

### @PREFIX *PrefixStr*

If present, specifies a prefix string to be applied to the beginning of each message name in the message block. There should be at most one such line in every message definition file. If the PREFIX keyword to DEFINE_MSGBLK_FROM_FILE is

specified, the @PREFIX line is ignored and can be omitted. RSI recommends always specifying an @PREFIX line.

**Note**

IDL will force the string specified by the @PREFIX line to upper case before installing the message block. You do not need to use upper case when supplying the @PREFIX *PrefixStr* string, but !ERROR_STATE.BLOCK will always contain an upper-case string.

### @ *MessageName* "*MessageFormat*"

Specifies a single message name and format string pair. The format string should be delimited with double quotes. A message definition file should contain one such line for every message it defines.

This routine is written in the IDL language. Its source code can be found in the file `define_msgblk_from_file.pro` in the `lib` subdirectory of the IDL distribution.

# Syntax

DEFINE_MSGBLK_FROM_FILE, *Filename* [, BLOCK = *BlockName*] [, /IGNORE_DUPLICATE] [, PREFIX = *PrefixStr*] [, /VERBOSE]

**Note**

IDL will force the values of the message bock name, the individual message names, and any message prefix string to upper case before installing the message block. Because IDL is generally case-insensitive, you do not need to use upper case when supplying these values to the DEFINE_MSGBLK_FROM_FILE or MESSAGE procedures. The values stored in the !ERROR_STATE system variable will, however, be upper-case strings. If you do string comparisons with values in !ERROR_STATE, you should take this case-folding into account.

# Arguments

## Filename

The name of the file containing the message block definition. The contents of this file must be formatted as described in the section “Format of Message Definition Files”.

# Keywords

## BLOCK

If present, this keyword specifies the name of the message block. Normally, this keyword is not specified, and an @IDENT line in the message file specifies the name of the block. We recommend that you follow the advice given in "Advice for Library Authors" in Chapter 4 of the *Building IDL Applications* manual when selecting this name in order to avoid name clashes. Use of a prefix is also recommended to enforce a consistent naming convention.

**Note**

IDL will force the string specified by the BLOCK keyword to upper case before installing the message block. You do not need to use upper case when supplying the BLOCK string to the DEFINE_MSGBLK_FROM_FILE procedure, but !ERROR_STATE.BLOCK will always contain an upper-case string.

## IGNORE_DUPLICATE

Attempts to define a given *BlockName* more than once in the same IDL session usually cause DEFINE_MSGBLK to issue an error and stop execution of the IDL program. Specify IGNORE_DUPLICATE to cause DEFINE_MSGBLK to quietly ignore attempts to redefine a message block. In this case, no error is issued and execution continues. The original message block remains installed and available for use.

## PREFIX

If present, this keyword specifies a prefix string to be applied to the beginning of each message name in the message block. Normally, this keyword is not specified, and an @PREFIX line in the message file specifies the prefix string. We recommend the use of a prefix to enforce a consistent naming scheme for your messages.

**Note**

IDL will force the string specified by the PREFIX keyword to upper case before installing the message block. You do not need to use upper case when supplying the PREFIX string to the DEFINE_MSGBLK_FROM_FILE procedure, but !ERROR_STATE.MSG_PREFIX will always contain an upper-case string.

### VERBOSE

If set, causes DEFINE_MSGBLK_FROM_FILE to print informational messages describing the message block loaded.

## Examples

The following example uses the same message block as in the example given for “DEFINE_MSGBLK” on page 470, but uses a message definition file to create the message block. The first step is to create a message definition file called `roadruner.msg` containing the following lines:

```
; Message definition file for ROADRUNNER message block
@IDENT roadrunner
@PREFIX ACME_M_
@       BADPLAN "Bad plan detected: %s."
@       RRNOTCAUGHT "Road Runner not captured."
```

Use the following statement to load in the message block:

```
DEFINE_MSGBLK_FROM_FILE, 'roadrunner.msg'
```

**Note**

A message block can only be defined once during an IDL session. If you see a message that looks like this:

```
% Attempt to install an existing message block: ROADRUNNER.
% Execution halted at: $MAIN$
```

the ROADRUNNER message block has already been defined. You must either exit and restart IDL or issue the .FULL_RESET_SESSION executive command.

Once this message block is loaded, the ACME_M_BADPLAN message can be issued using the following statement:

```
MESSAGE, NAME = 'acme_m_badplan', BLOCK='roadrunner', $
   'Exploding bridge while standing underneath'
```

This MESSAGE statement produces the output similar to:

```
% Bad plan detected: Exploding bridge while standing underneath.
% Execution halted at:  $MAIN$
```

The IDL command:

```
HELP, /STRUCTURES, !ERROR_STATE
```

can be used to examine the effect of this message on IDL’s error state.

## Version History

Introduced: 5.5

## See Also

DEFINE_MSGBLK, MESSAGE

# DEFROI

The DEFROI function defines an irregular region of interest of an image using the image display system and the cursor and mouse. DEFROI only works for interactive, pixel oriented devices with a cursor and an exclusive or writing mode. Regions may have at most 1000 vertices.

**Warning**

DEFROI does not function correctly when used with draw widgets. See CW_DEFROI.

This routine is written in the IDL language. Its source code can be found in the file `defroi.pro` in the `lib` subdirectory of the IDL distribution.

### Using DEFROI

After calling DEFROI, click in the image with the left mouse button to mark points on the boundary of the region of interest. The points are connected in sequence. Alternatively, press and hold the left mouse button and drag to draw a curved region. Click the middle mouse button to erase points. The most recently-placed point is erased first. Click the right mouse button to close the region. The function returns after the region has been closed.

## Syntax

*Result* = DEFROI( *Sx*, *Sy* [, *Xverts*, *Yverts*] [, /NOREGION] [, /NOFILL] [, /RESTORE] [, X0=*device_coord*, Y0=*device_coord*] [, ZOOM=*factor*] )

## Return Value

Returns a vector of subscripts of the pixels inside the region. The lowest bit in which the write mask is enabled is changed.

## Arguments

### Sx, Sy

Integers specifying the horizontal and vertical size of image, in pixels.

### Xverts, Yverts

Named vectors that will contain the vertices of the enclosed region.

# Keywords

## NOREGION

Set this keyword to inhibit the return of the pixel subscripts.

## NOFILL

Set this keyword to inhibit filling of the defined region on completion.

## RESTORE

Set this keyword to restore the display to its original state upon completion.

## X0, Y0

Set these keywords equal to the coordinates of the lower left corner of the displayed image (in device coordinates). If omitted, the default value (0,0) is used.

## ZOOM

Set this keyword equal to the zoom factor. If not specified, a value of 1 is assumed.

# Example

```
; Create an image:
TVSCL, DIST(200,200)

; Call DEFROI. The cursor becomes active in the graphics window.
; Define a region and click the right mouse button:
X = DEFROI(200, 200)

; Print subscripts of points included in the defined region:
PRINT, X
```

# Version History

Introduced: Original

# See Also

CW_DEFROI

# DEFSYSV

The DEFSYSV procedure creates a new system variable called *Name* initialized to *Value*.

## Syntax

DEFSYSV, *Name*, *Value* [, *Read_Only*] [, EXISTS=*variable*]

## Arguments

### Name

A scalar string containing the name of the system variable to be created. All system variable names must begin with the character ‘!’.

### Value

An expression from which the type, structure, and initial value of the new system variable is taken. *Value* can be a scalar, array, or structure.

### Read_Only

If the *Read_Only* argument is present and nonzero, the value of the newly-created system variable cannot be changed (i.e., the system variable is read-only, like the !PI system variable). Otherwise, the value of the new system variable can be modified.

## Keywords

### EXISTS

Set this keyword to a named variable that returns 1 if the system variable specified by *Name* exists. If this keyword is specified, *Value* can be omitted. For example, the following commands could be used to check that the system variable XYZ exists:

```
DEFSYSV, '!XYZ', EXISTS = i
IF i EQ 1 THEN PRINT, '!XYZ exists' ELSE PRINT, $
   '!XYZ does not exist'
```

## Examples

To create a new, floating-point, scalar system variable called !NEWVAR with an initial value of 2.0, enter:

```
DEFSYSV, '!NEWVAR', 2.0
```

You can both define and use a system variable within a single procedure:

```
PRO foo
   DEFSYSV, '!foo', $
      'Rocky, watch me pull a squirrel out of my hat!'

   ; Print !foo after defining it:
   PRINT, !foo
END
```

## Version History

Introduced: Original

## See Also

Appendix D, “System Variables”

# DELVAR

The DELVAR procedure deletes variables from the main IDL program level. DELVAR frees any memory used by the variable and removes it from the main program's symbol table. The following restrictions apply:

- DELVAR can only be called from the main program level.
- If a main program is created with the .RUN or .RNEW command, then each time DELVAR is called, this main program is erased. Variables that are not deleted remain unchanged.

## Syntax

DELVAR, $V_1$, ..., $V_n$

## Arguments

### $V_i$

One or more named variables to be deleted.

## Examples

Suppose that the variable Q is defined at the main program level. Q can be deleted by entering:

```
DELVAR, Q
```

## Version History

Introduced: Pre 4.0

## See Also

TEMPORARY

# DERIV

The DERIV function performs numerical differentiation using 3-point, Lagrangian interpolation.

## Syntax

*Result* = DERIV([*X*,] *Y*)

## Return Value

Returns the derivative of the numerical differentiation.

## Arguments

### X

Differentiate with respect to this variable. If omitted, unit spacing for Y (i.e., X*i* = *i*) is assumed.

### Y

The variable to be differentiated.

## Examples

```
X = [ 0.1, 0.3, 0.4, 0.7, 0.9]
Y = [ 1.2, 2.3, 3.2, 4.4, 6.6]
PRINT, DERIV(Y)
PRINT, DERIV(X,Y)
```

IDL prints:

```
1.20000   1.00000   1.05000   1.70000   2.70000
3.16666   7.83333   7.75000   8.20000   13.8000
```

## Version History

Introduced: Original

## See Also

DERIVSIG

# DERIVSIG

The DERIVSIG function computes the standard deviation of a derivative as found by the DERIV function, using the input variables of DERIV and the standard deviations of those input variables.

## Syntax

*Result* = DERIVSIG( [*X*, *Y*, $Sig_x$,] $Sig_y$ )

## Return Value

Returns the standard deviation of a derivative as found by the DERIV function.

## Arguments

### X

Differentiate with respect to this variable. If omitted, unit spacing for Y (i.e., X*i* = *i*) is assumed.

### Y

The variable to be differentiated. Omit if *X* is omitted.

### Sigx

The standard deviation of *X* (either vector or constant). Use “0.0” if the abscissa is exact; omit if *X* is omitted.

### Sigy

The standard deviation of *Y*. *Sigy* must be a vector if the other arguments are omitted, but may be either a vector or a constant if *X*, *Y*, and *Sigx* are supplied.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

DERIV

# DETERM

The DETERM function computes the determinant of an *n* by *n* array. LU decomposition is used to represent the input array in triangular form. The determinant is then computed as the product of diagonal elements of the triangular form. Row interchanges are tracked during the LU decomposition to ensure the correct sign.

This routine is written in the IDL language. Its source code can be found in the file `determ.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

If you are working with complex inputs, instead use the LA_DETERM procedure.

## Syntax

*Result* = DETERM( *A* [, /CHECK] [, /DOUBLE] [, ZERO=*value*] )

## Return Value

Returns the determinant of an *n* by *n* array

## Arguments

### A

An *n* by *n* single- or double-precision floating-point array.

## Keywords

### CHECK

Set this keyword to check *A* for singularity. The determinant of a singular array is returned as zero if this keyword is set. Run-time errors may result if *A* is singular and this keyword is not set.

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### ZERO

Use this keyword to set the absolute value of the floating-point zero. A floating-point zero on the main diagonal of a triangular array results in a zero determinant. For single-precision inputs, the default value is $1.0 \times 10^{-6}$. For double-precision inputs, the default value is $1.0 \times 10^{-12}$. Setting this keyword to a value less than the default may improve the precision of the result.

## Examples

```
; Define an array A:
A = [[ 2.0,  1.0,  1.0], $
   [ 4.0, -6.0,  0.0], $
   [-2.0,  7.0,  2.0]]

; Compute the determinant:
PRINT, DETERM(A)
```

IDL prints:

```
-16.0000
```

## Version History

Introduced: Original

## See Also

COND, INVERT, LA_DETERM

# DEVICE

The DEVICE procedure provides device-dependent control over the current graphics device (as set by the SET_PLOT routine). The IDL graphics procedures and functions are device-independent. That is, IDL presents the user with a consistent interface to all devices. However, most devices have extra abilities that are not directly available through this interface. DEVICE is used to access and control such abilities. It is used by specifying various keywords that differ from device to device.

See Appendix A, "IDL Graphics Devices" for a description of the keywords available for each graphics device.

## Syntax

**Note**

Each keyword to DEVICE is followed by the device(s) to which it applies.

DEVICE

[, /AVANTGARDE | , /BKMAN | , /COURIER | , /HELVETICA | , /ISOLATIN1 | , /PALATINO | , /SCHOOLBOOK | , /SYMBOL | , /TIMES | , /ZAPFCHANCERY | , /ZAPFDINGBATS {PS}]
[, /AVERAGE_LINES{REGIS}]
[, /BINARY | , /NCAR | , /TEXT {CGM}]
[, BITS_PER_PIXEL={1 | 2 | 4 | 8}{PS}]
[, /BOLD{PS}]
[, /BOOK{PS}]
[, /BYPASS_TRANSLATION{WIN, X}]
[, /CLOSE{Z}]
[, /CLOSE_DOCUMENT{PRINTER}]
[, /CLOSE_FILE{CGM, HP, METAFILE, PCL, PS, REGIS, TEK}]
[, /COLOR{PCL, PS}]
[, COLORS=*value*{CGM, TEK}]
[, COPY=*[Xsource, Ysource, cols, rows, Xdest, Ydest* [, *Window_index*]*]*{WIN, X}]
[, /CURSOR_CROSSHAIR{WIN, X}]
[, CURSOR_IMAGE=*value*{16-element short int vector}{WIN, X}]
[, CURSOR_MASK=value{WIN, X}]
[, /CURSOR_ORIGINAL{WIN, X}]
[, CURSOR_STANDARD=*value*{WIN: arrow=32512, I-beam=32513, hourglass=32514, black cross=32515, up arrow=32516, size(NT)=32640, icon(NT)=32641, size NW-SE=32642, size NE-SW=32643, size E-

W=32644, size N-S=32645}{X: one of the values in file cursorfonts.h}]
[, CURSOR_XY=*[x,y]*{WIN, X}]
[, /DECOMPOSED{WIN, X}]
[, /DIRECT_COLOR{X}]
[, EJECT={0 | 1 | 2}{HP}]
[, ENCAPSULATED={0 | 1}{PS}]
[, ENCODING={1 (binary) | 2 (text) | 3 (NCAR binary)}{CGM}]
[, FILENAME=*filename*{CGM, HP, METAFILE, PCL, PS, REGIS, TEK}]
[, /FLOYD{PCL, X}]
[, FONT_INDEX=*integer*{PS}]
[, FONT_SIZE=*points*{PS}]
[, GET_CURRENT_FONT=*variable*{METAFILE, PRINTER, WIN, X}]
[, GET_DECOMPOSED=*variable*{WIN, X}]
[, GET_FONTNAMES=*variable*{METAFILE, PRINTER, WIN, X}]
[, GET_FONTNUM=*variable*{METAFILE, PRINTER, WIN, X}]
[, GET_GRAPHICS_FUNCTION=*variable*{WIN, X, Z}]
[, GET_PAGESIZE=*variable*{PRINTER}]
[, GET_SCREEN_SIZE=*variable*{WIN, X}]
[, GET_VISUAL_DEPTH=*variable*{WIN, X}]
[, GET_VISUAL_NAME=*variable*{WIN, X}]
[, GET_WINDOW_POSITION=*variable*{WIN, X}]
[, GET_WRITE_MASK=*variable*{X, Z}]
[, GIN_CHARS=*number_of_characters*{TEK}]
[, GLYPH_CACHE=*number_of_glyphs*{METAFILE, PRINTER, PS, WIN, Z}]
[, /INCHES{HP, PCL, METAFILE, PRINTER, PS}]
[, /INDEX_COLOR{METAFILE, PRINTER}]
[, /ITALIC{PS}]
[, /LANDSCAPE | , /PORTRAIT{HP, PCL, PRINTER, PS}]
[, LANGUAGE_LEVEL={1 | 2}{PS}]
[, /DEMI | , /LIGHT | , /MEDIUM | , /NARROW | , /OBLIQUE{PS}]
[, OPTIMIZE={0 | 1 | 2}{PCL}] [, /ORDERED{PCL, X}]
[, OUTPUT=*scalar string*{HP, PS}]
[, /PIXELS{PCL}]
[, PLOT_TO=*logical unit num*{REGIS, TEK}]
[, /PLOTTER_ON_OFF{HP}]
[, /POLYFILL{HP}]
[, PRE_DEPTH=*value*{PS}]
[, PRE_XSIZE=*width*{PS}]
[, PRE_YSIZE=*height*{PS}]
[, /PREVIEW{PS}]
[, PRINT_FILE=*filename*{WIN}]

[, /PSEUDO_COLOR{X}]
[, RESET_STRING=*string*{TEK}]
[, RESOLUTION=*value*{PCL}]
[, RETAIN={0 | 1 | 2}{WIN, X}]
[, SCALE_FACTOR=*value*{PRINTER, PS}]
[, SET_CHARACTER_SIZE=*[font size, line spacing]*{CGM, HP, METAFILE, PCL, PS, REGIS, TEK, WIN, X, Z}]
[, SET_COLORMAP=*value*{14739-element byte vector}{PCL}]
[, SET_COLORS=*value*{2 to 256}{Z}]
[, SET_FONT=*scalar string*{METAFILE, PRINTER, PS, WIN, Z}]
[, SET_GRAPHICS_FUNCTION=*code*{0 to 15}{WIN, X, Z}]
[, SET_RESOLUTION=*[width, height]*{Z}]
[, SET_STRING=*string*{TEK}]
[, SET_TRANSLATION=*variable*{X}]
[, SET_WRITE_MASK=*value*{0 to $2^n$-1 for *n*-bit system}{X, Z}]
[, STATIC_COLOR=*value*{bits per pixel}{X}]
[, STATIC_GRAY=*value*{bits per pixel}{X}]
[, /TEK4014{TEK}]
[, /TEK4100{TEK}]
[, THRESHOLD=*value*{PCL, X}]
[, TRANSLATION=*variable*{WIN, X}]
[, TRUE_COLOR=*value*{bits per pixel}{METAFILE, PRINTER, X}]
[, /TT_FONT{METAFILE, PRINTER, WIN, X, Z}]
[, /TTY{REGIS, TEK}]
[, /VT240 | , /VT241 | , /VT340 | , /VT341 {REGIS}]
[, WINDOW_STATE=*variable*{WIN, X}]
[, XOFFSET=*value*{HP, PCL, PRINTER, PS}]
[, XON_XOFF={0 | 1 (default)}{HP}]
[, XSIZE=*width*{HP, METAFILE, PCL, PRINTER, PS}]
[, YOFFSET=*value*{HP, PCL, PRINTER, PS}]
[, YSIZE=*height*{HP, PCL, METAFILE, PRINTER, PS}]
[, Z_BUFFERING={0 | 1 (default)}{Z}]

## Keywords

See “Keywords Accepted by the IDL Devices” on page 3784.

## Examples

The following example retains the name of the current graphics device, sets plotting to the PostScript device, makes a PostScript file, then resets plotting to the original device:

```
; The NAME field of the !D system variable contains the name of the
; current plotting device.
mydevice = !D.NAME

; Set plotting to PostScript:
SET_PLOT, 'PS'

; Use DEVICE to set some PostScript device options:
DEVICE, FILENAME='myfile.ps', /LANDSCAPE

; Make a simple plot to the PostScript file:
PLOT, FINDGEN(10)

; Close the PostScript file:
DEVICE, /CLOSE

; Return plotting to the original device:
SET_PLOT, mydevice
```

## Version History

Introduced: Original

# DFPMIN

The DFPMIN procedure minimizes a user-written function *Func* of two or more independent variables using the Broyden-Fletcher-Goldfarb-Shanno variant of the Davidon-Fletcher-Powell method, using its gradient as calculated by a user-written function *Dfunc*.

DFPMIN is based on the routine `dfpmin` described in section 10.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

DFPMIN, *X*, *Gtol*, *Fmin*, *Func*, *Dfunc* [, /DOUBLE] [, EPS=*value*]
[, ITER=*variable*] [, ITMAX=*value*] [, STEPMAX=*value*] [, TOLX=*value*]

## Arguments

### X

On input, *X* is an *n*-element vector specifying the starting point. On output, it is replaced with the location of the minimum.

### Gtol

An input value specifying the convergence requirement on zeroing the gradient.

### Fmin

On output, *Fmin* contains the value at the minimum-point *X* of the user-supplied function specified by *Func*.

### Func

A scalar string specifying the name of a user-supplied IDL function of two or more independent variables to be minimized. This function must accept a vector argument *X* and return a scalar result.

For example, suppose we wish to find the minimum value of the function

$$y = (x_0 - 3)^4 + (x_1 - 2)^2$$

To evaluate this expression, we define an IDL function named MINIMUM:

```
FUNCTION minimum, X
   RETURN, (X[0] - 3.0)^4 + (X[1] - 2.0)^2
END
```

### Dfunc

A scalar string specifying the name of a user-supplied IDL function that calculates the gradient of the function specified by *Func*. This function must accept a vector argument *X* and return a vector result.

For example, the gradient of the above function is defined by the partial derivatives:

$$\frac{\partial y}{\partial x_0} = 4(x_0 - 3)^3, \qquad \frac{\partial y}{\partial x_1} = 2(x_1 - 2)$$

We can write a function GRAD to express these relationships in the IDL language:

```
FUNCTION grad, X
   RETURN, [4.0*(X[0] - 3.0)^3, 2.0*(X[1] - 2.0)]
END
```

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### EPS

Use this keyword to specify a number close to the machine precision. For single-precision calculations, the default value is $3.0 \times 10^{-8}$. For double-precision calculations, the default value is $3.0 \times 10^{-16}$.

### ITER

Use this keyword to specify a named variable which returns the number of iterations performed.

### ITMAX

Use this keyword to specify the maximum number of iterations allowed. The default value is 200.

### STEPMAX

Use this keyword to specify the scaled maximum step length allowed in line searches. The default value is 100.0

### TOLX

Use this keyword to specify the convergence criterion on *X* values. The default value is 4 x EPS.

## Examples

To minimize the function MINIMUM:

```
PRO example_dfpmin

   ; Make an initial guess (the algorithm's starting point):
   X = [1.0, 1.0]

   ; Set the convergence requirement on the gradient:
   Gtol = 1.0e-7

   ; Find the minimizing value:
   DFPMIN, X, Gtol, Fmin, 'minimum', 'grad'

   ; Print the minimizing value:
   PRINT, X

END


FUNCTION minimum, X
   RETURN, (X[0] - 3.0)^4 + (X[1] - 2.0)^2
END

FUNCTION grad, X
   RETURN, [4.0*(X[0] - 3.0)^3, 2.0*(X[1] - 2.0)]
END
```

IDL prints:

```
  3.00175  2.00000
```

## Version History

Introduced: 4.0

## See Also

AMOEBA, POWELL, SIMPLEX

# DIAG_MATRIX

The DIAG_MATRIX function constructs a diagonal matrix from an input vector, or if given a matrix, then DIAG_MATRIX will extract a diagonal vector.

## Syntax

*Result* = DIAG_MATRIX(*A* [, *Diag*] )

## Return Value

- If given an input vector with *n* values, the result is an *n*-by-*n* array of the same type. The DIAG_MATRIX function may also be used to construct subdiagonal or superdiagonal arrays.
- If given an input *n*-by-*m* array, the result is a vector with MIN(*n*,*m*) elements containing the diagonal elements. The DIAG_MATRIX function may also be used to extract subdiagonals or superdiagonals.

## Arguments

### A

Either an *n*-element input vector to convert to a diagonal matrix, or a *n*-by-*m* input array to extract a diagonal. *A* may be any numeric type.

### Diag

An optional argument that specifies the subdiagonal (*Diag* < 0) or superdiagonal (*Diag* > 0) to fill or extract. The default is *Diag*=0 which puts or extracts the values along the diagonal. If *A* is a vector with the *m* elements, then the result is an *n*-by-*n* array, where *n* = *m* + *ABS*(*Diag*). If *A* is an array, then the result is a vector whose length depends upon the number of elements remaining along the subdiagonal or superdiagonal.

**Tip**

The *Diag* argument may be used to easily construct tridiagonal arrays. For example, the expression,

```
DIAG_MATRIX(VL,-1) + DIAG_MATRIX(V) + DIAG_MATRIX(VU,1)
```

will create an *n*-by-*n* array, where *VL* is an (*n* - 1)-element vector containing the

subdiagonal values, *V* is an *n*-element vector containing the diagonal values, and *VU* is an (*n* - 1)-element vector containing the superdiagonal values.

## Keywords

None.

## Examples

Create a tridiagonal matrix and extract the diagonal using the following program:

```
PRO ExDiagMatrix
; Convert three input vectors to a tridiagonal matrix:
diag = [1, -2, 3, -4]
sub = [5, 10, 15]
super = [3, 6, 9]
array = DIAG_MATRIX(diag) + $
DIAG_MATRIX(super, 1) + DIAG_MATRIX(sub, -1)
PRINT, 'DIAG_MATRIX array:'
PRINT, array

; Extract the diagonal:
PRINT, 'DIAG_MATRIX diagonal:'
PRINT, DIAG_MATRIX(array)
END
```

When this program is compiled and run, IDL prints:

```
DIAG_MATRIX array:
1       3       0       0
5      -2       6       0
0      10       3       9
0       0      15      -4
DIAG_MATRIX diagonal:
1      -2       3      -4
```

## Version History

Introduced: 5.6

## See Also

IDENTITY, MATRIX_MULTIPLY, “Multiplying Arrays” in Chapter 22 of the *Using IDL* manual.

# DIALOG_MESSAGE

The DIALOG_MESSAGE function creates a modal (blocking) dialog box that can be used to display information for the user. The dialog must be dismissed, by clicking on one of its option buttons, before execution of the widget program can continue.

This function differs from widgets in a number of ways. The DIALOG_MESSAGE dialog does not exist as part of a widget tree, has no children, does not exist in an unrealized state, and generates no events. Instead, the dialog is displayed whenever this function is called. While the DIALOG_MESSAGE dialog is displayed, widget activity is limited because the dialog is modal. The function does not return to its caller until the user selects one of the dialog's buttons. Once a button has been selected, the dialog disappears.

There are four basic dialogs that can be displayed. The default type is "Warning". Other types can be selected by setting one of the keywords described below. Each dialog type displays different buttons. Additionally any dialog can be made to show a "Cancel" button by setting the CANCEL keyword. The four types of dialogs are described in the table below:

| Dialog Type | Default Buttons |
|---|---|
| Error | OK |
| Warning | OK |
| Question | Yes, No |
| Information | OK |

*Table 21: Types of DIALOG_MESSAGE Dialogs*

## Syntax

*Result* = DIALOG_MESSAGE( *Message_Text* [, /CANCEL]
[, /DEFAULT_CANCEL | , /DEFAULT_NO] [, DIALOG_PARENT=*widget_id*]
[, DISPLAY_NAME=*string*] [, /ERROR | , /INFORMATION | , /QUESTION]
[, RESOURCE_NAME=*string*] [, TITLE=*string*] )

## Return Value

DIALOG_MESSAGE returns a text string containing the text of the button selected by the user. Possible returned values are "Yes", "No", "OK", and "Cancel".

# Arguments

## Message_Text

A scalar string or string array that contains the text of the message to be displayed. If this argument is set to an array of strings, each array element is displayed as a separate line of text.

# Keywords

## CANCEL

Set this keyword to add a “Cancel” button to the dialog.

## DEFAULT_CANCEL

Set this keyword to make the “Cancel” button the default selection for the dialog. The default selection is the button that is selected when the user presses the default keystroke (usually Space or Return depending on the platform). Setting DEFAULT_CANCEL implies that the CANCEL keyword is also set.

## DEFAULT_NO

Set this keyword to make the “No” button the default selection for “Question” dialogs. Normally, the default is “Yes”.

## DIALOG_PARENT

Set this keyword to the widget ID of a widget over which the message dialog should be positioned. When displayed, the DIALOG_MESSAGE dialog will be positioned over the specified widget. Dialogs are often related to a non-dialog widget tree. The ID of the widget in that tree to which the dialog is most closely related should be specified.

## DISPLAY_NAME

Set this keyword equal to a string indicating the name of the X Windows display on which the dialog is to appear. This keyword is ignored if the DIALOG_PARENT keyword is specified. This keyword is also ignored on Microsoft Windows platforms.

## ERROR

Set this keyword to create an “Error” dialog. The default dialog type is “Warning”.

### INFORMATION

Set this keyword to create an “Information” dialog. The default dialog type is “Warning”.

### QUESTION

Set this keyword to create a “Question” dialog. The default dialog type is “Warning”.

### RESOURCE_NAME

A string containing an X Window System resource name to be applied to the dialog. See “RESOURCE_NAME” on page 2157 for a complete discussion of this keyword.

### TITLE

Set this keyword to a scalar string that contains the text of a title to be displayed in the dialog frame. If this keyword is not specified, the dialog has the dialog type as its title as shown in the table under DIALOG_MESSAGE.

## Version History

Introduced: 5.0

## See Also

XDISPLAYFILE

# DIALOG_PICKFILE

The DIALOG_PICKFILE function allows the user to interactively pick a file, or multiple files, using the platform's own native graphical file-selection dialog. The user can also enter the name of a file that does not exist (see the description of the WRITE keyword, below).

## Syntax

*Result* = DIALOG_PICKFILE( [, DEFAULT_EXTENSION=*string*]
[, /DIRECTORY] [, DIALOG_PARENT=*widget_id*] [, DISPLAY_NAME=*string*]
[, FILE=*string*] [, FILTER=*string/string array*] [, /FIX_FILTER]
[, GET_PATH=*variable*] [, GROUP=*widget_id*] [, /MULTIPLE_FILES]
[, /MUST_EXIST] [, /OVERWRITE_PROMPT] [, PATH=*string*]
[, /READ | , /WRITE] [, RESOURCE_NAME=*string*] [, TITLE=*string*] )

## Return Value

DIALOG_PICKFILE returns a string array that contains the full path name of the selected file or files. If no file is selected, DIALOG_PICKFILE returns a null string.

## Keywords

### DEFAULT_EXTENSION

Set this keyword to a scalar string representing the default extension to be appended onto the returned file name or names. If the returned file name already has an extension, then the value set for this keyword is not appended. The string value set for this keyword should not include a period (.).

**Note**

This keyword only applies to file names typed into the dialog. This keyword does not apply to files selected within the dialog.

### DIALOG_PARENT

Set this keyword to the widget ID of a widget to be used as the parent of this dialog.

## DIRECTORY

Set this keyword to display only the existing directories in the current directory. Individual files are not displayed.

## DISPLAY_NAME

Set this keyword equal to a string that specifies the name of the X Windows display on which the dialog should be displayed. This keyword is ignored on Microsoft Windows platforms.

## FILE

Set this keyword to a scalar string that contains the name of the initial file selection. This keyword is useful for specifying a default filename.

On Windows, this keyword also has the effect of filtering the file list if a wildcard is used, but this keyword should be used to specify a specific filename. To list only files of a certain type, use the FILTER keyword.

## FILTER

Set this keyword to a string value or an array of strings specifying the file types to be displayed in the file list. This keyword is used to reduce the number of files displayed in the file list. The user can modify the filter unless the FIX_FILTER keyword is set. If the value contains a vector of strings, multiple filters are used to filter the files. The filter `*.*` is automatically added to any filter you specify.

For example, to display only files of type `.jpg`, `.tif`, or `.png` in the file selection window, you could use the following code:

```
filters = ['*.jpg', '*.tif', '*.png']
file = DIALOG_PICKFILE(/READ, FILTER = filters)
```

The filter list shown above is displayed as five options in the dialog:

```
*.jpg, *.tif, *.png
*.jpg
*.tif
*.png
*.*
```

Multiple file types can be included in a single filter by providing a semicolon-separated list of types within the string. For example, to account for different extensions used for similar file types, you could use the following code:

```
filters = ['*.jpg;*.jpeg', '*.tif;*.tiff', '*.png']
file = DIALOG_PICKFILE(/READ, FILTER = filters)
```

The filter list shown above is displayed as five options in the dialog:

```
*.jpg, *.jpeg, *.tif, *.tiff, *.png
*.jpg, *.jpeg
*.tif, *.tiff
*.png
*.*
```

The FILTER keyword can optionally be set equal to an *n* x 2 array. In this case, the first vector contains the file types, and the second vector contains a list of descriptions that are displayed in the dialog in place of the file type strings. For example:

```
filters = [['*.jpg;*.jpeg', '*.tif;*.tiff', '*.png', '*.*'], $
           ['JPEG', 'TIFF', 'Bitmap', 'All files']]
file = DIALOG_PICKFILE(/READ, FILTER = filters)
```

The filter list shown above is displayed as four options in the dialog:

```
JPEG
TIFF
Bitmap
All files
```

**Note**

When an *n* x 2 array is provided, the `*.*` filter is not automatically added to the list. If you want this filter included in the list, you must include it explicitly.

Under Microsoft Windows, the user cannot modify the displayed filter. The user can enter a filter string in the Filename field to interactively update the list of files displayed. For example, entering `*.pro` in the Filename field causes only `.pro` files to be displayed.

## FIX_FILTER

When this keyword is set, only files that satisfy the filter can be selected. The user has no ability to modify the filter and the filter is not shown.

Under Microsoft Windows, the filter string can never be modified, but the user can enter a filter string in the Filename field to interactively update the list of files displayed even if FIX_FILTER is set.

## GET_PATH

Set this keyword to a named variable in which the path of the selection is returned.

## GROUP

*This keyword is obsolete and has been replaced by the DIALOG_PARENT keyword. Code that uses the GROUP keyword will continue to function as before, but we suggest that all new code use DIALOG_PARENT.*

## MULTIPLE_FILES

Set this keyword to allow for multiple file selection in the file-selection dialog. When you set this keyword, the user can select multiple files using the platform-specific selection method. The currently selected files appear in the selection text field of the dialog. With this keyword set, DIALOG_PICKFILE can return a string array that contains the full path name of the selected file or files.

## MUST_EXIST

Set this keyword to allow only files that already exist to be selected.

## OVERWRITE_PROMPT

If this keyword is set along with the WRITE keyword and the user selects a file that already exists, then a dialog will be displayed asking if the user wants to replace the existing file or not. For multiple selections, the user is prompted separately for each file. If the user selects **No** the file selection dialog is displayed again; if the user selects **Yes** then the selection is allowed. This keyword has no effect unless the WRITE keyword is also set.

## PATH

Set this keyword to a string that contains the initial path from which to select files. If this keyword is not set, the current working directory is used.

## READ

Set this keyword to make the title of the dialog “Select File to Read”.

## RESOURCE_NAME

Set this keyword equal to a string containing an X Window System resource name to be applied to the dialog.

## TITLE

Set this keyword to a scalar string to be used for the dialog title. If it is not specified, the default title is “Please Select a File”.

### WRITE

Set this keyword to make the title of the dialog “Select File to Write”.

## Examples

Create a DIALOG_PICKFILE dialog that lets users select only files with the extension ‘pro’. Use the ‘Select File to Read’ title and store the name of the selected file in the variable `file`. Enter:

```
file = DIALOG_PICKFILE(/READ, FILTER = '*.pro')
```

## Version History

Introduced: 5.0

## See Also

FILEPATH

# DIALOG_PRINTERSETUP

The DIALOG_PRINTERSETUP function opens a native dialog for setting the applicable properties for a particular printer.

## Syntax

*Result* = DIALOG_PRINTERSETUP( [*PrintDestination*]
[, DIALOG_PARENT=*widget_id*] [, DISPLAY_NAME=*string*]
[, RESOURCE_NAME=*string*] [, TITLE=*string*] )

## Return Value

DIALOG_PRINTERSETUP returns a nonzero value if the user pressed the “OK” button in the dialog, or zero otherwise. You can programmatically begin printing based on the value returned by this function.

## Arguments

### PrintDestination

An instance of the IDLgrPrinter object for which setup properties are to be set. If no *PrintDestination* is specified, the printer used by the IDL Direct Graphics `printer` device is modified.

## Keywords

### DIALOG_PARENT

Set this keyword to the widget ID of a widget to be used as the parent of this dialog.

### DISPLAY_NAME

Set this keyword equal to a string indicating the name of the X Windows display on which the dialog is to appear. This keyword is ignored if the DIALOG_PARENT keyword is specified. This keyword is also ignored on Microsoft Windows platforms.

### RESOURCE_NAME

Set this keyword equal to a string containing an X Window System resource name to be applied to the dialog.

### TITLE

Set this keyword equal to a string to be displayed on the dialog frame. This keyword is ignored on Microsoft Windows platforms.

## Version History

Introduced: 5.0

## See Also

DIALOG_PRINTJOB, “The Printer Device” on page 3839

# DIALOG_PRINTJOB

The DIALOG_PRINTJOB function opens a native dialog that allows you to set parameters for a printing job (number of copies to print, for example).

## Syntax

*Result* = DIALOG_PRINTJOB( [*PrintDestination*]
[, DIALOG_PARENT=*widget_id*] [, DISPLAY_NAME=*string*]
[, RESOURCE_NAME=*string*] [, TITLE=*string*] )

## Return Value

DIALOG_PRINTJOB returns a nonzero value if the user pressed the “OK” button in the dialog, or zero otherwise. You can use the result of this function to programmatically begin printing.

## Arguments

### PrintDestination

An instance of the IDLgrPrinter object for which a printing job is to be initiated. If no *PrintDestination* is specified, the printer used by the IDL Direct Graphics `printer` device is modified.

## Keywords

### DIALOG_PARENT

Set this keyword to the widget ID of a widget to be used as the parent of this dialog.

### DISPLAY_NAME

Set this keyword to a string indicating the name of the X Windows display on which the dialog is to appear. This keyword is ignored if the DIALOG_PARENT keyword is specified. This keyword is also ignored on Microsoft Windows platforms.

### RESOURCE_NAME

Set this keyword to a string containing an X Window System resource name to be applied to the dialog.

### TITLE

Set this keyword to a string to be displayed on the dialog frame. This keyword is ignored on Microsoft Windows platforms.

## Version History

Introduced: 5.0

## See Also

DIALOG_PRINTERSETUP, “The Printer Device” on page 3839

# DIALOG_READ_IMAGE

The DIALOG_READ_IMAGE function is a graphical interface used for reading image files. The interface is created as a modal dialog with an optional parent widget.

## Syntax

*Result* = DIALOG_READ_IMAGE ( [*Filename*] [, BLUE=*variable*] [, DIALOG_PARENT=*widget_id*] [, FILE=*variable*] [, FILTER_TYPE=*string*] [, /FIX_FILTER] [, GET_PATH=*variable*] [, GREEN=*variable*] [, IMAGE=*variable*] [, PATH=*string*] [, QUERY=*variable*] [, RED=*variable*] [ ,TITLE=*string*] )

## Return Value

This function returns 1 if the “Open” button was clicked, and 0 if the “Cancel” button was clicked.

## Arguments

### Filename

An optional scalar string containing the full pathname of the file to be highlighted.

## Keywords

### BLUE

Set this keyword to a named variable that will contain the blue channel vector (if any).

### DIALOG_PARENT

The widget ID of a widget that calls DIALOG_READ_IMAGE. When this ID is specified, a death of the caller results in the death of the DIALOG_READ_IMAGE dialog. If DIALOG_PARENT is not specified, then the interface is created as a modal, top-level widget.

### FILE

Set this keyword to a named variable that will contain the selected filename with full path when the dialog is created.

## FILTER_TYPE

Set this keyword to a scalar string containing the format type the dialog filter should begin with. The default is “Image Files”. The user cannot modify the filter if the FIX_FILTER keyword is set. Valid values are obtained from the list of supported image types returned from QUERY_IMAGE. In addition, there is also the “All Files” type. If set to “All Files”, queries will only happen on filename clicks, making the dialog much more efficient.

Example:

```
FILTER='.jpg, .tiff'
```

## FIX_FILTER

When this keyword is set, only files that satisfy the filter can be selected. The user has no ability to modify the filter.

## GET_PATH

Set this keyword to a named variable in which the path of the selection is returned.

## GREEN

Set this keyword to a named variable that will contain the green channel vector (if any).

## IMAGE

Set this keyword to a named variable that will contain the image array read. If Cancel was clicked, no action is taken.

## PATH

Set this keyword to a string that contains the initial path from which to select files. If this keyword is not set, the current working directory is used.

## QUERY

Set this keyword to a named variable that will return the QUERY_IMAGE structure associated with the returned image. If the “Cancel” button was pressed, the variable set to this keyword is not changed. If an error occurred during the read, the FILENAME field of the structure will be a null string.

### RED

Set this keyword to a named variable that will contain the red channel vector (if any).

### TITLE

Set this keyword to a scalar string to be used for the dialog title. If it is not specified, the default title is “Select Image File”.

## Version History

Introduced: 5.3

## See Also

DIALOG_WRITE_IMAGE

# DIALOG_WRITE_IMAGE

The DIALOG_WRITE_IMAGE function is a graphical user interface used for writing image files. The interface is created as a modal dialog with an optional parent widget.

## Syntax

*Result* = DIALOG_WRITE_IMAGE ( *Image* [, *R*, *G*, *B*]
[, DIALOG_PARENT=*widget_id*] [, FILE=*string*] [, /FIX_TYPE] [, /NOWRITE]
[, OPTIONS=*variable*] [, PATH=*string*] [ ,TITLE=*string*] [, TYPE=*variable*]
[, /WARN_EXIST] )

## Return Value

This routine returns 1 if the “Save” button was clicked, and 0 if the “Cancel” button was clicked.

## Arguments

### Image

The array to be written to the image file.

### R, G, B

These are optional arguments defining the Red, Green, and Blue color tables to be associated with the image array.

## Keywords

### DIALOG_PARENT

The widget ID of a widget that calls DIALOG_WRITE_IMAGE. When this ID is specified, a death of the caller results in the death of the DIALOG_WRITE_IMAGE dialog. If DIALOG_PARENT is not specified, then the interface is created as a modal, top-level widget.

### FILE

Set this keyword to a scalar string that contains the name of the initial file selection. This keyword is useful for specifying a default filename.

### FIX_TYPE

When this keyword is set, only files that satisfy the type can be selected. The user has no ability to modify the type.

### NOWRITE

Set this keyword to prevent the dialog from writing the file when “Save” is clicked. No data conversions will take place when the save type is chosen.

### OPTIONS

Set this keyword to a named variable to contain a structure of the chosen options by the user, including the filename and image type chosen.

### PATH

Set this keyword to a string that contains the initial path from which to select files. If this keyword is not set, the current working directory is used.

### TITLE

Set this keyword to a scalar string to be used for the dialog title. If it is not specified, the default title is “Save Image File”.

### TYPE

Set this keyword to a scalar string containing the format type the “Save as type” field should begin with. The default is “TIFF”. The user can modify the type unless the FIX_TYPE keyword is set. Valid values are obtained from the list of supported image types returned from QUERY_IMAGE. The “Save as type” field will reflect the type of the selected file (if one is selected).

### WARN_EXIST

Set this keyword to produce a question dialog if the user selects a file that already exists. The default is to quietly overwrite the file.

## Version History

Introduced: 5.3

## See Also

DIALOG_READ_IMAGE

# DIGITAL_FILTER

The DIGITAL_FILTER function returns the coefficients of a non-recursive, digital filter for evenly spaced data points. Frequencies are expressed in terms of the Nyquist frequency, 1/2T, where T is the time between data samples. Highpass, lowpass, bandpass and bandstop filters may be constructed with this function.

This routine is written in the IDL language. Its source code can be found in the file `digital_filter.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = DIGITAL_FILTER( *Flow*, *Fhigh*, *A*, *Nterms* [, /DOUBLE] )

## Return Value

This function returns a vector of coefficients with (2 x *Nterms* + 1) elements.

## Arguments

### Flow

The lower frequency of the filter as a fraction of the Nyquist frequency

### Fhigh

The upper frequency of the filter as a fraction of the Nyquist frequency. The following conditions are necessary for various types of filters:

- No Filtering: *Flow* = 0, *Fhigh* = 1
- Low Pass: *Flow* = 0, 0 < *Fhigh* < 1
- High Pass: 0 < *Flow* < 1, *Fhigh* =1
- Band Pass: 0 < *Flow* < *Fhigh* < 1
- Band Stop: 0 < *Fhigh* < *Flow* < 1

### A

The filter power relative to the Gibbs phenomenon wiggles in decibels. 50 is a good choice.

### Nterms

The number of terms used to construct the filter.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision result. Set DOUBLE=0 to use single-precision for computations and to return a single-precision result. The default is /DOUBLE if the Flow input is double precision, otherwise the default is DOUBLE=0.

## Examples

```
; Get coefficients:
Coeff = DIGITAL_FILTER(Flow, Fhigh, A, Nterms)
; Apply the filter:
Yout = CONVOL(Yin, Coeff)
```

## Version History

Introduced: Original

DOUBLE keyword added: 5.6

## See Also

CONVOL, LEEFILT, MEDIAN, SMOOTH

# DILATE

The DILATE function implements the morphologic dilation operator on both binary and grayscale images. For details on using DILATE, see “Using DILATE” on page 517.

## Using DILATE

Mathematical morphology is a method of processing digital images on the basis of shape. A discussion of this topic is beyond the scope of this manual. A suggested reference is: Haralick, Sternberg, and Zhuang, “Image Analysis Using Mathematical Morphology,” *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol. PAMI-9, No. 4, July, 1987, pp. 532-550. Much of this discussion is taken from that article.

Briefly, the DILATE function returns the dilation of *Image* by the structuring element *Structure*. This operator is commonly known as “fill”, “expand”, or “grow.” It can be used to fill “holes” of a size equal to or smaller than the structuring element.

Used with binary images, where each pixel is either 1 or 0, dilation is similar to convolution. Over each pixel of the image, the origin of the structuring element is overlaid. If the image pixel is nonzero, each pixel of the structuring element is added to the result using the “or” operator.

Letting $A \oplus B$ represent the dilation of an image $A$ by structuring element $B$, dilation can be defined as:

$$C = A \oplus B = \bigcup_{b \in B} (A)_b$$

where $(A)_b$ represents the translation of $A$ by $b$. Intuitively, for each nonzero element $b_{i,j}$ of $B$, $A$ is translated by $i,j$ and summed into $C$ using the “or” operator. For example:

$$\begin{array}{lcl} 0100 & & 0110 \\ 0100 & & 0110 \\ 0110 \oplus 11 & = & 0111 \\ 1000 & & 1100 \\ 0000 & & 0000 \end{array}$$

In this example, the origin of the structuring element is at (0,0).

Used with grayscale images, which are always converted to byte type, the DILATE function is accomplished by taking the maximum of a set of sums. It can be used to conveniently implement the neighborhood maximum operator with the shape of the neighborhood given by the structuring element.

### Openings and Closings

The *opening* of image *B* by structuring element *K* is defined as $(B \otimes K) \oplus K$. The *closing* of image *B* by *K* is defined as $(B \oplus K) \otimes K$ where the "o times" symbol represents the erosion operator implemented by the IDL ERODE function.

As stated by Haralick *et al*, the result of iteratively applied dilations and erosions is an elimination of specific image detail smaller than the structuring element without the global geometric distortion of unsuppressed features. For example, opening an image with a disk structuring element smooths the contour, breaks narrow isthmuses, and eliminates small islands and sharp peaks or capes.

Closing an image with a disk structuring element smooths the contours, fuses narrow breaks and long thin gulfs, eliminates small holes, and fills gaps on the contours.

**Note**

MORPH_OPEN and MORPH_CLOSE can also be used to perform these tasks.

## Syntax

*Result* = DILATE( *Image*, *Structure* [, $X_0$ [, $Y_0$ [, $Z_0$]]] [, /CONSTRAINED [, BACKGROUND=*value*]] [, /GRAY [, /PRESERVE_TYPE | , /UINT | , /ULONG]] [, VALUES=*array*] )

## Return Value

The DILATE function returns the dilation of *Image* by the structuring element *Structure*.

## Arguments

### Image

A one-, two-, or three-dimensional array upon which the dilation is to be performed. If the parameter is not of byte type, a temporary byte copy is obtained. If neither of

the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

### Structure

A one-, two-, or three-dimensional array that represents the structuring element. Elements are interpreted as binary: values are either zero or nonzero. This argument must have the same number of dimensions as *Image*.

### $X_0$, $Y_0$, $Z_0$

Optional parameters specifying the one-, two-, or three-dimensional coordinate of the structuring element's origin. If omitted, the origin is set to the center, ([$N_x$/2], [$N_y$/2], [$N_z$/2]), where $N_x$, $N_y$, and $N_z$ are the dimensions of the structuring element array. The origin need not be within the structuring element.

## Keywords

### BACKGROUND

Set this keyword to the pixel value that is to be considered the background when dilation is being performed in constrained mode. The default value is 0.

### CONSTRAINED

If this keyword is set and grayscale dilation has been selected, the dilation algorithm will operate in constrained mode. In this mode, a pixel is set to the value determined by normal grayscale dilation rules in the output image only if the current value destination pixel value matches the BACKGROUND pixel value. Once a pixel in the output image has been set to a value other than the BACKGROUND value, it cannot change.

### GRAY

Set this keyword to perform grayscale, rather than binary, dilation. The nonzero elements of the *Structure* parameter determine the shape of the structuring element (neighborhood). If VALUES is not present, all elements of the structuring element are 0, yielding the neighborhood maximum operator.

### PRESERVE_TYPE

Set this keyword to return the same type as the input array. This keyword only applies if the GRAY keyword is set.

### UINT

Set this keyword to return an unsigned integer array. This keyword only applies if the GRAY keyword is set.

### ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies if the GRAY keyword is set.

### VALUES

An array with the same dimensions as *Structure* providing the values of the structuring element. The presence of this parameter implies grayscale dilation. Each pixel of the result is the maximum of the sum of the corresponding elements of VALUE and the *Image* pixel value. If the resulting sum is greater than 255, the return value is 255.

## Examples

### Example 1

This example thresholds a gray scale image at the value of 100, producing a binary image. The result is then “opened” with a 3 pixel by 3 pixel square shape operator, using the DILATE and ERODE operators. The effect is to remove holes, islands, and peninsula smaller than the shape operator:

```
; Threshold and make binary image:
B = A GE

; Create the shape operator:
S = REPLICATE(1, 3, 3)

; "Opening" operator:
C = DILATE(ERODE(B, S), S)

; Show the result:
TVSCL, C
```

### Example 2

For grayscale images, DILATE takes the neighborhood maximum, where the shape of the neighborhood is given by the structuring element. Elements for which the structuring element extends off the array are indeterminate. For example, assume you have the following image and structuring element:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1]
```

If the origin of the structuring element is not specified in the call to DILATE, the origin defaults to one half the width of the structuring element, which is 1 in this case. Therefore, for the first element in the image array, the structuring element is aligned with the image as depicted below:

```
  [2,1,3,3,3,3,1,2]
   ↑
[1,1]
```

This will cause an indeterminate value for the first element in the DILATE result. If edge values are important, you must pad the image with as many zeros as there are elements in the structuring element that extend off the array, in all dimensions. In this case, you would need to pad the image with a single leading zero. If the structuring element were `s=[1,1,1,1]`, and you specified an origin of 2, the structuring element would align with the image as follows:

```
    [2,1,3,3,3,3,1,2]
     ↑             ↑
[1,1,1,1]     [1,1,1,1]
```

Therefore, you would need to pad the image with at least two leading zeros and at least one trailing zero. You would then perform the dilation operation on the padded image, and remove the padding from the result.

The following code illustrates this method:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1] ; Structuring element
PRINT, 'Image: '
PRINT, image

PRINT, 'Dilation using no padding: '
PRINT, DILATE(image, s, /GRAY)

result = DILATE([0, image], s, /GRAY)
PRINT, 'Dilation using padding: '
PRINT, result[1:N_ELEMENTS(image)]
```

IDL prints:

```
Image:
   2   1   3   3   3   3   1   2
Dilation using no padding:
   1   3   3   3   3   3   2   2
Dilation using padding:
   2   3   3   3   3   3   2   2
```

## Version History

Introduced: Pre 4.0

## See Also

ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

# DINDGEN

The DINDGEN function creates a double-precision, floating-point array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = DINDGEN($D_1$ *[, ..., $D_8$]*)

## Return Value

Returns a double-precision, floating-point array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create D, a 100-element, double-precision, floating-point array with each element set to the value of its subscript, enter:

```
D = DINDGEN(100)
```

## Version History

Introduced: Original

## See Also

BINDGEN, CINDGEN, DCINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# DISSOLVE

The DISSOLVE procedure provides a digital “dissolve” effect for images. The routine copies pixels from the image (arranged into square tiles) to the display in pseudo-random order. This routine is written in the IDL language. Its source code can be found in the file `dissolve.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

DISSOLVE, *Image* [, DELAY=*seconds*] [, /ORDER] [, SIZ=*pixels*] [, X0=*pixels*, Y0=*pixels*]

## Arguments

### Image

The image to be displayed. It is assumed that the image is already scaled. Byte-valued images display most rapidly.

## Keywords

### DELAY

The wait between displaying tiles. The default is 0.01 second.

### ORDER

The Image display order: 0 = bottom up (the default), 1 = top-down.

### SIZ

Size of square tile. The default is 32 x 32 pixels.

### X0, Y0

The X and Y offsets of the lower-left corner of the image on screen, in pixels.

## Examples

Display an image using 16 x 16 pixel tiles:

```
DISSOLVE, DIST(200), SIZ=16
```

## Version History

Introduced: Pre 4.0

## See Also

ERASE, TV

# DIST

The DIST function creates an array in which each array element value is proportional to its frequency. This array may be used for a variety of purposes, including frequency-domain filtering.

This routine is written in the IDL language. Its source code can be found in the file `dist.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = DIST(*N* [, *M*])

## Return Value

Returns a rectangular array in which the value of each element is proportional to its frequency.

## Arguments

### N

The number of columns in the resulting array.

### M

The number of rows in the resulting array. If *M* is omitted, the resulting array will be *N* by *N*.

## Keywords

None.

## Examples

```
; Display the results of DIST as an image:
TVSCL, DIST(100)
```

## Version History

Introduced: Original

## See Also

FFT

# DLM_LOAD

Normally, IDL system routines that reside in dynamically loadable modules (DLMs) are automatically loaded on demand when a routine from a DLM is called. The DLM_LOAD procedure can be used to explicitly cause a DLM to be loaded.

## Syntax

DLM_LOAD, *DLMNameStr*$_1$ [, *DLMNameStr*$_2$,..., *DLMNameStr*$_n$]

## Arguments

### DLMNameStr$_n$

A string giving the name of the DLM to be loaded. DLM_LOAD causes each named DLM to be immediately loaded.

## Keywords

None

## Example

Force the JPEG DLM to be loaded:

```
DLM_LOAD, 'jpeg'
```

IDL prints:

```
% Loaded DLM: JPEG.
```

## Version History

Introduced: 5.1

# DLM_REGISTER

The DLM_REGISTER procedure registers a Dynamically Loadable Module (DLM) in IDL that was not registered when starting IDL. This allows you to create DLMs using the MAKE_DLL procedure and register them in your current session without having to exit and restart IDL.

**Warning**

DLM_REGISTER intended as a convenience to be used when testing and debugging DLMs or when running demonstration code included in the IDL distribution. It is *not* the recommended way to make Dynamically Loadable Modules known to your IDL session. By design, DLMs are registered when IDL starts; among other things, this allows programs written in the IDL language that call the routines in a DLM to be compiled before the DLM itself is loaded into IDL. The mechanism involved is described in "Dynamically Loadable Modules" in Chapter 21 of the *External Development Guide* manual; you should read and understand this section before deciding to use DLM_REGISTER.

## Syntax

DLM_REGISTER, *DLMDefFilePath*$_1$ [, *DLMDefFilePath*$_2$, ..., *DLMDefFilePath*$_n$]

## Arguments

### DLMDefFilePath$_n$

The name of the DLM module definition file to read.

## Keywords

None.

## Version History

Introduced: 5.4

## See Also

"Dynamically Loadable Modules" in Chapter 21 of the *External Development Guide* manual

# DOC_LIBRARY

The DOC_LIBRARY procedure extracts documentation headers from one or more IDL programs (procedures or functions). This command provides a standard interface to the operating-system specific DL_DOS and DL_UNIX procedures.

The documentation header of the `.pro` file in question must have the following format:

- The first line of the documentation block contains only the characters `;+`, starting in column 1.
- The last line of the documentation block contains only the characters `;-`, starting in column 1.
- All other lines in the documentation block contain a `;` in column 1.

The file `template.pro` in the `general` subdirectory of the `examples` subdirectory of the IDL distribution contains a template for creating your own documentation headers.

This routine is supplied for users to view online documentation from their own IDL programs. Though it could be used to view documentation headers from the `lib` subdirectory of the IDL distribution, we do not recommend doing so. The documentation headers on the files in the `lib` directory are used for historical purposes—most do not contain the most current or accurate documentation for those routines. The most current documentation for IDL's built-in and library routines is found in IDL's online help system (enter `?` at the IDL prompt).

This routine is written in the IDL language. Its source code can be found in the file `doc_library.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

DOC_LIBRARY [, *Name*] [, /PRINT]

**UNIX keywords:** [, DIRECTORY=*string*] [, /MULTI]

## Arguments

### Name

A string containing the name of the IDL routine in question. Under Windows or UNIX, *Name* can be "`*`" to get information on all routines.

# Keywords

## DIRECTORY (UNIX Only)

A string containing the name of the directory to search. If omitted, the current directory and !PATH are used.

## MULTI (UNIX Only)

Set this keyword to allow printing of more than one file if the requested module exists in more than one directory.

## PRINT

Set this keyword to send the output of DOC_LIBRARY to the default printer. Under UNIX, if PRINT is a string, it is interpreted as a shell command used for output with the documentation from DOC_LIBRARY providing standard input (i.e., `PRINT="cat > junk"`).

## Obsolete Keywords

The following keywords are obsolete:

- FILE
- PATH
- OUTPUTS

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

# Examples

To view the documentation header for the library function DIST, enter:

```
DOC_LIBRARY, 'DIST'
```

# Version History

Introduced: Original

# See Also

MK_HTML_HELP

# DOUBLE

The DOUBLE function converts *Expression* into a double-precision floating-point value.

## Syntax

*Result* = DOUBLE(*Expression*[, *Offset* [, $D_1$ [, ..., $D_8$]]])

## Return Value

Returns a double-precision floating-point value or array of the specified dimensions. If *Expression* is a complex number, DOUBLE returns the real part.

## Arguments

### Expression

The expression to be converted to double-precision, floating-point.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as double-precision, floating-point data. See the description in Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual for details.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

Suppose that A contains the integer value 45. A double-precision, floating-point version of A can be stored in B by entering:

```
B = DOUBLE(A)
PRINT, B
```

IDL prints:

```
45.000000
```

# Version History

Introduced: Original

# See Also

BYTE, COMPLEX, DCOMPLEX, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG, ULONG64

# DRAW_ROI

The DRAW_ROI procedure draws a region or group of regions to the current Direct Graphics device. The primitives used to draw each ROI are based on the TYPE property of the given IDLanROI object. The TYPE property selects between points, polylines, and filled polygons.

## Syntax

DRAW_ROI, *oROI* [, /LINE_FILL] [, SPACING=*value*]

**Graphics Keywords:** [, CLIP=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, ORIENTATION=*ccw_degrees_from_horiz*] [, PSYM=*integer*{0 to 10}] [, SYMSIZE=*value*] [, /T3D] [, THICK=*value*]

## Arguments

### oROI

A reference to an IDLanROI object to be drawn.

## Keywords

### LINE_FILL

Set this keyword to indicate that polygonal regions are to be filled with parallel lines, rather than using the default solid fill. When using a line fill, the thickness, linestyle, orientation, and spacing of the lines may be specified by keywords.

### SPACING

The spacing, in centimeters, between the parallel lines used to fill polygons.

### Graphics Keywords Accepted

CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NORMAL, ORIENTATION, PSYM, SYMSIZE, T3D, THICK

## Examples

The following example displays an image and collects data for a region of interest. The resulting ROI is displayed as a filled polygon.

```
PRO roi_ex
; Load and display an image.
img=READ_DICOM(FILEPATH('mr_knee.dcm',SUBDIR=['examples','data']))
TV, img

; Create a polygon region object.
oROI = OBJ_NEW('IDLanROI', TYPE=2)

; Print instructions.
PRINT,'To create a region:'
PRINT,' Left mouse: select points for the region.'
PRINT,' Right mouse: finish the region.'

; Collect first vertex for the region.
CURSOR, xOrig, yOrig, /UP, /DEVICE
oROI->AppendData, xOrig, yOrig
PLOTS, xOrig, yOrig, PSYM=1, /DEVICE

;Continue to collect vertices for region until right mouse button.
x1 = xOrig
y1 = yOrig
while !MOUSE.BUTTON ne 4 do begin
   x0 = x1
   y0 = y1
   CURSOR, x1, y1, /UP, /DEVICE
   PLOTS, [x0,x1], [y0,y1], /DEVICE
   oROI->AppendData, x1, y1
endwhile
PLOTS, [x1,xOrig], [y1,yOrig], /DEVICE

; Draw the the region with a line fill.
DRAW_ROI, oROI, /LINE_FILL, SPACING=0.2, ORIENTATION=45, /DEVICE
END
```

## Version History

Introduced: 5.3

# EFONT

The EFONT procedure provides a simple widget-based vector font editor and display. Use this procedure to read and/or modify a local copy of the file `hersh1.chr`, located in the `resource/fonts` subdirectory of the main IDL directory, which contains the vector fonts used by IDL in plotting. This is a very rudimentary editor. Click the “Help” button on the EFONT main menu for more information.

This routine is written in the IDL language. Its source code can be found in the file `efont.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

EFONT [, *Init_Font*] [, /BLOCK] [, GROUP=*widget_id*]

## Arguments

### Init_Font

The initial font index, from 3 to 29. The default is 3.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have EFONT block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

### GROUP

The widget ID of the widget that calls EFONT. If GROUP is set, the death of the caller results in the death of EFONT.

## Version History

Introduced: Pre 4.0

## See Also

SHOWFONT, XFONT

# EIGENQL

The EIGENQL function computes the eigenvalues and eigenvectors of an *n*-by-*n* real, symmetric array using Householder reductions and the QL method with implicit shifts.

This routine is written in the IDL language. Its source code can be found in the file `eigenql.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

If you are working with complex inputs, instead use the LA_EIGENQL function.

## Syntax

*Result* = EIGENQL( *A* [, /ABSOLUTE] [, /ASCENDING] [, /DOUBLE] [, EIGENVECTORS=*variable*] [, /OVERWRITE | , RESIDUAL=*variable*] )

## Return Value

This function returns an *n*-element vector containing the eigenvalues.

## Arguments

### A

An *n*-by-*n* symmetric single- or double-precision floating-point array.

## Keywords

### ABSOLUTE

Set this keyword to sort the eigenvalues by their absolute value (their magnitude) rather than by their signed value.

### ASCENDING

Set this keyword to return eigenvalues in ascending order (smallest to largest). If not set or set to zero, eigenvalues are returned in descending order (largest to smallest). The eigenvectors are correspondingly reordered.

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### EIGENVECTORS

Set this keyword equal to a named variable that will contain the computed eigenvectors in an *n*-by-*n* array. The $i^{th}$ row of the returned array contains the $i^{th}$ eigenvalue. If no variable is supplied, the array will not be computed.

### OVERWRITE

Set this keyword to use the input array for internal storage and to overwrite its previous contents.

### RESIDUAL

Use this keyword to specify a named variable that will contain the residuals for each eigenvalue/eigenvector ($\lambda/x$) pair. The residual is based on the definition $Ax - (\lambda)x = 0$ and is an array of the same size as A and the same type as *Result*. The rows of this array correspond to the residuals for each eigenvalue/eigenvector pair.

**Note**

If the OVERWRITE keyword is set, the RESIDUAL keyword has no effect.

## Examples

```
 ; Define an n-by-n real, symmetric array:
A = [[ 5.0,  4.0,  0.0, -3.0], $
[ 4.0,  5.0,  0.0, -3.0], $
[ 0.0,  0.0,  5.0, -3.0], $
[-3.0, -3.0, -3.0,  5.0]]

 ; Compute the eigenvalues and eigenvectors:
 eigenvalues = EIGENQL(A, EIGENVECTORS = evecs, $
    RESIDUAL = residual)

 ;Print the eigenvalues and eigenvectors:
 PRINT, 'Eigenvalues: '
 PRINT, eigenvalues
 PRINT, 'Eigenvectors: '
 PRINT, evecs
```

IDL prints:

```
Eigenvalues:
12.0915    6.18662    1.00000    0.721870

Eigenvectors:
-0.554531    -0.554531   -0.241745     0.571446
-0.342981    -0.342981    0.813186    -0.321646
 0.707107    -0.707107   -6.13503e-008-6.46503e-008
 0.273605     0.273605    0.529422     0.754979
```

The accuracy of each eigenvalue/eigenvector ($\lambda/x$) pair may be checked by printing the residual array:

```
PRINT, residual
```

The RESIDUAL array has the same dimensions as the input array and the same type as the result. The residuals are contained in the rows of the RESIDUAL array. All residual values should be floating-point zeros.

## Version History

Introduced: 5.0

## See Also

EIGENVEC, LA_EIGENQL, TRIQL

# EIGENVEC

The EIGENVEC function computes the eigenvectors of an *n*-by-*n* real, non-symmetric array using Inverse Subspace Iteration. Use ELMHES and HQR to find the eigenvalues of an *n*-by-*n* real, nonsymmetric array.

This routine is written in the IDL language. Its source code can be found in the file `eigenvec.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

If you are working with complex inputs, instead use the LA_EIGENVEC function.

## Syntax

*Result* = EIGENVEC( *A*, *Eval* [, /DOUBLE] [, ITMAX=*value*] [, RESIDUAL=*variable*] )

## Return Value

This function returns a complex array with a column dimension equal to *n* and a row dimension equal to the number of eigenvalues.

## Arguments

### A

An *n*-by-*n* nonsymmetric, single- or double-precision floating-point array.

### EVAL

An *n*-element complex vector of eigenvalues.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### ITMAX

The maximum number of iterations allowed in the computation of each eigenvector. The default value is 4.

### RESIDUAL

Use this keyword to specify a named variable that will contain the residuals for each eigenvalue/eigenvector ($\lambda/x$) pair. The residual is based on the definition $Ax - \lambda x = 0$ and is an array of the same size and type as that returned by the function. The rows of this array correspond to the residuals for each eigenvalue/eigenvector pair.

## Examples

```
; Define an n-by-n real, nonsymmetric array:
A = [[1.0, -2.0, -4.0,  1.0], $
     [0.0, -2.0,  3.0,  4.0], $
     [2.0, -6.0, -1.0,  4.0], $
     [3.0, -3.0,  1.0, -2.0]]
; Compute the eigenvalues of A using double-precision complex
; arithmetic and print the result:
eval = HQR(ELMHES(A), /DOUBLE)
PRINT, 'Eigenvalues: '
PRINT, eval
evec = EIGENVEC(A, eval, RESIDUAL = residual)

; Print the eigenvectors:
PRINT, 'Eigenvectors:'
PRINT, evec[*,0], evec[*,1], evec[*,2], evec[*,3]
```

IDL prints:

```
Eigenvalues:
(  0.26366255, -6.1925899)(  0.26366255, 6.1925899)
(  -4.9384492,  0.0000000)(  0.41112406, 0.0000000)
Eigenvectors:
( 0.0076733129,  -0.42912489)(  0.40651652,  0.32973069)
(   0.54537624,  -0.28856257)(  0.33149359, -0.22632585)
(  -0.42145884, -0.081113711)(  0.23867007,  0.46584824)
(  -0.39497143,   0.47402647)( -0.28990600,  0.27760747)
(  -0.54965842,    0.0000000)( -0.18401243,   0.0000000)
(  -0.58124548,    0.0000000)(  0.57111192,   0.0000000)
(   0.79297048,    0.0000000)(  0.50289130,   0.0000000)
( -0.049618509,    0.0000000)(  0.34034720,   0.0000000)
```

You can check the accuracy of each eigenvalue/eigenvector ($\lambda/x$) pair by printing the residual array. All residual values should be floating-point zeros.

## Version History

Introduced: 4.0

## See Also

ELMHES, HQR, LA_EIGENVEC, TRIQL, TRIRED

# ELMHES

The ELMHES function reduces a real, nonsymmetric *n* by *n* array *A* to upper Hessenberg form. ELMHES is based on the routine `elmhes` described in section 11.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_ELMHES function.

## Syntax

*Result* = ELMHES( *A* [, /COLUMN] [, /DOUBLE] [, /NO_BALANCE] )

## Return Value

The result is an upper Hessenberg array with eigenvalues that are identical to those of the original array *A*. The Hessenberg array is stored in the upper triangle and the first subdiagonal. Elements below the subdiagonal should be ignored but are not automatically set to zero.

## Arguments

### A

An *n* by *n* real, nonsymmetric array.

## Keywords

### COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### NO_BALANCE

Set this keyword to disable balancing. By default, a balancing algorithm is applied to *A*. Balancing a nonsymmetric array is recommended to reduce the sensitivity of eigenvalues to rounding errors.

## Examples

See the description of the HQR for an example using this function.

## Version History

Introduced: 4.0

## See Also

EIGENVEC, HQR, LA_ELMHES, TRIQL, TRIRED

# EMPTY

The EMPTY procedure causes all buffered output for the current graphics device to be written. IDL uses buffered output on many display devices for reasons of efficiency. This buffering leads to rare occasions where a program needs to be certain that data are not waiting in a buffer, but have actually been output. EMPTY is a low-level graphics routine. IDL graphics routines generally handle flushing of buffered data transparently to the user, so the need for EMPTY is very rare.

## Syntax

EMPTY

## Arguments

None.

## Keywords

None.

## Version History

Introduced: Original

## See Also

FLUSH

# ENABLE_SYSRTN

The ENABLE_SYSRTN procedure enables/disables IDL system routines. This procedure is intended for use by runtime and callable IDL applications, and is not generally useful for interactive use.

### Special Cases

The following is a list of cases in which ENABLE_SYSRTN is unable to enable or disable a requested routine. All such attempts are simply ignored without issuing an error, allowing the application to run without error in different IDL environments:

- Attempts to enable/disable non-existent system routines.
- Attempts to enable a system routine disabled due to the mode in which IDL is licensed, as opposed to being disabled via ENABLE_SYSRTN, are quietly ignored (e.g. demo mode).
- The routines CALL_FUNCTION, CALL_METHOD, CALL_PROCEDURE, and EXECUTE cannot be disabled via ENABLE_SYSRTN. However, anything that can be called from them *can* be disabled, so this is not a significant drawback.

## Syntax

ENABLE_SYSRTN [, *Routines* ] [, /DISABLE] [, /EXCLUSIVE] [, /FUNCTIONS]

## Arguments

### Routines

A string scalar or array giving the names of routines to be enabled or disabled. By default, these are procedures, but this can be changed by setting the FUNCTIONS keyword.

## Keywords

### DISABLE

By default, the Routines are enabled. Setting this keyword causes them to be disabled instead.

### EXCLUSIVE

By default, ENABLE_SYSRTN does not alter routines not listed in Routines. If EXCLUSIVE is set, the specified routines are taken to be the only routines that should be enabled or disabled, and all other routines have the opposite action applied.

Therefore, setting EXCLUSIVE and not DISABLE means that the routines in the Routines argument are enabled and all other system routines of the same type (function or procedure) are disabled. Setting EXCLUSIVE and DISABLE means that all listed routines are disabled and all others are enabled.

### FUNCTIONS

Normally, the Routines argument specifies the names of procedures. Set the FUNCTIONS keyword to manipulate functions instead.

## Examples

To disable the PRINT procedure:

```
ENABLE_SYSRTN, /DISABLE, 'PRINT'
```

To enable the PRINT procedure and disable all other procedures:

```
ENABLE_SYSRTN, /EXCLUSIVE, 'PRINT'
```

To ensure all possible functions are enabled:

```
ENABLE_SYSRTN, /DISABLE, /EXCLUSIVE, /FUNCTIONS
```

In the last example, all named functions should be disabled and all other functions should be enabled. Since no *Routines* argument is provided, this means that all routines become enabled.

## Version History

Introduced: 5.2.1

# EOF

The EOF function tests the specified file unit for the end-of-file condition.

**Note**

The EOF function cannot be used with files opened with the RAWIO keyword to the OPEN routines. Many of the devices commonly used with RAWIO signal their end-of-file by returning a zero transfer count to the I/O operation that encounters the end-of-file.

## Syntax

*Result* = EOF(*Unit*)

## Return Value

If the file pointer is positioned at the end of the file, EOF returns true (1), otherwise false (0) is returned.

## Arguments

### Unit

The file unit to test for end-of-file.

## Keywords

None.

## Examples

If file unit number 1 is open, the end-of-file condition can be checked by examining the value of the expression EOF(1). For example, the following IDL code reads and prints a text file:

```
; Open the file test.lis:
OPENR, 1, 'test.lis'
; Define a string variable:
A = ''
; Loop until EOF is found:
WHILE ~ EOF(1) DO BEGIN
```

```
   ; Read a line of text:
   READF, 1, A
   ; Print the line:
   PRINT,
ENDWHILE
; Close the file:
CLOSE, 1
```

## Version History

Introduced: Original

## See Also

POINT_LUN

# EOS_* Routines

For information, see Chapter 5, “HDF-EOS” in the *IDL Scientific Data Formats* manual.

# ERASE

The ERASE procedure erases the screen of the currently selected graphics device (or starts a new page if the device is a printer). The device is reset to alphanumeric mode if it has such a mode (e.g., Tektronix terminals).

## Syntax

ERASE [, *Background_Color*] [, CHANNEL=*value*] [, COLOR=*value*]

## Arguments

### Background_Color

The color index for the screen to be erased to. If this argument is omitted, ERASE resets the screen to the default background color (normally 0) stored in the system variable !P.BACKGROUND. Providing a value for *Background_Color* overrides the default.

**Warning**

Not all devices support this feature.

## Keywords

### CHANNEL

The channel or channel mask for the erase operation. This parameter has meaning only when used with devices that support TrueColor or multiple-display channels. The default value is !P.CHANNEL.

### COLOR

Specifies the background color. Using this keyword is analogous to using the *Background_Color* argument.

## Examples

```
; Display a simple image in the current window:
TV, DIST(255)

; Erase the image from the window:
ERASE
```

## Version History

Introduced: Original

## See Also

SET_PLOT, WINDOW, WSET

# ERF

The ERF function returns the value of the error function:

$$erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt$$

## Syntax

*Result* = ERF(*Z*)

## Return Value

The result is double-precision if the argument is double-precision, otherwise the result is floating-point. The result always has the same structure as *Z*. The ERF function also accepts complex arguments.

## Arguments

### Z

The expression for which the error function is to be evaluated. *Z* may be complex.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To find the error function of 0.4 and print the result, enter:

```
PRINT, ERF(0.4D)
```

IDL prints:

```
0.42839236
```

## Version History

Introduced: Pre 4.0

*Z* argument accepts complex input: 5.6

## See Also

ERFC, ERFCX, EXPINT, GAMMA, IGAMMA

# ERFC

The ERFC function returns the value of the complementary error function:

$$erfc(x) = 1 - erf(x) = \frac{2}{\sqrt{\pi}} \int_{x}^{\infty} e^{-t^2} dt$$

## Syntax

*Result* = ERFC(*Z*)

## Return Value

The result is double-precision if the argument is double-precision, otherwise the result is floating-point. The result always has the same structure as *Z*. The ERFC function also accepts complex arguments.

## Arguments

### Z

The expression for which the complementary error function is to be evaluated. *Z* may be complex.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To find the complementary error function of 0.4 and print the result, enter:

```
PRINT, ERFC(0.4D)
```

IDL prints:

```
0.57160764
```

## Version History

Introduced: Pre 4.0

*Z* argument accepts complex input: 5.6

## See Also

ERFC, ERFCX

# ERFCX

The ERFCX function returns the value of the scaled complementary error function:

$$erfcx(x) = e^{x^2} erfc(x)$$

## Syntax

*Result* = ERFCX(*Z*)

## Return Value

The result is double-precision if the argument is double-precision, otherwise the result is floating-point. The result always has the same structure as *Z*. The ERFCX function also accepts complex arguments.

## Arguments

### Z

The expression for which the scaled complementary error function is to be evaluated. *Z* may be complex.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To find the scaled complementary error function of 0.4 and print the result, enter:

```
PRINT, ERFCX(0.4D)
```

IDL prints:

```
0.67078779
```

## Version History

Introduced: 5.5

*Z* argument accepts complex input: 5.6

## See Also

ERF, ERFC

# ERODE

The ERODE function implements the erosion operator on binary and grayscale images and vectors. This operator is commonly known as “shrink” or “reduce”.

## Using ERODE

See the description of the DILATE function for background on morphological operators. Erosion is the dual of dilation. It does to the background what dilation does to the foreground. Briefly, given an *Image* and a structuring element, *Structure*, the ERODE function can be used to remove islands smaller than the structuring element.

Over each pixel of the image, the origin of the structuring element is overlaid. If each nonzero element of the structuring element is contained in the image, the output pixel is set to one. Letting $A \otimes B$ represent the erosion of an image $A$ by structuring element $B$, erosion can be defined as:

$$C = A \otimes B = \bigcap_{b \in B} (A)_{-b}$$

where $(A)_{-b}$ represents the translation of $A$ by $b$. The structuring element $B$ can be visualized as a probe that slides across image $A$, testing the spatial nature of $A$ at each point. If $B$ translated by $i,j$ can be contained in $A$ (by placing the origin of $B$ at $i,j$), then $i,j$ belongs to the erosion of $A$ by $B$. For example:

$$\begin{matrix} 0100 & & 0000 \\ 0100 & & 0000 \\ 1110 & \otimes\ 11 = & 1100 \\ 1000 & & 0000 \\ 0000 & & 0000 \end{matrix}$$

In this example, the origin of the structuring element is at (0, 0).

Used with grayscale images, which are always converted to byte type, the ERODE function is accomplished by taking the minimum of a set of differences. It can be used to conveniently implement the neighborhood minimum operator with the shape of the neighborhood given by the structuring element.

# Syntax

*Result* = ERODE( *Image*, *Structure* [, $X_0$ [, $Y_0$ [, $Z_0$]]] [, /GRAY [, /PRESERVE_TYPE | , /UINT | , /ULONG]] [, VALUES=*array*] )

# Return Value

The ERODE function returns the erosion of *Image* by the structuring element *Structure*.

# Arguments

## Image

A one-, two-, or three-dimensional array upon which the erosion is to be performed. If this parameter is not of byte type, a temporary byte copy is obtained. If neither of the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

## Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values—either zero or nonzero. The structuring element must have the same number of dimensions as *Image*.

## $X_0$, $Y_0$, $Z_0$

Optional parameters specifying the one-, two-, or three-dimensional coordinate of the structuring element's origin. If omitted, the origin is set to the center, ([$N_x$/2], [$N_y$/2], [$N_z$/2]), where $N_x$, $N_y$, and $N_z$ are the dimensions of the structuring element array. The origin need not be within the structuring element.

# Keywords

## GRAY

Set this keyword to perform grayscale, rather than binary, erosion. Nonzero elements of the *Structure* parameter determine the shape of the structuring element (neighborhood). If VALUES is not present, all elements of the structuring element are 0, yielding the neighborhood minimum operator.

## PRESERVE_TYPE

Set this keyword to return the same type as the input array. This keyword only applies if the GRAY keyword is set.

### UINT

Set this keyword to return an unsigned integer array. This keyword only applies if the GRAY keyword is set.

### ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies if the GRAY keyword is set.

### VALUES

An array of the same dimensions as *Structure* providing the values of the structuring element. The presence of this keyword implies grayscale erosion. Each pixel of the result is the minimum of Image less the corresponding elements of VALUE. If the resulting difference is less than zero, the return value will be zero.

## Examples

### Example 1

This example thresholds a grayscale image at the value of 100, producing a binary image. The result is then “opened” with a 3 pixel by 3 pixel square shape operator, using the ERODE and DILATE operators. The effect is to remove holes, islands, and peninsula smaller than the shape operator:

```
; Threshold and make binary image:
B = A GE 100

; Create the shape operator:
S = REPLICATE(1, 3, 3)

; "Opening" operator:
C = DILATE(ERODE(B, S), S)

; Show the result:
TVSCL, C
```

### Example 2

For grayscale images, ERODE takes the neighborhood minimum, where the shape of the neighborhood is given by the structuring element. Elements for which the structuring element extends off the array are indeterminate. For example, assume you have the following image and structuring element:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1]
```

If the origin of the structuring element is not specified in the call to ERODE, the origin defaults to one half the width of the structuring element, which is 1 in this case. Therefore, for the first element in the image array, the structuring element is aligned with the image as depicted below:

```
  [2,1,3,3,3,3,1,2]
   ↑
[1,1]
```

This will cause an indeterminate value for the first element in the ERODE result. If edge values are important, you must pad the image with as many elements as there are elements in the structuring element that extend off the array, in all dimensions. The value of the padding elements must be the maximum value in the image, since ERODE calculates a neighborhood minimum. In this case, you would need to pad the image with a single leading 3. If the structuring element were `s=[1,1,1,1]`, and you specified an origin of 2, the structuring element would align with the image as follows:

```
     [2,1,3,3,3,3,1,2]
      ↑             ↑
[1,1,1,1]     [1,1,1,1]
```

Therefore, you would need to pad the image with at least two leading 3s and at least one trailing 3. You would then perform the erosion operation on the padded image, and remove the padding from the result.

The following code illustrates this method:

```
image = BYTE([2,1,3,3,3,3,1,2])
s = [1,1] ; Structuring element
PRINT, 'Image: '
PRINT, image

PRINT, 'Erosion using no padding: '
PRINT, ERODE(image, s, /GRAY)

result = ERODE([MAX(image), image], s, /GRAY)
PRINT, 'Erosion using padding: '
PRINT, result[1:N_ELEMENTS(image)]
```

IDL prints:

```
Image:
   2   1   3   3   3   3   1   2
Erosion using no padding:
   0   1   1   3   3   3   1   1
```

```
Erosion using padding:
   2   1   1   3   3   3   1   1
```

## Version History

Introduced: Pre 4.0

## See Also

DILATE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

# ERRPLOT

The ERRPLOT procedure plots error bars over a previously drawn plot.

This routine is written in the IDL language. Its source code can be found in the file `errplot.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

ERRPLOT, [ *X*, ] *Low*, *High* [, WIDTH=*value*]

## Arguments

### X

A vector containing the abscissa values at which the error bars are to be plotted. *X* only needs to be provided if the abscissa values are not the same as the index numbers of the plotted points.

### Low

A vector of lower estimates, equal to data - error.

### High

A vector of upper estimates, equal to data + error.

## Keywords

### WIDTH

The width of the error bars. The default is 1% of plot width.

## Examples

To plot symmetrical error bars where Y is a vector of data values and ERR is a symmetrical error estimate, enter:

```
; Plot data:
PLOT, Y

; Overplot error bars:
ERRPLOT, Y-ERR, Y+ERR
```

If error estimates are non-symmetrical, provide actual error estimates in the *upper* and *lower* arguments.

```
; Plot data:
PLOT,Y

; Provide custom lower and upper bounds:
ERRPLOT, lower, upper
```

To plot Y versus a vector of abscissas:

```
; Plot data (X versus Y):
PLOT, X, Y

; Overplot error estimates:
ERRPLOT, X, Y-ERR, Y+ERR
```

## Version History

Introduced: Original

## See Also

OPLOTERR, PLOT, PLOTERR

# EXECUTE

The EXECUTE function compiles and executes one or more IDL statements contained in a string at run-time.

Like the CALL_PROCEDURE and CALL_FUNCTION routines, calls to EXECUTE can be nested. However, compiling the string at run-time is inefficient. CALL_FUNCTION and CALL_PROCEDURE provide much of the functionality of EXECUTE without imposing this limitation, and should be used instead of EXECUTE whenever possible.

## Syntax

*Result* = EXECUTE(*String* [, *QuietCompile*])

## Return Value

EXECUTE returns *true* (1) if the string was successfully compiled and executed. If an error occurs during either phase, the result is *false* (0).

## Arguments

### String

A string containing the command(s) to be compiled and executed.

### QuietCompile

If this argument is set to a non-zero value, EXECUTE will not print the compiler generated error messages (such as syntax errors). If QuietCompile is omitted or set to 0, EXECUTE will output such errors.

## Keywords

None.

## Examples

Create a string that holds a valid IDL command by entering:

```
com = 'PLOT, [0,1]'
```

Execute the contents of the string by entering:

```
R = EXECUTE(com)
```

A plot should appear. You can confirm that the string was successfully compiled and executed by checking that the value of R is 1.

## Version History

Introduced: Original

## See Also

CALL_FUNCTION, CALL_METHOD, CALL_PROCEDURE

# EXIT

The EXIT procedure quits IDL and exits back to the operating system. All buffers are flushed and open files are closed. The values of all variables that were not saved are lost.

## Syntax

EXIT [, /NO_CONFIRM] [, STATUS=*code*]

## Arguments

None.

## Keywords

### NO_CONFIRM

Set this keyword to suppress any confirmation dialog that would otherwise be displayed in a GUI version of IDL such as the IDL Development Environment.

### STATUS

Set this keyword equal to an exit status code that will be returned when IDL exits. For example, on a UNIX system using the Bourne shell:

Start IDL:

```
$ idl
```

Exit IDL specifying exit status 45:

```
IDL> exit, status=45
```

Display last exit status code:

```
$ echo $?
```

The following displays:

```
45
```

## Version History

Introduced: Original

## See Also

CLOSE, FLUSH, STOP, WAIT

# EXP

The EXP function returns the natural exponential function of *Expression*.

## Syntax

*Result* = EXP(*Expression*)

## Return Value

Returns the natural exponential function of the given *Expression*.

## Arguments

### Expression

The expression to be evaluated. If *Expression* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. The definition of the exponential function for complex arguments is:

$$\text{EXP}(x) = \text{COMPLEX}(e^R \cos I, e^R \sin I)$$

where:

*R* = real part of *x*, and *I* = imaginary part of *x*. If *Expression* is an array, the result has the same structure, with each element containing the result for the corresponding element of *Expression*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Plot a Gaussian with a 1/e width of 10 and a center of 50 by entering:

```
PLOT, EXP(-(FINDGEN(100)/10. - 5.0)^2)
```

## Version History

Introduced: Original

## See Also

ALOG

# EXPAND

The EXPAND procedure shrinks or expands a two-dimensional array, using bilinear interpolation. It is similar to the CONGRID and REBIN routines.

This routine is written in the IDL language. Its source code can be found in the file `expand.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

EXPAND, *A*, *Nx*, *Ny*, *Result* [, FILLVAL=*value*] [, MAXVAL=*value*]

## Arguments

### A

A two-dimensional array to be magnified.

### Nx

Desired size of the X dimension, in pixels.

### Ny

Desired size of the Y dimension, in pixels.

### Result

A named variable that will contain the magnified array.

## Keywords

### FILLVAL

Set this keyword equal to the value to use when elements larger than MAXVAL are encountered. The default is -1.

### MAXVAL

Set this keyword equal to the largest desired value. Elements greater than this value are set equal to the value of the FILLVAL keyword.

## Version History

Introduced: Pre 4.0

## See Also

CONGRID, REBIN

# EXPAND_PATH

The EXPAND_PATH function is used to expand a simple path-definition string into a full path listing for use with the !PATH, !DLM_PATH, and !HELP_PATH system variables.

- !PATH is a list of locations where IDL searches for currently undefined procedures and functions.
- !DLM_PATH is a list of locations where IDL searches for dynamically loadable modules.
- !HELP_PATH is a list of locations where IDL searches for online help files when the online help facility is used.

**Note**

The mechanism used by EXPAND_PATH to expand the path-definition string is the same as that is used to expand the contents of the environment variables IDL_PATH, IDL_DLM_PATH, and IDL_HELP_PATH at startup. See "The Path Definition String" below for more information.

## The Path Definition String

EXPAND_PATH accepts a single argument, a scalar string that contains a simple path-definition string. EXPAND_PATH expands the path-definition string into a list of directories that can be assigned to the !PATH, !DLM_PATH, or !HELP_PATH system variables.

**Note**

The syntax of the path definition string describe here can also be used when setting the IDL_PATH, IDL_DLM_PATH, and IDL_HELP_PATH environment variables. When IDL reads the environment variable at startup, it will treat the contents of the environment variable in the same way EXPAND_PATH treats the path definition string.

IDL supports the following special notations within the path definition string:

- **Using "+"** — When IDL encounters a "+" in front of a directory name, it searches the directory and all of its subdirectories for files of the appropriate type for the given path:

- IDL program files (`.pro` or `.sav`) if neither the DLM nor the HELP keywords to EXPAND_PATH are present, or in the IDL_PATH environment variable.
- Dynamically Loadable Module files (`.dlm`) if the DLM keyword to EXPAND_PATH is present, or in the IDL_DLM_PATH environment variable.
- Files that can be used by IDL's online help system, if the HELP keyword to EXPAND_PATH is present, or in the IDL_HELP_PATH environment variable. On UNIX platforms, help files are Adobe Portable Document Format (`.pdf`) files, HTML format (`.html` or `.htm`) files, or have the file extension `.help` . On Windows systems, help files can be either HTML Help (`.chm`), WinHelp (`.hlp`), PDF (`.pdf`), or HTML (`.html` or `.htm`) files.

Any directory containing one or more of the appropriate type of file is added to the path.

If the "+" is *not* present, the specified directory is added to the path regardless of its contents.

**Order of Expanded Directories**

When expanding a path segment starting with "+", IDL ensures that all directories containing the appropriate type files are placed in the path string. The order in which the directories in such an expanded path segment appear is completely unspecified, and does not necessarily correspond to any specific order (such as top-down alphabetized). This allows IDL to construct the path in the fastest possible way and speeds the process of loading paths from environment variables at startup. This is only a problem if two subdirectories in such a hierarchy contain a file with the same name.

If the order in which "+" expands directories is a problem for your application, you should add the directories to the path explicitly and not use "+". Only the order of the files within a given "+" entry are determined by IDL. It never reorders !PATH (or !DLM_PATH or !HELP_PATH) in any other way. You can therefore obtain any search order you desire by writing the path explicitly.

- **Using "<IDL_DEFAULT>"** — IDL replaces any an occurrence of the token `<IDL_DEFAULT>` in a path definition string with the default value IDL would have used if no environment variable or preference were set. The actual value of this placeholder depends on where IDL has been installed. Hence, to view IDL's default path:

```
PRINT, EXPAND_PATH('<IDL_DEFAULT>')
```

To append your own directory after IDL's default DLM path using the IDL_DLM_PATH environment variable (under UNIX):

```
% setenv IDL_DLM_PATH "<IDL_DEFAULT>:/your/path/here"
```

(Setting the Windows environment variable IDL_DLM_PATH to a similar string would produce the same result on a Windows system.) This substitution allows you to set up your paths without having to hard-code IDL's defaults into your startup scripts or environment variables.

Note that the actual path that the token `<IDL_DEFAULT>` expands to depends on the context in which it is used. The default path for `.pro` and `.sav` files is different from the default path for `.dlm` files or help files. To see this, enter the following statements into IDL:

```
PRINT, EXPAND_PATH('<IDL_DEFAULT>')
PRINT, EXPAND_PATH('<IDL_DEFAULT>', /DLM)
PRINT, EXPAND_PATH('<IDL_DEFAULT>', /HELP)
```

- **Using "<IDL_BIN_DIRNAME>"** — IDL replaces any an occurrence of the token `<IDL_BIN_DIRNAME>` in a path definition string with the name of the subdirectory within the installed IDL distribution where binaries for the current system are kept. This feature is useful for distributing packages of DLMs (Dynamically Loadable Modules) with support for multiple operating system and hardware combinations.
- **Using "<IDL_VERSION_DIRNAME>"** — IDL replaces any an occurrence of the token `<IDL_VERSION_DIRNAME>` in a path definition string with a unique name for the IDL version that is currently running. This feature can be combined with `<IDL_BIN_DIRNAME>` to easily distribute packages of DLMs with support for multiple IDL versions, operating systems, and hardware platforms.

**Note**

See "!DLM_PATH" on page 3904 for examples using the `<IDL_BIN_DIRNAME>` and `<IDL_VERSION_DIRNAME>` tokens.

# Syntax

*Result* = EXPAND_PATH( *String* [, /ALL_DIRS] [, /ARRAY] [, COUNT=*variable*] [, /DLM] [, /HELP] )

# Return Value

Returns a list of directories that can be assigned to the !PATH, !DLM_PATH, or !HELP_PATH system variables given a string path to be expanded.

# Arguments

## String

A scalar string containing the path-definition string to be expanded. See “The Path Definition String” for details.

# Keywords

## ALL_DIRS

Set this keyword to return all directories without concern for their contents, otherwise, EXPAND_PATH only returns those directories that contain `.pro` or `.sav` files.

## ARRAY

Set this keyword to return the result as a string array with each element containing one path segment. In this case, there is no need for a separator character and none is supplied. Normally, the result is a string array with the various path segments separated with the correct special delimiter character for the current operating system.

## COUNT

Set this keyword to a named variable which returns the number of path segments contained in the result.

## DLM

Set this keyword to return those directories that contain IDL Dynamically Loadable Module (`.dlm`) description files.

## HELP

Set this keyword to return directories that contain help files. On UNIX platforms, help files are in Adobe Portable Document Format (`.pdf`), HTML format (`.html` or `.htm`), or have the file extension `.help`. On Windows systems, help files can be

either HTML Help (`.chm`), WinHelp (`.hlp`), PDF (`.pdf`), or HTML (`.html` or `.htm`) files.

# Examples

## Example 1

Assume you have the following directory structure:

```
/home
   myfile.txt
   /programs
      /pro
         myfile.pro
```

Search the `/home` directory and all its subdirectories, and return the directories containing `.pro` and `.sav` files:

```
PRINT, EXPAND_PATH('+/home')
```

IDL prints:

```
/home/programs/pro
```

## Example 2

Search the same directory, but this time return all directories, not just those containing `.pro` and `.sav` files:

```
PRINT, EXPAND_PATH('+home', /ALL_DIRS)
```

IDL prints:

```
/home/programs/pro:/home/programs
```

## Example 3

Print the default value of the !DLM_PATH system variable:

```
PRINT, EXPAND_PATH('<IDL_DEFAULT>', /DLM)
```

# Version History

Introduced: Pre 4.0

Modified to use the `<IDL_*_PATH>` syntax: 5.6

## See Also

"Running IDL Program Files" in Chapter 9 of the *Using IDL* manual and "IDL Environment System Variables" on page 3902.

# EXPINT

The EXPINT function returns the value of the exponential integral $E_n(x)$.

EXPINT is based on the routine `expint` described in section 6.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = EXPINT( *N*, *X* [, /DOUBLE] [, EPS=*value*] [, ITER=*variable*] [, ITMAX=*value*] )

## Return Value

Returns the exponential integral $E_n(x)$.

## Arguments

### N

An integer specifying the order of $E_n(x)$. *N* can be either a scalar or an array.

### X

The value at which $E_n(x)$ is evaluated. *X* can be either a scalar or an array.

Note: If an array is specified for both *N* and *X*, then EXPINT evaluates $E_n(x)$ for each $N_i$ and $X_i$. If either *N* or *X* is a scalar and the other an array, the scalar is paired with each array element in turn.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic. Set this keyword to zero to return a single-precision result.

**Note**

All internal computations are done using double-precision arithmetic.

### EPS

Use this keyword to specify a number close to the desired relative error. The default value is $3.0 \times 10^{-12}$.

### ITER

Set this keyword equal to a named variable that will contain the actual number of iterations performed.

### ITMAX

An input integer specifying the maximum allowed number of iterations. The default value is 100000.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To compute the value of the exponential integral at the following X values:

```
; Define the parametric X values:
X = [1.00, 1.05, 1.27, 1.34, 1.38, 1.50]

; Compute the exponential integral of order 1:
result = EXPINT(1, X)

; Print the result:
PRINT, result
```

IDL prints:

```
  0.219384 0.201873 0.141911 0.127354 0.119803 0.100020
```

This is the exact solution vector to six-decimal accuracy.

## Version History

Introduced: 4.0

ITER keyword added: 5.6

## See Also

ERF

# EXTRAC

The EXTRAC function returns a defined portion of an array or vector. The main advantage to EXTRAC is that, when parts of the specified subsection lie outside the bounds of the array, zeros are returned for these outlying elements. It is usually more efficient to use the array subscript ranges (the ":" operator; see "Subscript Ranges" in Chapter 6 of the *Building IDL Applications* manual) to perform such operations.

EXTRAC was originally a built-in system procedure in the PDP-11 version of IDL, and was retained in that form in the original VAX/VMS IDL for compatibility. Most applications of the EXTRAC function are more concisely written using subscript ranges (e.g., X(10:15)). EXTRAC has been rewritten as a library function that provides the same interface as the previous versions.

**Note**

If you know that the subarray will never lie beyond the edges of the array, it is more efficient to use array subscript ranges (the ":" operator) to extract the data instead of EXTRAC.

This routine is written in the IDL language. Its source code can be found in the file `extrac.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = EXTRAC( *Array*, $C_1$, $C_2$, ..., $C_n$, $S_1$, $S_2$, ..., $S_n$ )

## Return Value

Returns any rectangular sub-matrix or portion of the parameter array.

## Arguments

### Array

The array from which the subarray will be copied.

### $C_i$

The starting subscript in *Array* for the subarray. There should be one $C_i$ for each dimension of *Array*. These arguments must be integers.

### $S_i$

The size of each dimension. The result will have dimensions of ($S_1$, $S_2$, ..., $S_n$). There should be one $S_i$ for each dimension of *Array*. These arguments must be non-negative.

## Keywords

None.

## Examples

Extracting elements from a vector:

```
; Create a 1000 element floating-point vector with each element set
; to the value of its subscript:
A = FINDGEN(1000)
; Extract 300 points starting at A[200] and extending to A[499]:
B = EXTRAC(A, 200, 300)
```

In the next example, the first 50 elements extracted — `B[0]` to `B[49]` — lie outside the bounds of the vector and are set to 0. The value of `B[50]` is the same as the value of `A[0]`, and the value of `B[51]` is equal to `A[1]`which is 1. Enter:

```
; Create a 1000 element vector:
A = FINDGEN(1000)
; Extract 50 elements, 49 of which lie outside the bounds of A:
B = EXTRAC(A, -50, 100)
```

The following commands illustrate the use of EXTRAC with multi-dimensional arrays:

```
; Make a 64 by 64 array:
A = INTARR(64,64)
; Extract a 32 by 32 portion starting at A(20,30):
B = EXTRAC(A, 20, 30, 32, 32)
```

As suggested in the discussion above, a better way to perform the same operation as the previous line is:

```
; Use the array subscript operator instead of EXTRAC:
B = A(20:51, 30:61)
```

Extract the 20th column and 32nd row of A:

```
; Extract 20th column of A:
B = EXTRAC(A, 19, 0, 1, 64)
; Extract 32nd row of A:
B = EXTRAC(A, 0, 31, 64, 1)
```

Take a 32 BY 32 matrix from A starting at A(40,50):

```
; Note that those points beyond the boundaries of A are set to 0:
B = EXTRAC(A, 40, 50, 32, 32)
```

## Version History

Introduced: Pre 4.0

## See Also

"Subscript Ranges" in Chapter 6 of the *Building IDL Applications* manual.

# EXTRACT_SLICE

The EXTRACT_SLICE function extracts a specified planar slice of volumetric data. This function allows for a rotation or vector form of the slice equation. In the vector form, the slice plane is governed by the plane equation (ax+by+cz+d = 0) and a single vector which defines the x direction. This form is more common throughout the IDL polygon interface. In the rotation form, the slicing plane can be oriented at any angle and can pass through any desired location in the volume.

This function allows for a vertex grid to be generated without sampling the data. In this form, the vertices could be used to sample additional datasets or used to form polygonal meshes. It would also be useful to return the planar mesh connectivity in this case.

Support for anisotropic data volumes is included via an ANISOTROPY keyword. This is an important feature in the proper interpolation of common medical imaging data.

This routine is written in the IDL language. Its source code can be found in the file `extract_slice.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = EXTRACT_SLICE( *Vol*, *Xsize*, *Ysize*, *Xcenter*, *Ycenter*, *Zcenter*, *Xrot*, *Yrot*, *Zrot* [, ANISOTROPY=*[xspacing, yspacing, zspacing]*] [, /CUBIC] [, OUT_VAL=*value*] [, /RADIANS] [, /SAMPLE] [, VERTICES=*variable*] )

or

*Result* = EXTRACT_SLICE( *Vol*, *Xsize*, *Ysize*, *Xcenter*, *Ycenter*, *Zcenter*, *PlaneNormal*, *Xvec* [, ANISOTROPY=*[xspacing, yspacing, zspacing]*] [, /CUBIC] [, OUT_VAL=*value*] [, /RADIANS] [, /SAMPLE] [, VERTICES=*variable*] )

## Return Value

Returns a two-dimensional planar slice extracted from 3-D volumetric data or returns a vertex grid in the form of a [3,n] array of vertices.

# Arguments

## PlaneNormal

Set this input argument to a 3 element array. The values are interpreted as the normal of the slice plane.

## Xvec

Set this input argument to a 3 element array. The three values are interpreted as the 0 dimension directional vector. This should be a unit vector.

## Vol

The volume of data to slice. This argument is a three-dimensional array of any type except string or structure. The planar slice returned by EXTRACT_SLICE has the same data type as *Vol*.

## Xsize

The desired X size (dimension 0) of the returned slice. To preserve the correct aspect ratio of the data, Xsize should equal Ysize. For optimal results, set Xsize and Ysize to be greater than or equal to the largest of the three dimensions of *Vol*.

## Ysize

The desired Ysize (dimension 1) of the returned slice. To preserve the correct aspect ratio of the data, Ysize should equal Xsize. For optimal results, set Xsize and Ysize to be greater than or equal to the largest of the three dimensions of *Vol*.

## Xcenter

The X coordinate (index) of the point within the volume that the slicing plane passes through. The center of the slicing plane passes through *Vol* at the coordinate (*Xcenter, YCenter, Zcenter*).

## Ycenter

The Y coordinate (index) of the point within the volume that the slicing plane passes through. The center of the slicing plane passes through *Vol* at the coordinate (*Xcenter, YCenter, Zcenter*).

### Zcenter

The Z coordinate (index) of the point within the volume that the slicing plane passes through. The center of the slicing plane passes through *Vol* at the coordinate (*Xcenter, YCenter, Zcenter*).

### Xrot

The X-axis rotation of the slicing plane, in degrees. Before transformation, the slicing plane is parallel to the X-Y plane. The slicing plane transformations are performed in the following order:

- Rotate Z_rot degrees about the Z axis.
- Rotate Y_rot degrees about the Y axis.
- Rotate X_rot degrees about the X axis.
- Translate the center of the plane to Xcenter, Ycenter, Zcenter.

### Yrot

The Y-axis rotation of the slicing plane, in degrees.

### Zrot

The orientation Z-axis rotation of the slicing plane, in degrees.

## Keywords

### ANISOTROPY

Set this keyword to a three-element array. This array specifies the spacing between the planes of the input volume in grid units of the (isotropic) output image.

### OUT_VAL

Set this keyword to a value that will be assigned to elements of the returned slice that lie outside of the original volume.

### RADIANS

Set this keyword to indicate that Xrot, Yrot, and Zrot are in radians. The default is degrees.

### SAMPLE

Set this keyword to perform nearest neighbor sampling when computing the returned slice. The default is to use bilinear interpolation. A small reduction in execution time results when SAMPLE is set and the OUT_VAL keyword is *not* used.

### VERTICES

Set this output keyword to a named variable in which to return a [3,Xsize,Ysize] floating point array. This is an array of the x, y, z sample locations for each pixel in the normal output.

## Obsolete Keywords

The following keywords are obsolete:

- CUBIC

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Examples

Display an oblique slice through volumetric data:

```
; Create some data:
vol = RANDOMU(s, 40, 40, 40)

; Smooth the data:
FOR i=0, 10 DO vol = SMOOTH(vol, 3)

; Scale the smoothed part into the range of bytes:
vol = BYTSCL(vol(3:37, 3:37, 3:37))

; Extract a slice:
slice = EXTRACT_SLICE(vol, 40, 40, 17, 17, 17, 30.0, 30.0, 0.0, $
   OUT_VAL=0B)

; Display the 2D slice as a magnified image:
TVSCL, REBIN(slice, 400, 400)
```

## Version History

Introduced: Pre 4.0

## See Also

SLICER3

# F_CVF

The F_CVF function computes the cutoff value *V* in an F distribution with degrees of freedom in the numerator and degrees of freedom in the denominator such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

This routine is written in the IDL language. Its source code can be found in the file `f_cvf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = F_CVF(*P*, *Dfn*, *Dfd*)

## Return Value

Returns the cutoff value *V*, given a distribution *F*, with specified degrees of freedom in the numerator and denominator.

## Arguments

### P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

### Dfn

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the F distribution numerator.

### Dfd

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the F distribution denominator.

## Keywords

None.

## Examples

Use the following command to compute the cutoff value in an F distribution with ten degrees of freedom in the numerator and six degrees of freedom in the denominator such that the probability that a random variable X is greater than the cutoff value is 0.01. The result should be 7.87413:

```
PRINT, F_CVF(0.01, 10, 6)
```

## Version History

Introduced: 4.0

## See Also

CHISQR_CVF, F_PDF, GAUSS_CVF, T_CVF

# F_PDF

The F_PDF function computes the probability *P* that, in an F distribution with defined degrees of freedom in the numerator and denominator, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

This routine is written in the IDL language. Its source code can be found in the file `f_pdf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = F_PDF(*V, Dfn*, *Dfd*)

## Return Value

If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of *V, Dfn*, and *Dfd*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other arguments are arrays, the function uses the scalar value with each element of the arrays, and returns an array with the same dimensions as the smallest input array.

If any of the arguments are double-precision, the result is double-precision, otherwise the result is single-precision.

## Arguments

### V

A scalar or array that specifies the cutoff value(s).

### Dfn

A positive scalar or array that specifies the number of degrees of freedom of the F distribution numerator.

### Dfd

A positive scalar or array that specifies the number of degrees of freedom of the F distribution denominator.

## Keywords

None.

## Examples

Use the following command to compute the probability that a random variable X, from the F distribution with five degrees of freedom in the numerator and 24 degrees of freedom in the denominator, is less than or equal to 3.90. The result should be 0.990059:

```
PRINT, F_PDF(3.90, 5, 24)
```

## Version History

Introduced: 4.0

## See Also

BINOMIAL, CHISQR_PDF, F_CVF, GAUSS_PDF, T_PDF

# FACTORIAL

The FACTORIAL function computes the factorial *N*! For integers, the factorial is computed as (*N*) · (*N* – 1) · (*N* – 2) · ... · 3 · 2 · 1. For non-integers the factorial is computed using GAMMA( *N*+1 ).

This routine is written in the IDL language. Its source code can be found in the file `factorial.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = FACTORIAL( *N* [, /STIRLING] [, /UL64] )

## Return Value

Returns the product of the non-negative scalar value or array of values.

## Arguments

### N

A non-negative scalar or array of values.

**Note**

Large values of *N* will cause floating-point overflow errors. The maximum size of *N* varies with machine architecture. On machines that support the IEEE standard for floating-point arithmetic, the maximum value of *N* is 170. See MACHAR for a discussion of machine-specific parameters affecting floating-point arithmetic.

## Keywords

### STIRLING

Set this keyword to use Stirling's asymptotic formula to approximate *N*!:

$$N! = \sqrt{2\pi N}\left[\frac{N}{e}\right]^{N}$$

where *e* is the base of the natural logarithm.

### UL64

Set this keyword to return the results as unsigned 64-bit integers. This keyword is ignored if STIRLING is set.

**Note**

Unsigned 64-bit integers will overflow for values of *N* greater than 20.

## Examples

Compute 20!:

```
PRINT, FACTORIAL(20)
```

IDL prints:

```
2.4329020e+18
```

## Version History

Introduced: Pre 4.0

## See Also

BINOMIAL, TOTAL

# FFT

The FFT function returns a result equal to the complex, discrete Fourier transform of *Array*. The result of this function is a single- or double-precision complex array.

The discrete Fourier transform, $F(u)$, of an $N$-element, one-dimensional function, $f(x)$, is defined as:

$$F(u) = \frac{1}{N} \sum_{x=0}^{N-1} f(x) \exp[-j2\pi ux/N]$$

And the inverse transform, (*Direction* > 0), is defined as:

$$f(x) = \sum_{u=0}^{N-1} F(u) \exp[j2\pi ux/N]$$

If the keyword OVERWRITE is set, the transform is performed in-place, and the result overwrites the original contents of the array.

## Running Time

For a one-dimensional FFT, running time is roughly proportional to the total number of points in *Array* times the sum of its prime factors. Let $N$ be the total number of elements in *Array*, and decompose $N$ into its prime factors:

$$N = 2^{K_2} \cdot 3^{K_3} \cdot 5^{K_5} \ldots$$

Running time is proportional to:

$$T_0 + N(T_1 + 2K_2T_2 + T_3(3K_3 + 5K_5 + \ldots))$$

where $T_3 \sim 4T_2$. For example, the running time of a 263 point FFT is approximately 10 times longer than that of a 264 point FFT, even though there are fewer points. The sum of the prime factors of 263 is 264 (1 + 263), while the sum of the prime factors of 264 is 20 (2 + 2 + 2 + 3 + 11).

# Syntax

*Result* = FFT( *Array* [, *Direction*] [, DIMENSION=*vector*] [, /DOUBLE] [, /INVERSE] [, /OVERWRITE] )

# Return Value

FFT returns a complex array that has the same dimensions as the input array. The output array is ordered in the same manner as almost all discrete Fourier transforms. Element 0 contains the zero frequency component, $F_0$. The array element $F_1$ contains the smallest, nonzero positive frequency, which is equal to $1/(N_i T_i)$, where $N_i$ is the number of elements and $T_i$ is the sampling interval of the $i^{th}$ dimension. $F_2$ corresponds to a frequency of $2/(N_i T_i)$. Negative frequencies are stored in the reverse order of positive frequencies, ranging from the highest to lowest negative frequencies.

**Note**

The FFT function can be performed on functions of up to eight (8) dimensions. If a function has *n* dimensions, IDL performs a transform in each dimension separately, starting with the first dimension and progressing sequentially to dimension *n*. For example, if the function has two dimensions, IDL first does the FFT row by row, and then column by column.

For an even number of points in the $i^{th}$ dimension, the frequencies corresponding to the returned complex values are:

$$0, 1/(N_iT_i), 2/(N_iT_i), ..., (N_i/2-1)/(N_iT_i), 1/(2/T_i), -(N_i/2-1)/(N_iT_i), ..., -1/(N_iT_i)$$

where $1/(2T_i)$ is the Nyquist critical frequency.

For an odd number of points in the $i^{th}$ dimension, the frequencies corresponding to the returned complex values are:

$$0, 1/(N_iT_i), 2/(N_iT_i), ..., (N_i/2-0.5)/(N_iT_i), -(N_i/2-0.5)/(N_iT_i), ..., -1/(N_iT_i)$$

# Arguments

## Array

The array to which the Fast Fourier Transform should be applied. If *Array* is not of complex type, it is converted to complex type. The dimensions of the result are identical to those of *Array*. The size of each dimension may be any integer value and

does not necessarily have to be an integer power of 2, although powers of 2 are certainly the most efficient.

### Direction

*Direction* is a scalar indicating the direction of the transform, which is negative by convention for the forward transform, and positive for the inverse transform. If *Direction* is not specified, the forward transform is performed.

A normalization factor of 1/*N*, where *N* is the number of points, is applied during the forward transform.

**Note**

When transforming from a real vector to complex and back, it is slightly faster to set *Direction* to 1 in the real to complex FFT.

Note also that the value of *Direction* is ignored if the INVERSE keyword is set.

## Keywords

### DIMENSION

Set this keyword to the dimension across which to calculate the FFT. If this keyword is not present or is zero, then the FFT is computed across all dimensions of the input array. If this keyword is present, then the FFT is only calculated only across a single dimension. For example, if the dimensions of *Array* are N1, N2, N3, and DIMENSION is 2, the FFT is calculated only across the second dimension.

### DOUBLE

Set this keyword to a value other than zero to force the computation to be done in double-precision arithmetic, and to give a result of double-precision complex type. If DOUBLE is set equal to zero, computation is done in single-precision arithmetic and the result is single-precision complex. If DOUBLE is not specified, the data type of the result will match the data type of *Array*.

### INVERSE

Set this keyword to perform an inverse transform. Setting this keyword is equivalent to setting the *Direction* argument to a positive value. Note, however, that setting INVERSE results in an inverse transform even if *Direction* is specified as negative.

### OVERWRITE

If this keyword is set, and the *Array* parameter is a variable of complex type, the transform is done “in-place”. The result overwrites the previous contents of the variable. For example, to perform a forward, in-place FFT on the variable a:

```
a = FFT(a, -1, /OVERWRITE)
```

### Thread Pool Keywords

This routine is written to make use of IDL’s *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

**Note**

Specifically, FFT will use the thread pool to overlap the inner loops of the computation when used on data with dimensions which have factors of 2, 3, 4, or 5. The prime-number DFT does not use the thread pool, as doing so would yield a relatively small benefit for the complexity it would introduce. Our experience shows that the improvement in performance from using the thread pool for FFT is highly dependent upon many factors (data length and dimensions, single *vs.* double precision, operating system, and hardware) and can vary between platforms.

## Examples

Display the log of the power spectrum of a 100-element index array by entering:

```
PLOT, /YLOG, ABS(FFT(FINDGEN(100), -1))
```

As a more complex example, display the power spectrum of a 100-element vector sampled at a rate of 0.1 seconds per point. Show the 0 frequency component at the center of the plot and label the abscissa with frequency:

```
; Define the number of points:
N = 100

; Define the interval:
T = 0.1

; Midpoint+1 is the most negative frequency subscript:
N21 = N/2 + 1
```

```
; The array of subscripts:
F = INDGEN(N)
; Insert negative frequencies in elements F(N/2 +1), ..., F(N-1):
F[N21] = N21 -N + FINDGEN(N21-2)
```

```
; Compute T0 frequency:
F = F/(N*T)

; Shift so that the most negative frequency is plotted first:
PLOT, /YLOG, SHIFT(F, -N21), SHIFT(ABS(FFT(F, -1)), -N21)
```

Compute the FFT of a two-dimensional image by entering:

```
; Create a cosine wave damped by an exponential.
n = 256
x = FINDGEN(n)
y = COS(x*!PI/6)*EXP(-((x - n/2)/30)^2/2)

; Construct a two-dimensional image of the wave.
z = REBIN(y, n, n)
; Add two different rotations to simulate a crystal structure.
z = ROT(z, 10) + ROT(z, -45)
WINDOW, XSIZE=540, YSIZE=540
LOADCT, 39
TVSCL, z, 10, 270

; Compute the two-dimensional FFT.
f = FFT(z)
logpower = ALOG10(ABS(f)^2)   ; log of Fourier power spectrum.
TVSCL, logpower, 270, 270

; Compute the FFT only along the first dimension.
f = FFT(z, DIMENSION=1)
logpower = ALOG10(ABS(f)^2)   ; log of Fourier power spectrum.
TVSCL, logpower, 10, 10

; Compute the FFT only along the second dimension.
f = FFT(z, DIMENSION=2)
logpower = ALOG10(ABS(f)^2)   ; log of Fourier power spectrum.
TVSCL, logpower, 270, 10
```

## Version History

Introduced: Original

## See Also

HILBERT

# FILE_BASENAME

The FILE_BASENAME function returns the *basename* of a *file path*. A file path is a string containing one or more segments consisting of names separated by directory delimiter characters (slash (/) under UNIX, or backslash (\) under Microsoft Windows). The basename is the final rightmost segment of the file path; it is usually a file, but can also be a directory name. See "Rules used by FILE_BASENAME" on page 606 for additional information.

**Note**

FILE_BASENAME operates on strings based strictly on their syntax. The *Path* argument need not refer to actual or existing files.

FILE_BASENAME is based on the standard UNIX `basename(1)` utility.

**Note**

To retrieve the leftmost portion of the file path (the *dirname*), use the FILE_DIRNAME function.

## Syntax

*Result* = FILE_BASENAME(*Path* [, *RemoveSuffix*] [, /FOLD_CASE])

## Return Value

A scalar string or string array containing the basename for each element of the *Path* argument.

## Arguments

### Path

A scalar string or string array containing paths for which the basename is desired.

**Note**

Under Microsoft Windows, the backslash (\) character is used to separate directories within a path. For compatibility with UNIX, and general convenience, the forward slash (/) character is also accepted as a directory separator in the *Path* argument.

### RemoveSuffix

An optional scalar string or 1-element string array specifying a filename suffix to be removed from the end of the basename, if present.

**Note**

If the entire basename string matches the suffix, the suffix is *not* removed.

## Keywords

### FOLD_CASE

By default, FILE_BASENAME follows the case sensitivity policy of the underlying operating system when attempting to match a string specified by the *RemoveSuffix* argument. By default, matches are case sensitive on UNIX platforms, and case insensitive on Microsoft Windows platforms. The FOLD_CASE keyword is used to change this behavior. Set it to a non-zero value to cause FILE_BASENAME to do all string matching case insensitively. Explicitly set FOLD_CASE equal to zero to cause all string matching to be case sensitive.

**Note**

The value of the FOLD_CASE keyword is ignored if the *RemoveSuffix* argument is not present.

## Rules used by FILE_BASENAME

FILE_BASENAME makes a copy of the input file path string, then modifies the copy according to the following rules:

- If *Path* is a NULL string, then FILE_BASENAME returns a NULL string.
- If *Path* consists entirely of directory delimiter characters, the result of FILE_BASENAME is a single directory delimiter character.
- If there are any trailing directory delimiter characters, they are removed.
- Under Microsoft Windows, remove any of the following, if present:
  - The drive letter and colon (for file paths of the form `c:\directory\file`).
  - The initial double-backslash and host name (for UNC file paths of the form `\\host\share\directory\file`).

- If any directory delimiter characters remain, all characters up to and including the last directory delimiter are removed.
- If the *RemoveSuffix* argument is present, is not identical to the characters remaining, and matches the *suffix* of the characters remaining, the suffix is removed. Otherwise, the *Result* is not modified by this step. The case sensitivity of the string comparison used in this step is controlled by the FOLD_CASE keyword.

## Examples

The following command prints the basename of an IDL `.pro` file, removing the `.pro` suffix:

```
PRINT, FILE_BASENAME('/usr/local/rsi/idl/lib/dist.pro', '.pro')
```

IDL prints:

```
dist
```

Similarly, the following command prints the basenames of all `.pro` files in the `lib` subdirectory of the IDL distribution that begin with the letter “I,” performing a case insensitive match for the suffix:

```
PRINT, FILE_BASENAME(FILE_SEARCH(FILEPATH('lib')+'/i*.pro'),
   '.pro', /FOLD_CASE)
```

## Version History

Introduced: 6.0

## See Also

FILE_DIRNAME, PATH_SEP, STREGEX, STRMID, STRPOS, STRSPLIT

# FILE_CHMOD

The FILE_CHMOD procedure allows you to change the current access permissions (sometimes known as modes on UNIX platforms) associated with a file or directory. File modes are specified using the standard Posix convention of three protection classes (user, group, other), each containing three attributes (read, write, execute). These permissions can be specified as an octal bitmask in which desired permissions have their associated bit set and unwanted ones have their bits cleared. This is the same format familiar to users of the UNIX `chmod(1)` command).

Keywords are available to specify permissions without the requirement to specify a bitmask, providing a simpler way to handle many situations. All of the keywords share a similar behavior: Setting them to a non-zero value adds the specified permission to the *Mode* argument. Setting the keyword to 0 removes that permission.

To find the current protection settings for a given file, you can use the GET_MODE keyword to the FILE_TEST function.

## Syntax

FILE_CHMOD, *File* [, *Mode*] [, /A_EXECUTE |, /A_READ |, /A_WRITE]
[, /G_EXECUTE | /G_READ | , /G_WRITE] [, /NOEXPAND_PATH]
[, /O_EXECUTE | /O_READ | , /O_WRITE]
[, /U_EXECUTE | /U_READ | , /U_WRITE]

**UNIX-Only Keywords:** [, /SETGID] [, /SETUID] [, /STICKY_BIT]

## Arguments

### File

A scalar or array of file or directory names for which protection modes will be changed.

### Mode

An optional bit mask specifying the absolute protection settings to be applied to the files. If *Mode* is not supplied, FILE_CHMOD looks up the current modes for the file and uses it instead. Any additional modes specified via keywords are applied relative to the value in *Mode*. Setting a keyword adds the necessary mode bits to *Mode*, and clearing it by explicitly setting a keyword to 0 removes those bits from *Mode*.

The values of the bits in these masks correspond to those used by the UNIX `chmod(2)` system call and `chmod(1)` user command, and are given in the following table. Since these bits are usually manipulated in groups of three, octal notation is commonly used when referring to them. When constructing a mode, the following platform specific considerations should be kept in mind:

- The setuid, setgid, and sticky bits are specific to the UNIX operating system, and have no meaning elsewhere. FILE_CHMOD ignores them on non-UNIX systems. The UNIX kernel may quietly refuse to set the sticky bit if you are not the root user. Consult the chmod(2) man page for details.
- The Microsoft Windows operating system does not have 3 permission classes like UNIX does. Therefore, setting for all three classes are combined into a single request.
- The Microsoft Windows operating system always allows read access to any files visible to a program. FILE_CHMOD therefore ignores any requests to remove read access.
- The Microsoft Windows operating system does not maintain an execute bit for files, but instead uses the file suffix to decide if a file is executable. FILE_CHMOD cannot change the execution status of a file in the Windows environment; such requests are quietly ignored.

| Bit | Octal Mask | Meaning |
|---|---|---|
| 12 | '4000'o | Setuid: Set user ID on execution. |
| 11 | '2000'o | Setgid: Set group ID on execution. |
| 10 | '1000'o | Turn on sticky bit. See the UNIX documentation on chmod(2) for details. |
| 9 | '0400'o | Allow read by owner. |
| 8 | '0200'o | Allow write by owner. |
| 7 | '0100'o | Allow execute by owner. |
| 6 | '0040'o | Allow read by group. |
| 5 | '0020'o | Allow write by group. |
| 4 | '0010'o | Allow execute by group. |
| 3 | '0004'o | Allow read by others. |

*Table 22: UNIX chmod(2) mode bits*

| Bit | Octal Mask | Meaning |
|---|---|---|
| 2 | '0002'o | Allow write by others. |
| 1 | '0001'o | Allow execute by others. |

*Table 22: UNIX chmod(2) mode bits (Continued)*

# Keywords

## A_EXECUTE

Execute access for all three (user, group, other) categories.

## A_READ

Read access for all three (user, group, other) categories.

## A_WRITE

Write access for all three (user, group, other) categories.

## G_EXECUTE

Execute access for the group category.

## G_READ

Read access for the group category.

## G_WRITE

Write access for the group category.

## NOEXPAND_PATH

Set this keyword to cause FILE_CHMOD to use the *File* argument exactly as specified, without applying the usual file path expansion.

## O_EXECUTE

Execute access for the other category.

## O_READ

Read access for the other category.

### O_WRITE

Write access for the other category.

### SETGID (UNIX Only)

The Set Group ID bit.

### SETUID (UNIX Only)

The Set User ID bit.

### STICKY_BIT (UNIX Only)

Sets the sticky bit.

### U_EXECUTE

Execute access for the user category.

### U_READ

Read access for the user category.

### U_WRITE

Write access for the user category.

## Examples

In the first example, we make the file `moose.dat` read only to everyone except the owner of the file, but not change any other settings:

```
FILE_CHMOD, 'moose.dat', /U_WRITE, G_WRITE=0, O_WRITE=0
```

In the next example, we make the file readable and writable to the owner and group, but read-only to anyone else, and remove any other modes:

```
FILE_CHMOD, 'moose.dat', '664'o
```

## Version History

Introduced: 5.4

# FILE_COPY

The FILE_COPY procedure copies files, or directories of files, to a new location. The copies retain the permission settings of the original files, and belong to the user that performed the copy. See “Rules Used By FILE_COPY” on page 614 for additional information.

FILE_COPY copies files based on their names. To copy data between open files, see the COPY_LUN procedure.

## Syntax

FILE_COPY, *SourcePath*, *DestPath* [, /ALLOW_SAME] [, /NOEXPAND_PATH] [, /OVERWRITE] [, /RECURSIVE] [, /REQUIRE_DIRECTORY] [, /VERBOSE]

**UNIX-Only Keywords:** [, /COPY_NAMED_PIPE] [, /COPY_SYMLINK] [, /FORCE]

## Arguments

### SourcePath

A scalar string or string array containing the names of the files or directories to be copied.

**Note**

If *SourcePath* contains a directory, the RECURSIVE keyword must be set.

### DestPath

A scalar string or string array containing the names of the destinations to which the files and directories specified by *SourcePath* are to be copied. If more than one file is to be copied to a given destination, that destination must exist and be a directory.

## Keywords

### ALLOW_SAME

Attempting to copy a file on top of itself by specifying the same file for *SourcePath* and *DestPath* is usually considered to be an error. If the ALLOW_SAME keyword is set, no copying is done and the operation is considered successful.

## COPY_NAMED_PIPE (UNIX Only)

When FILE_COPY encounters a UNIX *named pipe* (also called a *fifo*) in *SourcePath*, it usually opens it as a regular file and attempts to copy data from it to the destination file. If COPY_NAMED_PIPE is set, FILE_COPY will instead replicate the pipe, creating a new named pipe at the destination using the system `mkfifo()` function.

## COPY_SYMLINK (UNIX Only)

When FILE_COPY encounters a UNIX *symbolic link* in *SourcePath*, it attempts to copy the file or directory pointed to by the link. If COPY_SYMLINK is set, FILE_COPY will instead create a symbolic link at the destination with the same name as the source symbolic link, and pointing to the same path as the source.

## FORCE (UNIX Only)

Even if the OVERWRITE keyword is set, FILE_COPY does not overwrite files that have their file permissions set to prevent it. If the FORCE keyword is set, such files are quietly removed to make way for the overwrite operation to succeed.

**Note**

FORCE does not imply OVERWRITE; both must be specified to overwrite a protected file.

## NOEXPAND_PATH

Set this keyword to cause FILE_COPY to use *SourcePath* and *DestPath* exactly as specified, without expanding any wildcard characters or environment variable names included in the paths. See FILE_SEARCH for details on path expansion.

## OVERWRITE

Set this keyword to allow FILE_COPY to overwrite an existing file.

## RECURSIVE

Set this keyword to cause directories specified by *SourcePath* to be copied to *DestPath* recursively, preserving the hierarchy and names of the files from the source. If *SourcePath* includes one or more directories, the RECURSIVE keyword *must* be set.

**Note**

On a UNIX system, when performing a recursive copy on a directory hierarchy that includes files that are links to other files, the destination files will be copies, not

links. Setting the COPY_SYMLINK keyword will cause files that are *symbolic* links to be copied as symbolic links, but FILE_COPY does not include a similar facility for copying *hard* links. See the description of the FILE_LINK for more information on UNIX file links.

---

### REQUIRE_DIRECTORY

Set this keyword to cause FILE_COPY to require that *DestPath* exist and be a directory.

### VERBOSE

Set this keyword to cause FILE_COPY to issue an informative message for every file copy operation it carries out.

## Rules Used By FILE_COPY

The following rules govern how FILE_COPY operates:

- The arguments to FILE_COPY can be scalar or array. If both arguments are arrays, the arrays must contain the same number of elements; in this case, the files are copied pairwise, with each file from *SourcePath* being copied to the corresponding file in the *DestPath*. If *SourcePath* is an array and *DestPath* is a scalar, all files in *SourcePath* are copied to the single location given by *DestPath*, which must exist and be a directory.
- Elements of *SourcePath* may use wildcard characters (as accepted by the FILE_SEARCH function) to specify multiple files. All the files matched for a given element of *SourcePath* are copied to the location specified by the corresponding element of *DestPath*. If multiple files are copied to a single element of *DestPath*, that element must exist and be a directory.
- If a file specified in *DestPath* does not exist, the corresponding file from *SourcePath* is copied using the name specified by *DestPath*. Any parent directories to the file specified by *DestPath* must already exist.
- If *DestPath* names an existing regular file, FILE_COPY will not overwrite it, unless the OVERWRITE keyword is specified.
- If *DestPath* names an existing directory and *SourcePath* names a regular (non-directory) file, then FILE_COPY creates a file with the same name as the file given by *SourcePath* within the *DestPath* directory.
- If *DestPath* specifies an existing directory and *SourcePath* also names a directory, and the RECURSIVE keyword is set, FILE_COPY checks for the

existence of a subdirectory of *DestPath* with the same name as the source directory. If this subdirectory does not exist, it is created using the same permissions as the directory being copied. Then, all the files and directories underneath the source directory are copied to this subdirectory. FILE_COPY will refuse to overwrite existing files within the destination subdirectory unless the OVERWRITE keyword is in effect.

## Examples

Make a backup copy of a file named `myroutine.pro` in the current working directory:

```
FILE_COPY, 'myroutine.pro', 'myroutine.pro.backup'
```

Create a subdirectory named BACKUP in the current working directory and copy all `.pro` files, `makefile`, and `mydata.dat` into it:

```
FILE_MKDIR, 'BACKUP'
FILE_COPY, ['*.pro', 'makefile', 'mydata.dat'], 'BACKUP'
```

## Version History

Introduced: 5.6

## See Also

COPY_LUN, FILE_LINK, FILE_MOVE

# FILE_DELETE

The FILE_DELETE procedure deletes a file or empty directory, if the process has the necessary permissions to remove the file as defined by the current operating system. FILE_CHMOD can be used to change file protection settings.

**Note**

On UNIX, if a file to be deleted is a symbolic link, FILE_DELETE deletes the link itself, and not the file that the link points to.

### Operating System Syntax

The syntax used to specify directories for removal depends on the operating system in use, and is in general the same as you would use when issuing commands to the operating system command interpreter.

Microsoft Windows users must be careful to not specify a trailing backslash at the end of a specification. For example:

```
FILE_DELETE, 'c:\mydir\myfile'
```

and not:

```
FILE_DELETE, 'c:\mydir\myfile\'
```

## Syntax

FILE_DELETE, *File$_1$ [,... File$_n$]* [, /ALLOW_NONEXISTENT] [, /NOEXPAND_PATH] [, /QUIET] [, /RECURSIVE] [, /VERBOSE]

## Arguments

### File$_i$

A scalar or array of file or directory names to be deleted, one name per string element. Directories must be specified in the native syntax for the current operating system. See “Operating System Syntax” below for additional details.

# Keywords

## ALLOW_NONEXISTENT

If set, FILE_DELETE will quietly ignore attempts to delete a non-existent file. Other errors will still be reported. The QUIET keyword can be used instead to suppress all errors.

## NOEXPAND_PATH

Set this keyword to cause FILE_DELETE to use the *File* argument exactly as specified, without applying the usual file path expansion.

## QUIET

FILE_DELETE will normally issue an error if it is unable to remove a requested file or directory. If QUIET is set, no error is issued and FILE_DELETE simply moves on to the next requested item.

## RECURSIVE

By default, FILE_DELETE will refuse to delete directories that are not empty. If RECURSIVE is set, FILE_DELETE will instead quietly delete all files contained within that directory and any subdirectories below it, and then remove the directory itself.

**Warning**

Recursive delete is a very powerful and useful operation. However, it is a relatively dangerous command with the ability to rapidly destroy a great deal of data. Once deleted, files cannot be recovered unless you have a separate backup, so a mistaken recursive delete can be very damaging. Be very careful to specify correct arguments to FILE_DELETE when using the RECURSIVE keyword.

## VERBOSE

The VERBOSE keyword causes FILE_DELETE to issue an informative message for every file it deletes.

# Examples

In this example, we remove an empty directory named `moose`:

```
FILE_DELETE, 'moose'
```

## Version History

Introduced: 5.4

ALLOW_NONEXISTENT and VERBOSE keywords added: 5.6

# FILE_DIRNAME

The FILE_DIRNAME function returns the *dirname* of a *file path*. A file path is a string containing one or more segments consisting of names separated by directory delimiter characters (slash (/) under UNIX, or backslash (\) under Microsoft Windows). The dirname is all of the file path except for the final rightmost segment, which is usually a file name, but can also be a directory name. See "Rules use by FILE_DIRNAME" on page 620 for additional information.

**Note**

FILE_DIRNAME operates on strings based strictly on their syntax. The *Path* argument need not refer to actual or existing files.

FILE_DIRNAME is based on the standard Unix `dirname(1) utility`.

**Note**

To retrieve the rightmost portion of the file path (the *basename*), use the FILE_BASENAME function.

## Syntax

*Result* = FILE_DIRNAME(*Path* [, /MARK_DIRECTORY])

## Return Value

A scalar string or string array containing the dirname for each element of the *Path* argument.

**Note**

By default, the dirname does not include a final directory separator character; this behavior can be changed using the MARK_DIRECTORY keyword.

**Note**

On Windows platforms, the string returned by FILE_DIRNAME always uses the backslash (\) as the directory separator character, even if the slash (/) was used in the *Path* argument.

# Arguments

## Path

A scalar string or string array containing paths for which the dirname is desired.

**Note**

Under Microsoft Windows, the backslash (\) character is used to separate directories within a path. For compatibility with UNIX, and general convenience, the forward slash (/) character is also accepted as a directory separator in the *Path* argument. However, all *results* produced by FILE_DIRNAME on Windows platforms use the standard backslash for this purpose, regardless of the separator character used in the input *Path* argument.

# Keywords

## MARK_DIRECTORY

Set this keyword to include a directory separator character at the end of the returned directory name string. Including the directory character allows you to concatenate a file name to the end of the directory name string without having to supply the separator character manually. This is convenient for cross platform programming, as the separator characters differ between operating systems.

# Rules use by FILE_DIRNAME

FILE_DIRNAME makes a copy of the input path string, and then modifies the copy according to the following rules:

- If *Path* is a NULL string, then FILE_DIRNAME returns a single dot (.) character, representing the current working directory of the IDL process.
- Under Microsoft Windows, a file path can start with either of the following:
  - A drive letter and a colon (for file paths of the form `c:\directory\file`).
  - An initial double-backslash and a host name (for UNC file paths of the form `\\host\share\directory\file`).

  If either of these are present in *Path*, they are considered to be part of the dirname, and are copied to the result *without interpretation by the remaining steps below.*

- If *Path* consists entirely of directory delimiter characters, the result of FILE_DIRNAME is a single directory delimiter character (prefixed by a Windows drive letter and colon or a UNC prefix, if necessary).
- All characters to the right of the rightmost directory delimiter character are removed.
- All trailing directory delimiter characters are removed.
- If the MARK_DIRECTORY keyword is set, a single directory delimiter character is appended to the end.

## Examples

The following statements print the directory in which IDL locates the file `dist.pro` when it needs a definition for the DIST function. (DIST is part of the standard IDL user library, included with IDL):

```
temp = DIST(4) ; Ensure that DIST is compiled
PRINT, FILE_DIRNAME((ROUTINE_INFO('DIST', $
   /FUNCTION, /SCOURE)).path)
```

Depending on the platform and location where IDL is installed, IDL prints something like:

```
/usr/local/rsi/idl/lib
```

## Version History

Introduced: 6.0

## See Also

FILE_BASENAME, PATH_SEP, STREGEX, STRMID, STRPOS, STRSPLIT

# FILE_EXPAND_PATH

The FILE_EXPAND_PATH function expands a given file or partial directory name to its fully qualified name regardless of the current working directory.

**Note**

This routine should be used only to make sure that file paths are fully qualified, but not to expand wildcard characters (e.g. *). The behavior of FILE_EXPAND_PATH when it encounters a wildcard is platform dependent, and should not be depended on. These differences are due to the underlying operating system, and are beyond IDL's control. To expand wildcards and obtain fully qualified paths, combine the FINDFILE function with FILE_EXPAND_PATH:

```
A = FILE_EXPAND_PATH(FINDFILE('*.pro'))
```

Alternatively, use the FILE_SEARCH function with the FULLY_QUALIFY_PATH keyword:

```
A = FILE_SEARCH('*.pro', /FULLY_QUALIFY_PATH)
```

## Syntax

*Result* = FILE_EXPAND_PATH (*Path*)

## Return Value

FILE_EXPAND_PATH returns a fully qualified file path that completely specifies the location of *Path* without the need to consider the user's current working directory.

## Arguments

### Path

A scalar or array of file or directory names to be fully qualified.

## Keywords

None.

## Examples

In this example, we change directories to the IDL `lib` directory and expand the file path for the DIST function:

```
cd, FILEPATH('', SUBDIRECTORY=['lib'])
print, FILE_EXPAND_PATH('dist.pro')
```

This results in the following if run on a UNIX system:

```
/usr/local/rsi/idl_5.4/lib/dist.pro
```

## Version History

Introduced: 5.4

## See Also

FILE_SEARCH, FINDFILE

# FILE_INFO

The FILE_INFO function returns status information about a specified file.

## Syntax

*Result* = FILE_INFO(*Path* [, /NOEXPAND_PATH] )

## Return Value

The FILE_INFO function returns a structure expression of type FILE_INFO containing status information about the specified file or files. The result will contain one structure for each element in the *Path* argument.

### Fields of the FILE_INFO Structure

The FILE_INFO structure consists of the following fields:

| Field Name | Meaning |
|---|---|
| NAME | The name of the file. |
| EXISTS | True (1) if the file exists. False (0) if it does not exist. |
| READ | True (1) if the file is exists and is readable by the user. False (0) if it is not readable. |
| WRITE | True (1) if the file exists and is writable by the user. False (0) if it is not writable. |
| EXECUTE | True (1) if the file exists and is executable by the user. False (0) if it is not executable. The source of this information differs between operating systems:<br>**UNIX**: IDL checks the execute bit maintained by the operating system.<br>**Microsoft Windows**: The determination is made on the basis of the file name extension (e.g. .exe). |

*Table 23: Fields of the FILE_INFO Structure*

| Field Name | Meaning |
|---|---|
| REGULAR | True (1) if the file exists and is a regular disk file and not a directory, pipe, socket, or other special file type. False (0) if it is not a regular disk file (it maybe a directory, pipe, socket, or other special file type). |
| DIRECTORY | True (1) if the file exists and is a directory. False (0) if it is not a directory. |
| BLOCK_SPECIAL | True (1) if the file exists and is a UNIX block special device. On non-UNIX operating systems, this field will always be False (0). |
| CHARACTER_SPECIAL | True (1) if the file exists and is a UNIX character special device. On non-UNIX operating systems, this field will always be False (0). |
| NAMED_PIPE | True (1) if the file exists and is a UNIX named pipe (fifo) device. On non-UNIX operating systems, this field will always be False (0). |
| SETGID | True (1) if the file exists and has its Set-Group-ID bit set. On non-UNIX operating systems, this field will always be False (0). |
| SETUID | True (1) if the file exists and has its Set-User-ID bit set. On non-UNIX operating systems, this field will always be False (0). |
| SOCKET | True (1) if the file exists and is a UNIX domain socket. On non-UNIX operating systems, this field will always be False (0). |
| STICKY_BIT | True (1) if the file exists and has its sticky bit set. On non-UNIX operating systems, this field will always be False (0). |
| SYMLINK | True (1) if the file exists and is a UNIX symbolic link. On non-UNIX operating systems, this field will always be False (0). |

*Table 23: Fields of the FILE_INFO Structure (Continued)*

| Field Name | Meaning |
|---|---|
| DANGLING_SYMLINK | True (1) if the file exists and is a UNIX symbolic link that points at a non-existent file. On non-UNIX operating systems, this field will always be False (0). |
| ATIME, CTIME, MTIME | The date of last access, date of creation, and date of last modification given in seconds since 1 January 1970 UTC. Use the SYSTIME function to convert these dates into a textual representation.<br>Note that some file systems do not maintain all of these dates (e.g. MS DOS FAT file systems), and may return 0. On some non-UNIX operating systems, access time is not maintained, and ATIME and MTIME will always return the same date. |
| SIZE | The current length of the file in bytes. If *Path* is not to a regular file (possibly to a directory, pipe, socket, or other special file type), the value of SIZE will not contain any useful information. |

*Table 23: Fields of the FILE_INFO Structure (Continued)*

# Arguments

## Path

A string or string array containing the path or paths to the file or files about which information is required.

# Keywords

## NOEXPAND_PATH

If specified, FILE_INFO uses *Path* exactly as specified, without applying the usual file path expansion.

# Examples

To get information on the file `dist.pro` within the IDL User Library:

```
HELP,/STRUCTURE, FILE_INFO(FILEPATH('dist.pro', $
    SUBDIRECTORY = 'lib'))
```

Executing the above command will produce output similar to:

```
** Structure FILE_INFO, 21 tags, length=72:
NAME                STRING   '/usr/local/rsi/idl/lib/dist.pro'
EXISTS              BYTE         1
READ                BYTE         1
WRITE               BYTE         0
EXECUTE             BYTE         0
REGULAR             BYTE         1
DIRECTORY           BYTE         0
BLOCK_SPECIAL       BYTE         0
CHARACTER_SPECIAL   BYTE         0
NAMED_PIPE          BYTE         0
SETGID              BYTE         0
SETUID              BYTE         0
SOCKET              BYTE         0
STICKY_BIT          BYTE         0
SYMLINK             BYTE         0
DANGLING_SYMLINK    BYTE         0
MODE                LONG         420
ATIME               LONG64       970241431
CTIME               LONG64       970241595
MTIME               LONG64       969980845
SIZE                LONG64       1717
```

# Version History

Introduced: 5.5

# See Also

FILE_TEST, FSTAT

# FILE_LINES

The FILE_LINES function reports the number of lines of text contained within the specified file or files.

Text files containing data are very common. To read such a file usually requires knowing how many lines of text it contains. Under UNIX and Windows, there is no special text file type, and it is not possible to tell how many lines are contained in a file from basic file attributes. Rather, lines are encoded using a special character or characters at the end of each line:

- UNIX operating systems use an ASCII linefeed (LF) character at the end of each line.
- Older Macintosh systems (prior to the UNIX-based Mac OS X) use a carriage return (CR).
- Microsoft Windows uses a two character CR/LF sequence.

The only way to determine the number of lines of text contained within a file is to open it and count lines while reading and skipping over them until the end of the file is encountered. Since files are often copied from one type of system to another without going through the proper line termination conversion, portable software needs to be able to recognize any of these terminations, regardless of the system being used. FILE_LINES performs this operation in an efficient and portable manner, handling all three of the line termination conventions listed above.

This routine works by opening the file and reading the data contained within. It is therefore only suitable for regular disk files, and only when access to that file is fast enough to justify reading it more than once. For other types of files, other approaches are necessary, such as:

- Reading the file once, using an adaptive (expandable) data structure, counting the number of lines as they are input, and growing the data structure as necessary.
- Building a header into your file format that includes the necessary information, or somehow embedding the number of lines into the file data.
- Maintaining file information in a separate file associated with each file.
- Using a self describing data format that avoids these issues.

This routine assumes that the specified file or files contain only lines of text. It is unable to correctly count lines in files that contain binary data, or which do not use the standard line termination characters. Results are undefined for such files.

Note that FILE_LINES is equivalent to the following IDL code:

```
FUNCTION file_lines, filename
   OPENR, unit, filename, /GET_LUN
   str = ''
   count = 0ll
   WHILE ~ EOF(unit) DO BEGIN
      READF, unit, str
      count = count + 1
   ENDWHILE
   FREE_LUN, unit
   RETURN, count
END
```

The primary advantage of FILE_LINES over the IDL version shown here is efficiency. FILE_LINES is able to avoid the overhead of the WHILE loop as well as not having to create an IDL string for each line of the file.

# Syntax

*Result* = FILE_LINES(*Path* [ ,/COMPRESS] [, /NOEXPAND_PATH] )

# Return Value

Returns the number of lines of text contained within the specified file or files. If an array of file names is specified via the *Path* parameter, the return value is an array with the same number of elements as *Path*, with each element containing the number of lines in the corresponding file.

# Arguments

## Path

A scalar string or string array containing the names of the text files for which the number of lines is desired.

# Keywords

## COMPRESS

If this keyword is set, FILE_LINES assumes that the files specified in *Path* contain data compressed in the standard GZIP format, and decompresses the data in order to count the number of lines. See the description of the COMPRESS keyword to the OPEN procedure for additional information.

### NOEXPAND_PATH

If this keyword is set, FILE_LINES uses *Path* exactly as specified, without expanding any wildcard characters or environment variable names included in the path. See FILE_SEARCH for details on path expansion.

## Examples

Read the contents of the text file `mydata.dat` into a string array.

```
nlines = FILE_LINES('mydata.dat')
sarr = STRARR(nlines)
OPENR, unit, 'mydata.dat',/GET_LUN
READF, unit, sarr
FREE_LUN, unit
```

## Version History

Introduced: 5.6

COMPESS keyword: 6.0

## See Also

OPEN, READ/READF

# FILE_LINK

The FILE_LINK procedure creates UNIX file links, both regular (hard) and symbolic. FILE_LINK is available only under UNIX.

A hard link is a directory entry that references a file. UNIX allows multiple such links to exist simultaneously, meaning that a given file can be referenced by multiple names. All such links are fully equivalent references to the same file (there are no concepts of primary and secondary names). All files carry a reference count that contains the number of hard links that point to them; deleting a link to a file does not remove the actual file from the filesystem until the last hard link to the file is removed. The following limitations on hard links are enforced by the operating system:

- Hard links may not span filesystems, as hard linking is only possible within a single filesystem.
- Hard links may not be created between directories, as doing so has the potential to create infinite circular loops within the hierarchical UNIX filesystem. Such loops will confuse many system utilities, and can even cause filesystem damage.

A symbolic link is an indirect pointer to a file; its directory entry contains the name of the file to which it is linked. Symbolic links may span filesystems and may refer to directories.

Many users find symbolic links easier to understand and use. Due to their generality and lack of restriction, RSI recommends their use over hard links for most purposes. FILE_LINK creates symbolic links by default.

See “Rules Used by FILE_LINK” on page 632 for information on how FILE_LINK interprets its arguments.

## Syntax

FILE_LINK, *SourcePath*, *DestPath* [, /ALLOW_SAME] [, /HARDLINK] [, /NOEXPAND_PATH] [, /VERBOSE]

## Arguments

### SourcePath

A scalar string or string array containing the names of the files or directories to be linked.

### DestPath

A scalar string or string array containing the names of the destinations to which the files and directories given by *SourcePath* are to be linked. If more than one file is to be linked to a given destination, that destination must exist and be a directory.

## Keywords

### ALLOW_SAME

Attempting to link a file to itself by specifying the same file for *SourcePath* and *DestPath* is usually considered to be an error. If the ALLOW_SAME keyword is set, no link is created and the operation is considered to be successful.

### HARDLINK

Set this keyword to create hard links. By default, FILE_LINK creates symbolic links.

### NOEXPAND_PATH

Set this keyword to cause FILE_LINK to use *SourcePath* and *DestPath* exactly as specified, without expanding any wildcard characters or environment variable names included in the paths. See FILE_SEARCH for details on path expansion.

### VERBOSE

Set this keyword to cause FILE_LINK to issue an informative message for every file link operation it carries out.

## Rules Used by FILE_LINK

The following rules govern how FILE_LINK operates:

- The arguments to FILE_LINK can be scalar or array. If both arguments are arrays, they must contain the same number of elements, and the files are paired, with each file from *SourcePath* being linked to the corresponding file in the *DestPath*. If *SourcePath* is an array and *DestPath* is a scalar, all links are created in the single location given by *DestPath*, which must exist and be a directory.
- Elements of *SourcePath* may use wildcard characters (as accepted by the FILE_SEARCH function) to specify multiple files. All the files matched for a given element of *SourcePath* are linked to the corresponding element of

*DestPath*. If multiple files are linked to a single element of *DestPath*, that element must exist and be a directory.

- If a file specified in *DestPath* does not exist, the corresponding file from *SourcePath* is linked using the name specified by *DestPath*. Any parent directories to the filename specified by *DestPath* must already exist.
- If *DestPath* names an existing regular file, FILE_LINK will not overwrite it.
- If *DestPath* names an existing directory, a link with the same name as the source file is created in the directory. This is primarily of interest with hard links.

## Examples

Create a symbolic link named `current.dat` in the current working directory, pointing to the file `/master/data/saturn7.dat`:

```
FILE_LINK, '/master/data/saturn7.dat', 'current.dat'
```

## Version History

Introduced: 5.6

## See Also

COPY_LUN, FILE_COPY, FILE_MOVE, FILE_READLINK

# FILE_MKDIR

The FILE_MKDIR procedure creates a new directory, or directories, with the default access permissions for the current process.

**Note**

Use the FILE_CHMOD procedure to alter access permissions.

If a specified directory has non-existent parent directories, FILE_MKDIR automatically creates all the intermediate directories as well.

## Syntax

FILE_MKDIR, *File1* [,... *FileN*] [, /NOEXPAND_PATH]

## Arguments

### FileN

A scalar or array of directory names to be created, one name per string element. Directories must be specified in the native syntax for the current operating system.

## Keywords

### NOEXPAND_PATH

Set this keyword to cause FILE_MKDIR to use the *File* argument exactly as specified, without applying the usual file path expansion.

## Examples

To create a subdirectory named `moose` in the current working directory:

```
FILE_MKDIR, 'moose'
```

## Version History

Introduced: 5.4

# FILE_MOVE

The FILE_MOVE procedure renames files and directories, effectively moving them to a new location. The moved files retain their permission and ownership attributes. Within a given filesystem or volume, FILE_MOVE does not copy file data. Rather, it simply changes the file names by updating the directory structure of the filesystem. This operation is fast and safe, but is only possible within a single filesystem. Attempts to move a regular file from one filesystem to another are carried out by copying the file using FILE_COPY, and then deleting the original file. It is an error to attempt to use FILE_MOVE to move a directory from one filesystem to another.

See "Rules Used by FILE_MOVE" on page 636 for information on how FILE_MOVE interprets its arguments.

## Syntax

FILE_MOVE, *SourcePath*, *DestPath* [, /ALLOW_SAME] [, /NOEXPAND_PATH] [, /OVERWRITE] [, /REQUIRE_DIRECTORY] [, /VERBOSE]

## Arguments

### SourcePath

A scalar string or string array containing the names of the files or directories to be moved.

### DestPath

A scalar string or string array containing the names of the destinations to which the files and directories specified by *SourcePath* are to be moved. If more than one file is to be moved to a given destination, that destination must exist and be a directory.

## Keywords

### ALLOW_SAME

Attempting to move a file on top of itself by specifying the same file for *SourcePath* and *DestPath* is usually considered to be an error. If the ALLOW_SAME keyword is set, no renaming is done and the operation is considered to be successful.

### NOEXPAND_PATH

Set this keyword to cause FILE_MOVE to use *SourcePath* and *DestPath* exactly as specified, without expanding any wildcard characters or environment variable names included in the paths. See FILE_SEARCH for details on path expansion.

### OVERWRITE

Set this keyword to allow FILE_MOVE to overwrite an existing file.

### REQUIRE_DIRECTORY

Set this keyword to cause FILE_MOVE to require that *DestPath* exist and be a directory.

### VERBOSE

Set this keyword to cause FILE_MOVE to issue an informative message for every file move operation it carries out.

## Rules Used by FILE_MOVE

The following rules govern how FILE_MOVE operates:

- The arguments to FILE_MOVE can be scalar or array. If both arguments are arrays, they must contain the same number of elements, and the files are moved in pairs, with each file from *SourcePath* being renamed to the corresponding file in the *DestPath*. If *SourcePath* is an array and *DestPath* is a scalar, all files in *SourcePath* are renamed to the single location given by *DestPath*, which must exist and be a directory.
- Elements of *SourcePath* may use wildcard characters (as accepted by the FILE_SEARCH function) to specify multiple files. All the files matched for that element of *SourcePath* are renamed to the location specified by the corresponding element of *DestPath*. If multiple files are renamed to a single element of *DestPath*, that element must exist and be a directory.
- If a file specified in *DestPath* does not exist, the corresponding file from *SourcePath* is moved using the name specified by *DestPath*. Any parent directories to the filename specified by *DestPath* must already exist.
- If *DestPath* names an existing regular file, FILE_MOVE will not overwrite it, unless the OVERWRITE keyword is specified.
- If *DestPath* names an existing directory and *SourcePath* names a regular (non-directory) file, the source file is moved into the specified directory.

- If *DestPath* specifies an existing directory and *SourcePath* also names a directory, FILE_MOVE checks for the existence of a subdirectory of *DestPath* with the same name as the source directory. If this subdirectory does not exist, the source directory is moved to the specified location. If the subdirectory does exist, an error is issued, and the rename operation is not carried out.

## Examples

Rename the file `backup.dat` to `primary.dat` in the current working directory:

```
FILE_MOVE, 'backup.dat', 'primary.dat'
```

Create a subdirectory named `BACKUP` in the current working directory and move all `.pro` files, `makefile`, and `mydata.dat` into it:

```
FILE_MKDIR, 'BACKUP'
FILE_MOVE, ['*.pro', 'makefile', 'mydata.dat'], 'BACKUP'
```

## Version History

Introduced: 5.6

## See Also

COPY_LUN, FILE_COPY, FILE_LINK

# FILE_READLINK

The FILE_READLINK function returns the path pointed to by UNIX symbolic links.

## Syntax

*Result* = FILE_READLINK(*Path* [, /ALLOW_NONEXISTENT] [, /ALLOW_NONSYMLINK] [, /NOEXPAND_PATH] )

## Return Value

Returns the path associated with a symbolic link.

## Arguments

### Path

A scalar string or string array containing the names of the symbolic links to be translated.

## Keywords

### ALLOW_NONEXISTENT

Set this keyword to return a NULL string rather than throwing an error if *Path* contains a non-existent file.

### ALLOW_NONSYMLINK

Set this keyword to return a NULL string rather than throwing an error if *Path* contains a path to a file that is not a symbolic link.

### NOEXPAND_PATH

Set this keyword to cause FILE_READLINK to use *Path* exactly as specified, without expanding any wildcard characters or environment variable names included in the path. See FILE_SEARCH for details on path expansion.

## Examples

Under Mac OS X, the `/etc` directory is actually a symbolic link. The following statement reads it and returns the location to which the link points:

```
path = FILE_READLINK('/etc')
```

It is possible to have chains of symbolic links, each pointing to another. The following function uses FILE_READLINK to iteratively translate such links until it finds the actual file:

```
FUNCTION RESOLVE_SYMLINK, path

  savepath = path      ; Remember last successful translation
  WHILE (path NE '') DO BEGIN
    path = FILE_READLINK(path, /ALLOW_NONEXISTENT, $
      /ALLOW_NONSYMLINK)
    IF (path NE '') THEN BEGIN
      ; If returned path is not absolute, use it to replace the
      ; last path segment of the previous path.
      IF (STRMID(path, 0, 1) NE '/') THEN BEGIN
        last = STRPOS(savepath, '/', /REVERSE_SEARCH)
        IF (last NE -1) THEN path = STRMID(savepath, 0, last) $
          + '/' + path
      ENDIF
      savepath = path
    ENDIF
  ENDWHILE

  ; FILE_EXPAND_PATH removes redundant things like /./ from
  ; the result.
  RETURN, FILE_EXPAND_PATH(savepath)

END
```

## Version History

Introduced: 5.6

## See Also

FILE_LINK

# FILE_SAME

It is common for a given file to be accessible via more than one name. For example, a relative path and a fully-qualified path to the same file are considered different names, since the strings that make up the paths are not lexically identical. In addition, under UNIX, the widespread use of links (hard and symbolic) makes multiple names for the same file very common.

The FILE_SAME function is used to determine if two different file names refer to the same underlying file.

The mechanism used to determine whether two names refer to the same file depends on the operating system in use:

**UNIX**: Under UNIX, all files are uniquely identified by two integer values: the filesystem that contains the file and the *inode number*, which identifies the file within the filesystem. If the input arguments are lexically identical, FILE_SAME will return True, regardless of whether the file specified actually exists. Otherwise, FILE_SAME compares the device and inode numbers of the two files, and returns True if they are identical, or False otherwise.

**Windows**: Unlike UNIX, Microsoft Windows identifies files solely by their names. FILE_SAME therefore expands the two supplied paths to their fully qualified forms, and then performs a simple case insensitive string comparison to determine if the paths are identical. This is reliable for local disk files, but can produce incorrect results under some circumstances:

- UNC network paths can expand to different, but equivalent, paths. For example, a network server may be referred to by either a name or an IP address.
- Network attached storage can have mechanisms for giving multiple names to the same file, but to the Windows client system the names will appear to refer to different files. For example, a UNIX server using Samba software to serve files to machines on a Windows network can use symbolic links to produce two names for the same file, but these will appear as two distinct files to a Windows machine.

For these reasons, FILE_SAME is primarily of interest on UNIX systems. Under Windows, RSI recommends its use only on local files.

## Syntax

Result = FILE_SAME(*Path1*, *Path2* [, /NOEXPAND_PATH] )

# Return Value

FILE_SAME returns True (1) if two filenames refer to the same underlying file, or False (0) otherwise. If either or both of the input arguments are arrays of file names, the result is an array, following the same rules as standard IDL operators.

# Arguments

## Path1, Path2

Scalar or array string values containing the two file paths to be compared.

# Keywords

## NOEXPAND_PATH

Set this keyword to cause FILE_SAME to use the *Path* arguments exactly as specified, without expanding any wildcard characters or environment variable names included in the paths. See FILE_SEARCH for details on path expansion. The utility of doing this depends on the operating system in use:

**UNIX**: Under UNIX, path expansion is not necessary unless the *Path* arguments use shell meta characters or environment variables.

**Windows**: By default, FILE_SAME expands the supplied paths to their fully qualified forms in order to be able to compare them. Preventing this path expansion cripples its ability to make a useful comparison, and is not recommended.

# Examples

UNIX command shells often provide the `HOME` environment variable to point at the user's home directory. Many shells also expand the `'~'` character to point at the home directory. The following IDL statement determines if these two mechanisms refer to the same directory:

```
PRINT, FILE_SAME('~', '$HOME')
```

On a UNIX system, the following statement determines if the current working directory is the same as your home directory:

```
PRINT, FILE_SAME('.', '$HOME')
```

On some BSD-derived UNIX systems, the three commands `/bin/cp`, `/bin/ln`, and `/bin/mv` are actually three hard links to the same binary file. The following statement will print the number 1 if this is true on your system:

```
PRINT, TOTAL(FILE_SAME('/bin/cp', ['/bin/ln', '/bin/mv'])) EQ 2
```

Under Mac OS X, the `/etc` directory is actually a symbolic link to `/private/etc`. As a result, the following lines of code provide a simple test to determine whether Mac OS X is the current platform:

```
IF FILE_SAME('/etc', '/private/etc') THEN $
   PRINT, 'Running Mac OS X' ELSE $
   PRINT, 'Not Running Mac OS X'
```

**Note**

The above lines are shown simply as an example; checking the value of !VERSION.OS_FAMILY is a more reliable method of determining which operating system is in use.

## Version History

Introduced: 5.6

## See Also

FILE_EXPAND_PATH, FILE_INFO, FILE_SEARCH, FILE_TEST

# FILE_SEARCH

The FILE_SEARCH function returns a string array containing the names of all files matching the input path specification. Input path specifications may contain wildcard characters, enabling them to match multiple files. A *relative path* is a file path that can only be unambiguously interpreted by basing it relative to some other known location. Usually, this location is the current working directory for the process. A *fully qualified path* is a complete and unambiguous path that can be interpreted directly. For example, `bin/idl` is a relative path, while `/usr/local/rsi/idl/bin/idl` is a fully qualified path. By default, FILE_SEARCH follows the format of the input to decide whether to return relative or fully-qualified paths.

The wildcards understood by FILE_SEARCH are based on those used by standard UNIX tools. They are described in "Supported Wildcards and Expansions" on page 643.

**Note**

RSI strongly recommends the use of the FILE_SEARCH function in place of the FINDFILE function. FILE_SEARCH is more platform-independent, provides greater functionality, and is easier to use than FINDFILE. FILE_SEARCH is ultimately intended as a replacement for FINDFILE.

## Supported Wildcards and Expansions

The wildcards understood by FILE_SEARCH are based on those used by the standard UNIX shell `/bin/sh` (the `?`, `*`, `[`, and `]`, characters, and environment variables) with some enhancements commonly found in the C-shell `/bin/csh` (the `~`, `{`, and `}` characters). These wildcards are processed identically across all IDL supported platforms. The supported wildcards are shown in the following table:

| Wildcard | Description |
|---|---|
| * | Matches any string, including the null string. |
| ? | Matches any single character. |

*Table 24: Supported Wildcards and Espansions*

| Wildcard | Description |
|---|---|
| [...] | Matches any one of the enclosed characters. A pair of characters separated by "-" matches any character lexically between the pair, inclusive. If the first character following the opening bracket ( [ ) is a ! or ^, any character not enclosed is matched. |
| {*str, str, ...*} | Expand to each string (or filename-matching pattern) in the comma-separated list. |
| ~<br>~*user* | If used at start of input file specification, is replaced with the path to the appropriate home directory. See the description of the EXPAND_TILDE keyword for details. |
| $*var* | Replace with value of the named environment variable. See the description of the EXPAND_ENVIRONMENT keyword for full details. |
| ${*var*} | Replace ${*var*} with the value of the *var* environment variable. If *var* is not found in the environment, ${*var*} is replaced with a null string. This format is useful when the environment variable reference sits directly next to unrelated text, as the use of the {} brackets make it possible for IDL to determine where the environment variable ends and the remaining text starts (e.g. ${mydir} other text). |
| ${*var*:-*alttext*} | If environment variable *var* is present in the environment and has a non-NULL value, then substitute that value. If *var* is not present, or has a NULL value, then substitute the alternative text (*alttext*) provided instead. |
| ${var-alttext} | If environment variable *var* is present in the environment (even if it has a NULL value) then substitute that value. If *var* is not present, then substitute the alternative text (*alttext*) provided instead. |

*Table 24: Supported Wildcards and Espansions (Continued)*

These wildcards can appear anywhere in an input file specification, with the following exceptions:

### Tilde (~)

The tilde character is only considered to be a wildcard if it is the first character in the input file specification and the EXPAND_TILDE keyword is set. Otherwise, it is treated as a regular character.

### Microsoft Windows UNC Paths

On a local area network, Microsoft Windows offers an alternative to the drive letter syntax for accessing files. The *Universal Naming Convention* (UNC) allows for specification of paths on other hosts using the syntax:

```
\\hostname\sharename\dir\dir\...\file
```

UNC paths are distinguished from normal paths by the use of two initial slashes in the path. FILE_SEARCH can process such paths, but wildcard characters are not allowed in the `hostname` or `sharename` segments. Wildcards are allowed for specifying directories and files. For performance reasons, RSI does not recommend using the recursive form of FILE_SEARCH with UNC paths on very large directory trees.

## Filename Matching Issues

When using FILE_SEARCH, you should be aware of the following issues:

### Initial Dot Character

The default is for wildcards not to match the dot (`.`) character if it occurs as the first character of a directory or file name. This follows the convention of UNIX shells, which treat such names as hidden files. In order to match such files, you can take any of the following actions:

- Explicitly include the dot character at the start of your pattern (e.g. ".*").
- Specify the MATCH_INITIAL_DOT keyword, which changes the dot matching policy so that wildcards will match any names starting with dot (except for the special "." and ".." directories).
- Specify the MATCH_ALL_INITIAL_DOT keyword, which changes the dot matching policy so that wildcards will match any names starting with dot (including the special "." and ".." directories).

### File Path Syntax

The syntax allowed for file paths differs between operating systems. FILE_SEARCH always processes file paths using the syntax rules for the platform on which the IDL session is running. As a convenience for Microsoft Windows users, Windows IDL

accepts UNIX style forward slashes as well as the usual backslashes as path separators.

### Differing Defaults Between Platforms

The different operating systems supported by IDL have some conventions for processing file paths that are inherently incompatible. If FILE_SEARCH attempted to force an identical default policy for these features across all platforms, the resulting routine would be inconvenient to use on all platforms. FILE_SEARCH resolves this inherent tension between convenience and control in the following way:

- These features are controlled by keywords which are listed in the table below. If a keyword is not explicitly specified, FILE_SEARCH will determine an appropriate default for that feature based on the conventions of the underlying operating system. Hence, FILE_SEARCH will by default behave in a way that is reasonable on the platform it is used on.
- If one of these keywords is explicitly specified, FILE_SEARCH will use its value to determine support for that feature. Hence, if the keyword is used, FILE_SEARCH will behave identically on all platforms. If maximum cross-platform control is desired, you can achieve it by specifying all the relevant keywords.

The keywords that have different defaults on different platforms are listed in the following table:

| Wildcard | Keyword | Default UNIX | Default Win |
|---|---|---|---|
| $*var*<br>${*var*}<br>${*var*:-*alttext*}<br>${*var*-*alttext*} | EXPAND_ENVIRONMENT | yes | no |
| ~ | EXPAND_TILDE | yes | no |
| | FOLD_CASE | no | yes |

*Table 25: Defaults Between Platforms*

# Syntax

*Result* = FILE_SEARCH(*Path_Specification*)

or for recursive searching,

*Result* = FILE_SEARCH(*Dir_Specification*, *Recur_Pattern*)

**Keywords:** [, COUNT=*variable* ] [, /EXPAND_ENVIRONMENT ]
[, /EXPAND_TILDE ] [, /FOLD_CASE ] [, /FULLY_QUALIFY_PATH ]
[, /ISSUE_ACCESS_ERROR ] [, /MARK_DIRECTORY ]
[, /MATCH_INITIAL_DOT | /MATCH_ALL_INITIAL_DOT ] [, /NOSORT ]
[, /QUOTE ] [, /TEST_DIRECTORY ] [, /TEST_EXECUTABLE ]
[, /TEST_READ ] [, /TEST_REGULAR ] [, /TEST_WRITE ]
[, /TEST_ZERO_LENGTH ]

**UNIX-Only Keywords:** [, /TEST_BLOCK_SPECIAL ]
[, /TEST_CHARACTER_SPECIAL ] [, /TEST_DANGLING_SYMLINK ]
[, /TEST_GROUP ] [, /TEST_NAMED_PIPE ] [, /TEST_SETGID ]
[, /TEST_SETUID ] [, /TEST_SOCKET ] [, /TEST_STICKY_BIT ]
[, /TEST_SYMLINK ] [, /TEST_USER ]

# Return Value

Returns all matched filenames in a string array, one file name per array element. If no files exist with names matching the input arguments, a null scalar string is returned instead of a string array.

If the input path is relative, the results will be relative. If the input is fully qualified, the results will also be fully qualified. If you specify the FULLY_QUALIFY_PATH keyword, the results will be fully qualified no matter which form of input is used. FILE_SEARCH returns results based on standard and recursive searches:

- **Standard:** When called with a single *Path_Specification* argument, FILE_SEARCH returns all files that match that specification. This is the same operation, sometimes referred to as *file globbing*, performed by most operating system command interpreters when wildcard characters are used in file specifications.
- **Recursive:** When called with two arguments, FILE_SEARCH performs recursive searching of directory hierarchies. In a recursive search, FILE_SEARCH looks recursively for any and all subdirectories in the file hierarchy rooted at the *Dir_Specification* argument. Within each of these subdirectories, it returns the names of all files that match the pattern in the

*Recur_Pattern* argument. This operation is similar to that performed by the UNIX `find(1)` command.

**Note**

To avoid going into an infinite loop, the FILE_SEARCH routine does not follow symbolic links.

# Arguments

Any of the arguments described in this section can contain wildcard characters, as described in "Supported Wildcards and Expansions" on page 643.

## Path_Specification

A scalar or array variable of string type, containing file paths to match. If *Path_Specification* is not supplied, or if it is supplied as a null string, FILE_SEARCH uses a default pattern of `'*'`, which matches all files in the current directory.

## Dir_Specification

A scalar or array variable of string type, containing directory paths within which FILE_SEARCH will perform recursive searching for files matching the *Recur_Pattern* argument. FILE_SEARCH examines *Dir_Specification*, and any directory found below it, and returns the paths of any files in those directories that match *Recur_Pattern*. If *Dir_Specification* is supplied as a null string, FILE_SEARCH searches the current directory.

## Recur_Pattern

A scalar string containing a pattern for files to match in any of the directories specified by the *Dir_Specification* argument. If *Recur_Pattern* is supplied as a null string, FILE_SEARCH uses a default pattern of `'*'`, which matches all files in the specified directories.

# Keywords

## COUNT

A named variable into which the number of files found is placed. If no files are found, a value of 0 (zero) is returned.

## EXPAND_ENVIRONMENT

By default, FILE_SEARCH follows the conventions of the underlying operating system to determine whether it should expand environment variable references in input file specification patterns. The default is to do such expansions under UNIX, and not to do them under Microsoft Windows. The EXPAND_ENVIRONMENT keyword is used to change this behavior. Set it to a non-zero value to cause FILE_SEARCH to perform environment variable expansion on all platforms. Set it to zero to disable such expansion.

The syntax for expanding environment variables in an input file pattern is based on that supported by the standard UNIX shell (`/bin/sh`), as described in "Supported Wildcards and Expansions" on page 643.

## EXPAND_TILDE

Users of the UNIX C-shell (`/bin/csh`), and other tools influenced by it, are familiar with the use of a tilde (~) character at the beginning of a path to denote a home directory. A tilde by itself at the beginning of the path (e.g. `~/directory/file`) is equivalent to the home directory of the user executing the command, while a tilde followed by the name of a user (e.g. `~user/directory/file`) is expanded to the home directory of the named user.

By default, FILE_SEARCH follows the conventions of the underlying operating system in deciding whether to expand a leading tilde or to treat it as a literal character. Hence, the default is to expand the leading tilde under UNIX, and not under Microsoft Windows. The EXPAND_TILDE keyword is used to change this behavior.

Set EXPAND_TILDE to 0 (zero) to disable tilde expansion on all platforms. Set it to a non-zero value to enable tilde expansion.

**Note**

Under Microsoft Windows, only the plain form of tilde is recognized. Attempts to use the ~user form will cause IDL to issue an error. IDL uses the HOME and HOMEPATH environment variables to obtain a home directory for the current Windows user.

## FOLD_CASE

By default, FILE_SEARCH follows the case sensitivity policy of the underlying operating system. By default, matches are case sensitive on UNIX platforms, and case insensitive on Microsoft Windows platforms. The FOLD_CASE keyword is used to change this behavior. Set it to a non-zero value to cause FILE_SEARCH to do

all file matching case insensitively. Explicitly set FOLD_CASE equal to zero to cause all file matching to be case sensitive.

RSI does not recommend changing the default value of FOLD_CASE, for the following reasons:

- Under UNIX, case-insensitive file searching (that is, setting FOLD_CASE=1) can lead to confusing behavior, since files with the same name in different combinations of upper- and lower-case letters are actually distinct files that can exist simultaneously in the same directory. However, case insensitivity can be useful under UNIX when combined with wildcards in order to find all instances of a given file type without regard to case. For example, the following will find all files in the current directory that end with a `.dat` extension without regard to the case of the extension:

```
datafiles = FILE_SEARCH('*.dat', /FOLD_CASE)
```

- Under Windows, case-sensitive file searching (that is, setting FOLD_CASE=0) is rarely useful, since files with the same name in different combinations of upper- and lower-case letters cannot exist simultaneously in the same directory, and a case-insensitive search will return any version.

## FULLY_QUALIFY_PATH

If set, FILE_SEARCH expands all returned file paths so that they are complete. Under UNIX, this means that all files are specified relative to the root of the file system. On Windows platforms, it means that all files are specified relative to the drive on which they are located. By default, FILE_SEARCH returns fully qualified paths when the input specification is fully qualified, and returns relative paths otherwise. For example:

```
CD, '/usr/local/rsi/idl/bin'
PRINT, FILE_SEARCH('idl')
idl
PRINT, FILE_SEARCH('idl',/FULLY_QUALIFY_PATH)
/usr/local/rsi/idl/bin/idl
```

Under Microsoft Windows, any use of a drive letter colon (:) character implies full qualification, even if the path following the colon does not start with a slash character.

## ISSUE_ACCESS_ERROR

If the IDL process lacks the necessary permission to access a directory included in the input specification, FILE_SEARCH will normally skip over it quietly and not include it in the generated results. Set ISSUE_ACCESS_ERROR to cause an error to be issued instead.

## MARK_DIRECTORY

If set, all directory paths are returned with a path separator character appended to the end. This allows the caller to concatenate a file name directly to the end without having to supply a separator character first. This is convenient for cross-platform programming, as the separator characters differ between operating systems:

```
PRINT, FILE_SEARCH(!DIR)
/usr/local/rsi/idl
PRINT, FILE_SEARCH(!DIR, /MARK_DIRECTORY)
/usr/local/rsi/idl/
```

## MATCH_ALL_INITIAL_DOT

By default, wildcards do not match leading dot (.) characters, and FILE_SEARCH does not return the names of files that start with the dot (.) character unless the leading dot is actually contained within the search string. Set MATCH_ALL_INITIAL_DOT to change this policy so that wildcards will match all files starting with a dot, including the special “.” (current directory) and “..” (parent directory) entries. RSI recommends the use of the MATCH_INITIAL_DOT keyword instead of MATCH_ALL_INITIAL_DOT for most purposes.

## MATCH_INITIAL_DOT

MATCH_INITIAL_DOT serves the same function as MATCH_ALL_INITIAL_DOT, except that the special “.” (current directory) and “..” (parent directory) directories are not included.

## NOSORT

If set, FILE_SEARCH will not sort the list of files returned by the operating system. On some operating systems, particularly UNIX, this can make FILE_SEARCH execute faster. Under Microsoft Windows, setting NOSORT has no effect, since the operating system returns a sorted list of files to IDL.

## QUOTE

FILE_SEARCH usually treats all wildcards found in the input specification as having the special meanings described in “Supported Wildcards and Expansions” on page 643. This means that such characters cannot normally be used as plain literal characters in file names. For example, it is not possible to match a file that contains a literal asterisk character in its name because asterisk is interpreted as the “match zero or more characters” wildcard.

If the QUOTE keyword is set, the backslash character can be used to escape any character so that it is treated as a plain character with no special meaning. In this mode, FILE_SEARCH replaces any two-character sequence starting with a backslash with the second character of the pair. In the process, any special wildcard meaning that character might have had disappears, and the character is treated as a literal.

If QUOTE is set, any literal backslash characters in your path must themselves be escaped with a backslash character. This is especially important for Microsoft Windows users, because the directory separator character for that platform is the backslash. Windows IDL also accepts UNIX-style forward slashes for directory separators, so Windows users have two choices in handling this issue:

```
Result = FILE_SEARCH('C:\\home\\bob\\\*.dat', /QUOTE)
Result = FILE_SEARCH('C:/home/bob/\*.dat', /QUOTE)
```

On a Windows system, either of these options gives the path to a file named `*.dat`.

## TEST_BLOCK_SPECIAL (UNIX Only)

Only include a matching file if it is a block special device.

## TEST_CHARACTER_SPECIAL (UNIX Only)

Only include a matching file if it is a character special device.

## TEST_DANGLING_SYMLINK (UNIX Only)

Only include a matching file if it is a symbolic link that points at a non-existent file.

## TEST_DIRECTORY

Only include a matching file if it is a directory.

## TEST_EXECUTABLE

Only include a matching file if it is executable. The source of this information differs between operating systems:

**UNIX:** IDL checks the per-file information (the execute bit) maintained by the operating system.

**Microsoft Windows:** The determination is made on the basis of the file name extension (e.g. `.exe`).

### TEST_GROUP (UNIX Only)

Only include a matching file if it belongs to the same effective group ID (GID) as the IDL process.

### TEST_NAMED_PIPE (UNIX Only)

Only include a matching file if it is a named pipe (fifo) device.

### TEST_READ

Only include a matching file if it is readable by the user.

**Note**

This keyword does not support Access Control List (ACL) settings for files.

### TEST_REGULAR

Only include a matching file if it is a regular disk file and not a directory, pipe, socket, or other special file type.

### TEST_SETGID (UNIX Only)

Only include a matching file if it has its Set-Group-ID bit set.

### TEST_SETUID (UNIX Only)

Only include a matching file if it has its Set-User-ID bit set.

### TEST_SOCKET (UNIX Only)

Only include a matching file if it is a UNIX domain socket.

### TEST_STICKY_BIT (UNIX Only)

Only include a matching file if it has its sticky bit set.

### TEST_SYMLINK (UNIX Only)

Only include a matching file if it is a symbolic link that points at an existing file.

### TEST_USER (UNIX Only)

Only include a matching file if it belongs to the same effective user ID (UID) as the IDL process.

## TEST_WRITE

Only include a matching file if it is writable by the user.

**Note**

This keyword does not support Access Control List (ACL) settings for files.

## TEST_ZERO_LENGTH

Only include a matching file if it has zero length.

**Note**

The length of a directory is highly system-dependent and does not necessarily correspond to the number of files it contains. In particular, it is possible for an empty directory to report a non-zero length. RSI does not recommend using the TEST_ZERO_LENGTH keyword on directories, as the information returned cannot be used in a meaningful way.

## TEST_* Keywords

The keywords with names that start with the TEST_ prefix allow you to filter the list of resulting file paths based on various criteria. If you remove the TEST_ prefix from these keywords, they correspond directly to the same keywords to the FILE_TEST function, and are internally implemented by the same test code. One could therefore use FILE_TEST instead of the TEST_ keywords to FILE_SEARCH. For example, the following statement locates all subdirectories of the current directory:

```
Result = FILE_SEARCH(/TEST_DIRECTORY)
```

It is equivalent to the following statements, using FILE_TEST:

```
result = FILE_SEARCH()
idx = where(FILE_TEST(result, /DIRECTORY), count)
result = (count eq 0) ? '' : result[idx]
```

The TEST_* keywords are more succinct, and can be more efficient in the common case in which FILE_SEARCH generates a long list of results, only to have FILE_TEST discard most of them.

# Examples

## Example 1

Find all files in the current working directory:

```
Result = FILE_SEARCH()
```

## Example 2

Find all IDL program (*.pro) files in the current working directory:

```
Result = FILE_SEARCH('*.pro')
```

## Example 3

Under Microsoft Windows, find all files in the top level directories of all drives other than the floppy drives:

```
Result=FILE_SEARCH('[!ab]:*')
```

This example relies on the following:

- FILE_SEARCH allows wildcards within the drive letter part of an input file specification.
- Drives A and B are always floppies, and are not used by Windows for any other type of drive.

## Example 4

Find all files in the user's home directory that start with the letters A-D. Match both upper and lowercase letters:

```
Result = FILE_SEARCH('~/[a-d]*', /EXPAND_TILDE, /FOLD_CASE)
```

## Example 5

Find all directories in the user's home directory that start with the letters A-D. Match both upper and lowercase letters:

```
Result = FILE_SEARCH('~/[a-d]*', /EXPAND_TILDE, /FOLD_CASE, $
     /TEST_DIRECTORY)
```

### Example 6

Recursively find all subdirectories found underneath the user's home directory that do not start with a dot character:

```
Result = FILE_SEARCH('$HOME', '*', /EXPAND_ENVIRONMENT, $
     /TEST_DIRECTORY)
```

### Example 7

Recursively find all subdirectories found underneath the user's home directory, including those that start with a dot character, but excluding the special "." and ".." directories:

```
Result = FILE_SEARCH('$HOME', '*', /MATCH_INITIAL_DOT, $
     /EXPAND_ENVIRONMENT, /TEST_DIRECTORY)
```

### Example 8

Find all .pro and .sav files in an IDL library search path, sorted by directory, in the order IDL searches for them:

```
Result = FILE_SEARCH(STRSPLIT(!PATH, PATH_SEP(/SEARCH_PATH), $
   /EXTRACT) + '/*.{pro,sav}')
```

Colon (:) is the UNIX path separator character, so the call to `STRSPLIT` breaks the IDL search path into an array of directories. To each directory name, we concatenate the wildcards necessary to match any .pro or .sav files in that directory. When this array is passed to FILE_SEARCH, it locates all files that match these specifications. FILE_SEARCH sorts all of the files found by each input string. The files for each string are then placed into the output array in the order they were searched for.

### Example 9

Recursively find all directories in your IDL distribution:

```
Result = FILE_SEARCH(!DIR, '*', /TEST_DIRECTORY)
```

## Version History

Introduced: 5.5

## See Also

FILE_TEST, FILEPATH, FINDFILE, GETENV

# FILE_TEST

The FILE_TEST function checks files for existence and other attributes without having to first open the file.

## Syntax

*Result* = FILE_TEST( *File* [, /DIRECTORY | , /EXECUTABLE | , /READ | , /REGULAR | , /WRITE | , /ZERO_LENGTH] [, GET_MODE=*variable*] [, /NOEXPAND_PATH] )

**UNIX-Only Keywords:** [, /BLOCK_SPECIAL | , /CHARACTER_SPECIAL | , /DANGLING_SYMLINK | , /GROUP | , /NAMED_PIPE | , /SETGID | , /SETUID | , /SOCKET | , /STICKY_BIT | , /SYMLINK | , /USER]

## Return Value

FILE_TEST returns 1 (true), if the specified file exists and all of the attributes specified by the keywords are also true. If no keywords are present, a simple test for existence is performed. If the file does not exist or one of the specified attributes is not true, then FILE_TEST returns 0 (false).

## Arguments

### File

A scalar or array of file names to be tested. The result is of type integer with the same number of elements as *File*.

## Keywords

### BLOCK_SPECIAL (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and is a block special device.

### CHARACTER_SPECIAL (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and is a character special device.

## DANGLING_SYMLINK (UNIX Only)

Set this keyword to return 1 (true) if *File* is a symbolic link that points at a non-existent file.

## DIRECTORY

Set this keyword to return 1 (true) if *File* exists and is a directory.

## EXECUTABLE

Set this keyword to return 1 (true) if *File* exists and is executable. The source of this information differs between operating systems:

- UNIX: IDL checks the per-file information (the execute bit) maintained by the operating system.
- Microsoft Windows: The determination is made on the basis of the file name extension (e.g. `.exe`).

## GET_MODE

Set this keyword to a named variable to receive the UNIX style mode (permission) mask for the specified file. The bits in these masks correspond to those used by the UNIX `chmod(2)` system call, and are explained in detail in the description of the *Mode* argument to the FILE_CHMOD procedure. When interpreting the value returned by this keyword, the following platform specific details should be kept in mind:

- The setuid, setgid, and sticky bits are specific to the UNIX operating system, and will never be returned on any other platform. Consult the `chmod(2)` man page and/or other UNIX programming documentation for more details.
- The Microsoft Windows operating system does not have 3 permission classes like UNIX does. Therefore, IDL returns the same settings for all three classes.
- The Microsoft Windows operating system does not maintain an execute bit for files, but instead uses the file suffix to decide if a file is executable.

## GROUP (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and belongs to the same effective group ID (GID) as the IDL process.

## NAMED_PIPE (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and is a named pipe (fifo) device.

### NOEXPAND_PATH

Set this keyword to cause FILE_TEST to use the *File* argument exactly as specified, without applying the usual file path expansion.

### READ

Set this keyword to return 1 (true) if *File* exists and is readable by the user.

### REGULAR

Set this keyword to return 1 (true) if *File* exists and is a regular disk file and not a directory, pipe, socket, or other special file type.

### SETGID (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and has its Set-Group-ID bit set.

### SETUID (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and has its Set-User-ID bit set.

### SOCKET (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and is a UNIX domain socket.

### STICKY_BIT (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and has its sticky bit set.

### SYMLINK (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and is a symbolic link that points at an existing file.

### USER (UNIX Only)

Set this keyword to return 1 (true) if *File* exists and belongs to the same effective user ID (UID) as the IDL process.

### WRITE

Set this keyword to return 1 (true) if *File* exists and is writable by the user.

### ZERO_LENGTH

Set this keyword to return 1 (true) if *File* exists and has zero length.

**Note**

The length of a directory is highly system dependent and does not necessarily correspond to the number of files it contains. In particular, it is possible for an empty directory to report a non-zero length. RSI does not recommend using the ZERO_LENGTH keyword on directories, as the information returned cannot be used in a meaningful way.

## Examples

Does my IDL distribution support the IRIX operating system?

```
result = FILE_TEST(!DIR + '/bin/bin.sgi', /DIRECTORY)
PRINT, 'IRIX IDL Installed: ', result ? 'yes' : 'no'
```

## Version History

Introduced: 5.4

## See Also

FILE_INFO, FILE_SEARCH, FSTAT

# FILE_WHICH

The FILE_WHICH function separates a specified file path into its component directories, and searches each directory in turn for a specific file. This command is modeled after the UNIX `which(1)` command.

This routine is written in the IDL language. Its source code can be found in the file `file_which.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = FILE_WHICH( [*Path*, ] *File* [, /INCLUDE_CURRENT_DIR] )

## Return Value

Returns the path for the first file for the given name found by searching the specified path. If FILE_WHICH does not find the desired file, a NULL string is returned.

## Arguments

### Path

A search path to be searched. If *Path* is not present, the value of the IDL !PATH system variable is used.

### File

The file to look for in the directories given by *Path*.

## Keywords

### INCLUDE_CURRENT_DIR

If set, FILE_WHICH looks in the current directory before starting to search *Path* for *File*. When IDL searches for a routine to compile, it looks in the current working directory before searching !PATH. The INCLUDE_CURRENT_DIR keyword allows FILE_WHICH to mimic this behavior.

## Examples

To find the location of this routine:

```
Result = FILE_WHICH('file_which.pro')
```

To find the location of the UNIX `ls` command:

```
Result = FILE_WHICH(getenv('PATH'), 'ls')
```

## Version History

Introduced: 5.4

# FILEPATH

The FILEPATH function returns the fully-qualified path to a file contained in the IDL distribution. Operating system dependencies are taken into consideration. This routine is used by RSI to make the library routines portable. This routine is written in the IDL language. Its source code can be found in the file `filepath.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = FILEPATH( *Filename* [, ROOT_DIR=*string*]
[, SUBDIRECTORY=*string/string_array*] [, /TERMINAL] [, /TMP] )

## Return Value

Returns the fully-qualified path to a specified file.

## Arguments

### Filename

A string containing the name of the file to be found. The file should be specified in all lowercase characters. No device or directory information should be included.

## Keywords

### ROOT_DIR

A string containing the name of the directory from which the resulting path should be based. If not present, the value of !DIR is used. This keyword is ignored if TERMINAL or TMP are specified.

### SUBDIRECTORY

The name of the subdirectory in which the file should be found. If this keyword is omitted, the main IDL directory is used. This variable can be either a scalar string or a string array with the name of each level of subdirectory depth represented as an element of the array.

For example, to get a path to the file `filepath.pro` in IDL's `lib` subdirectory, enter:

```
path = FILEPATH('filepath.pro',SUBDIR=['lib'])
```

### TERMINAL

Set this keyword to return the filename of the user's terminal.

### TMP

Set this keyword to indicate that the specified file is a scratch file. Returns a path to the proper place for temporary files under the current operating system.

Under Microsoft Windows, FILEPATH checks to see if the following environment variables are set—TMP, TEMP, WINDIR—and uses the value of the first one it finds. If none of these environment variables exists, \TMP is used as the temporary directory.

## Examples

Open the IDL distribution file `people.dat`:

```
OPENR, 1, FILEPATH('people.dat', SUBDIRECTORY=['examples','data'])
```

## Version History

Introduced: Pre 4.0

## See Also

FILE_SEARCH, FINDFILE, PATH_SEP

# FINDFILE

The FINDFILE function retrieves a list of files that match *File_Specification*.

**Note**

RSI strongly recommends the use of the FILE_SEARCH function, included in IDL 5.5 and later, in place of the FINDFILE function. FILE_SEARCH offers many advantages over FINDFILE, including cross-platform consistency in wildcard syntax, uniform presentation of results, filtering by file attributes, and, under UNIX, freedom from performance and number of file limitations encountered by FINDFILE.

Platform specific differences are described below:

- Under UNIX, to include all the files in any subdirectories, use the * wildcard character in the *File_Specification*, such as in `result = FINDFILE('/path/*')`. If *File_Specification* contains only a directory, with no file information, only files in that directory are returned.
- Under Windows, FINDFILE appends a "\" character to the end of the returned file name if the file is a directory. To refer to all the files in a specific directory only, use `result = FINDFILE('\path\*')`.

## Syntax

*Result* = FINDFILE( *File_Specification* [, COUNT=*variable*] )

## Return Value

All matched filenames are returned in a string array, one file name per array element. If no files exist with names matching the *File_Specification*, a null scalar string is returned instead of a string array. FINDFILE returns the full path only if the path itself is specified in *File_Specification*. See the "Examples" section below for details.

## Arguments

### File_Specification

A scalar string used to find files. The string can contain any valid command-interpreter wildcard characters. If *File_Specification* contains path information, that path information is included in the returned value. If *File_Specification* is omitted, the names of all files in the current directory are returned.

# Keywords

## COUNT

A named variable into which the number of files found is placed. If no files are found, a value of 0 is returned.

# Examples

To print the file names of all the UNIX files with `.dat` extensions in the current directory, use the command:

```
PRINT, FINDFILE('*.dat')
```

To print the full path names of all `.pro` files in the IDL `lib` directory that begin with the letter “x”, use the command:

```
PRINT, FINDFILE('/usr/local/rsi/idl/lib/x*.pro')
```

To print the path names of all `.pro` files in the `profiles` subdirectory of the current directory (a relative path), use the command:

```
PRINT, FINDFILE('profiles/*.pro')
```

Note that the values returned are (like the *File_Specification*) relative path names. Use caution when comparing values against this type of relative path specification.

# Version History

Introduced: Original

# See Also

FILE_SEARCH, FILEPATH

# FINDGEN

The FINDGEN function creates a floating-point array of the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = FINDGEN($D_1$ [, ..., $D_8$])

## Return Value

Returns a single-precision, floating-point array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create F, a 6-element vector of single-precision, floating-point values where each element is set to the value of its subscript, enter:

```
F = FINDGEN(6)
```

The value of F[0] is 0.0, F[1] is 1.0, and so on.

## Version History

Introduced: Original

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# FINITE

The FINITE function identifies whether or not a given argument is finite.

## Syntax

*Result* = FINITE( *X* [, /INFINITY] [, /NAN] [, SIGN=*value*])

## Return Value

Returns 1 (True) if its argument is finite. If the argument is infinite or not a defined number (NaN), the FINITE function returns 0 (False). The result is a byte expression of the same structure as the argument *X*.

**Note**

See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.

## Arguments

### X

A floating-point, double-precision, or complex scalar or array expression. Strings are first converted to floating-point. This function is meaningless for byte, integer, or longword arguments.

## Keywords

### INFINITY

If INFINITY is set, FINITE returns True if X is positive or negative infinity, and it returns False otherwise.

### NAN

If NAN is set, FINITE returns True if X is "Not A Number" (NaN), otherwise it returns False.

### SIGN

If the INFINITY or NAN keyword is set, then set this keyword to one of the following values:

| Value | Description |
|---|---|
| > 0 | If the INFINITY keyword is set, return True (1) if *X* is positive infinity, False (0) otherwise. If the NAN keyword is set, return True (1) if *X* is +NaN (negative sign bit is not set), False (0) otherwise. |
| 0 (the default) | The sign of *X* (positive or negative) is ignored. |
| < 0 | If the INFINITY is set, return True (1) if *X* is negative infinity, False (0) otherwise. If the NAN keyword is set, return True (1) if *X* is -NaN (negative sign bit is set), False (0) otherwise. |

*Table 26: SIGN Keyword Values*

If neither the INFINITY nor NAN keyword is set, then this keyword is ignored.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

### Example 1

To find out if the logarithm of 5.0 is finite, enter:

```
PRINT, FINITE(ALOG(5.0))
```

IDL prints "1" because the argument is finite.

### Example 2

To determine which elements of an array are infinity or NaN (Not a Number) values:

```
A = FLTARR(10)

; Set some values to +/-NaN and positive or negative Infinity:
A[3] = !VALUES.F_NAN
A[4] = -!VALUES.F_NAN
A[6] = !VALUES.F_INFINITY
A[7] = -!VALUES.F_INFINITY
```

Find the location of values in A that are positive or negative

```
Infinity:
PRINT, WHERE(FINITE(A, /INFINITY))
```

IDL prints:

```
           6           7
```

Find the location of values in A that are NaN:

```
PRINT, WHERE(FINITE(A, /NAN))
```

IDL prints:

```
           3           4
```

Find the location of values in A that are negative Infinity:

```
PRINT, WHERE(FINITE(A, /INFINITY, SIGN=-1))
```

IDL prints:

```
           7
```

Find the location of values in A that are +NaN:

```
PRINT, WHERE(FINITE(A, /NAN, SIGN=1))
```

IDL prints:

```
           3
```

**Note**

On some platforms, there is no distinction between +NaN and -NaN.

## Version History

Introduced: Original

## See Also

CHECK_MATH, MACHAR, !VALUES, “Special Floating-Point Values” on page 434.

# FIX

The FIX function converts a given expression to an integer type. Optionally, the conversion type can be specified at runtime, allowing flexible runtime type-conversion to arbitrary types.

## Syntax

*Result* = FIX( *Expression [, Offset [, $D_1$ [, ..., $D_8$]]]* [, /PRINT]
[, TYPE=*type code*{0 to 15}] )

## Return Value

Returns a result equal to *Expression* converted to integer type.

## Arguments

### Expression

The expression to be converted.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as integer data. See the description in Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual for details.

The *Offset* and $Dim_i$ arguments are not allowed when converting to or from the string type.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

The *Offset* and $D_i$ arguments are not allowed when converting to or from the string type.

# Keywords

## PRINT

Set this keyword to specify that any special-case processing when converting between string and byte data, or the reverse, should be suppressed. The PRINT keyword is ignored unless the TYPE keyword is used to convert to these types.

## TYPE

FIX normally converts *Expression* to the integer type. If TYPE is specified, it is the type code to set the type of the conversion. This feature allows dynamic type conversion, where the desired type is not known until runtime, to be carried out without the use of large CASE or IF...THEN logic. When TYPE is specified, FIX behaves as if the appropriate type conversion routine for the desired type had been called. See the “See Also” list below for the complete list of such routines.

When using the TYPE keyword to convert BYTE data to STRING or the reverse, you should be aware of the special-case processing that the BYTE and STRING functions do in this case. To prevent this, and get a simple type conversion in these cases, you must specify the PRINT keyword.

## Thread Pool Keywords

This routine is written to make use of IDL’s *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

# Examples

Convert the floating-point array [2.2, 3.0, 4.5] to integer type and store the new array in the variable I by entering:

```
I = FIX([2.2, 3.0, 4.5])
```

# Version History

Introduced: Original

## See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FLOAT, LONG, LONG64, STRING, UINT, ULONG, ULONG64

# FLICK

The FLICK procedure causes the display to flicker between two output images at a given rate.

This routine is written in the IDL language. Its source code can be found in the file `flick.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

FLICK, *A*, *B* [, *Rate*]

## Arguments

### A

Byte image number 1, scaled from 0 to 255.

### B

Byte image number 2, scaled from 0 to 255.

### Rate

The flicker rate. The default is 1.0 sec/frame

## Keywords

None.

## Version History

Introduced: Original

## See Also

CW_ANIMATE, XINTERANIMATE

# FLOAT

The FLOAT function converts a given *Expression* into a single-precision floating-point value.

## Syntax

*Result* = FLOAT( *Expression [, Offset [, $D_1$ [, ..., $D_8$]]]* )

## Return Value

Returns the conversion of the given expression into single-precision floating point values. If *Expression* is a complex number, FLOAT returns the real part.

## Arguments

### Expression

The expression to be converted to single-precision floating-point.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as single-precision floating point data.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

If *A* contains the integer value 6, it can be converted to floating-point and stored in the variable *B* by entering:

```
B = FLOAT(A)
```

# Version History

Introduced: Original

# See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, LONG, LONG64, STRING, UINT, ULONG, ULONG64

# FLOOR

The FLOOR function returns the closest integer less than or equal to its argument.

## Syntax

*Result* = FLOOR(*X* [, /L64 ] )

## Return Value

If the input argument *X* is an integer type, *Result* has the same value and type as *X*. Otherwise, *Result* is a 32-bit longword integer with the same structure as *X*.

## Arguments

### X

The value for which the FLOOR function is to be evaluated. This value can be any numeric type (integer, floating, or complex).

## Keywords

### L64

If set, the result type is 64-bit integer regardless of the input type. This is useful for situations in which a floating point number contains a value too large to be represented in a 32-bit integer.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To print the floor function of 5.9, enter:

```
PRINT, FLOOR(5.9)
; IDL prints:
5
```

To print the floor function of 3000000000.1, the result of which is too large to represent in a 32-bit integer:

```
PRINT, FLOOR(3000000000.1D, /L64)
; IDL prints:
3000000000
```

## Version History

Introduced: Pre 4.0

## See Also

CEIL, COMPLEXROUND, ROUND

# FLOW3

The FLOW3 procedure draws lines representing a 3D flow/velocity field. Note that the 3D scaling system must be in place before calling FLOW3. This procedure works best with Z buffer output device.

This routine is written in the IDL language. Its source code can be found in the file `flow3.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

FLOW3, *Vx*, *Vy*, *Vz* [, ARROWSIZE=*value*] [, /BLOB] [, LEN=*value*] [, NSTEPS=*value*] [, NVECS=*value*] [, SX=*vector*, SY=*vector*, SZ=*vector*]

## Arguments

### Vx, Vy, Vz

3D arrays containing X, Y, and Z components of the field.

## Keywords

### ARROWSIZE

Size of arrowheads (default = 0.05).

### BLOB

Set this keyword to draw a blob at the beginning of each flow line and suppress the arrows.

### LEN

Length of each step used to follow flow lines (default = 2.0). Expressed in units of largest field vector (i.e., the length of the longest step is set to len times the grid spacing.

### NSTEPS

Number of steps used to follow the flow lines (default = largest dimension of *Vx* / 5).

### NVECS

Number of random flow lines to draw (default = 200). Only used if Sx, Sy, Sz are not present.

### SX, SY, SZ

Optional vectors containing the starting coordinates of the flow lines. If omitted random starting points are chosen.

## Examples

```
; Create a set of random three-dimensional arrays to represent
; the field:
vx = RANDOMU(seed, 5, 5, 5)
vy = RANDOMU(seed, 5, 5, 5)
vz = RANDOMU(seed, 5, 5, 5)

; Set up the 3D scaling system:
SCALE3, xr=[0,4], yr=[0,4], zr = [0,4]

; Plot the vector field:
FLOW3, vx, vy, vz
```

## Version History

Introduced: Pre 4.0

## See Also

VEL, VELOVECT

# FLTARR

The FLTARR function creates a floating-point vector or array of the specified dimensions.

## Syntax

*Result* = FLTARR( $D_1$ *[, ..., $D_8$]* [, /NOZERO] )

## Return Value

Returns a single-precision, floating-point vector or array.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, FLTARR sets every element of the result to zero. Set this keyword to inhibit zeroing of the array elements and cause FLTARR to execute faster.

## Examples

Create F, a 3-element by 3-element floating-point array with each element set to 0.0 by entering:

```
F = FLTARR(3, 3)
```

## Version History

Introduced: Original

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# FLUSH

The FLUSH procedure causes all buffered output on the specified file units to be written. IDL uses buffered output for reasons of efficiency. This buffering leads to rare occasions where a program needs to be certain that output data are not waiting in a buffer, but have actually been output.

## Syntax

FLUSH, $Unit_1$, ..., $Unit_n$

## Arguments

### $Unit_i$

The file units (logical unit numbers) to flush.

## Version History

Introduced: Original

## See Also

CLOSE, EMPTY, EXIT

# FOR

The FOR statement executes one or more statements repeatedly, incrementing or decrementing a variable with each repetition, until a condition is met.

**Note**

For more information on using FOR and other IDL program control statements, see Chapter 12, "Program Control" in the *Building IDL Applications* manual.

## Syntax

FOR *variable* = *init*, *limit* [, *Increment*] DO *statement*

or

FOR *variable* = *init*, *limit* [, *Increment*] DO BEGIN

*statements*

ENDFOR

## Examples

The following example iterates over the elements of an array, printing the value of each element:

```
array = ['one', 'two', 'three']
n = N_ELEMENTS(array)
FOR i=0,n-1 DO BEGIN
   PRINT, array[i]
ENDFOR
```

## Version History

Introduced: Original

# FORMAT_AXIS_VALUES

The FORMAT_AXIS_VALUES function converts a vector of numeric values into a vector of string values. This routine uses the same rules for formatting as do the axis routines that label tick marks given a set of tick values.

## Syntax

*Result* = FORMAT_AXIS_VALUES( *Values* )

## Return Value

Returns a vector of formatted string values from an input vector of numeric values.

## Arguments

### Values

Set this argument to a vector of numeric values to be formatted.

## Keywords

None.

## Examples

Suppose we have a vector of axis values:

```
axis_values = [7.9, 12.1, 15.3, 19.0]
```

Convert these values into an array of strings:

```
new_values = FORMAT_AXIS_VALUES(axis_values)
HELP, new_values
PRINT, new_values
PRINT, axis_values
```

IDL prints:

```
NEW_VALUES      STRING    = Array[4]
7.9 12.1 15.3 19.0
7.90000      12.1000      15.3000      19.0000
```

## Version History

Introduced: 5.1

# FORWARD_FUNCTION

The FORWARD_FUNCTION statement causes argument(s) to be interpreted as functions rather than variables (versions of IDL prior to 5.0 used parentheses to declare arrays).

**Note**

For information on using the FORWARD_FUNCTION statement, see Chapter 4, "Procedures and Functions" in the *Building IDL Applications* manual.

## Syntax

FORWARD_FUNCTION $Name_1$, $Name_2$, ..., $Name_n$

## Version History

Introduced: Pre 4.0

# FREE_LUN

The FREE_LUN procedure deallocates previously-allocated file units. This routine is usually used with file units allocated with GET_LUN, but it will also close any other specified file unit. If the specified file units are open, they are closed prior to the deallocation.

## Syntax

FREE_LUN [, *Unit*$_1$, ..., *Unit*$_n$] [, EXIT_STATUS=*variable*] [, /FORCE]

## Arguments

### Unit$_i$

The IDL file units (logical unit numbers) to deallocate.

## Keywords

### EXIT_STATUS

Set this keyword to a named variable that will contain the exit status reported by a UNIX child process started via the UNIT keyword to SPAWN. This value is the exit value reported by the process by calling EXIT, and is analogous to the value returned by $? under most UNIX shells.

### FORCE

Set this keyword to override the IDL file output buffer and force the file to be closed no matter what errors occur in the process.

IDL buffers file output for performance reasons. If it is not possible to properly flush this data when a file close is requested, an error is normally issued and the file remains open. An example of this might be that your disk does not have room to write the remaining data. This default behavior prevents data from being lost. To override it and force the file to be closed no matter what errors occur in the process, specify FORCE.

## Examples

See the example for the GET_LUN procedure.

## Version History

Introduced: Original

## See Also

CLOSE, GET_LUN

# FSTAT

The FSTAT function returns status information about a specified file unit.

## Syntax

*Result* = FSTAT(*Unit*)

## Return Value

The FSTAT function returns a structure expression of type FSTAT (or FSTAT64 in the case of files that are longer than 2^31-1 bytes in length) containing status information about a specified file unit. The contents of this structure are documented in "The FSTAT Function" in Chapter 10 of the *Building IDL Applications* manual.

### Fields of the FSTAT Structure

The following descriptions are of *fields* in the structure returned by the FSTAT function. They are *not* keywords to FSTAT.

- **UNIT** — The IDL logical unit number (LUN).
- **NAME** — The name of the file.
- **OPEN** — Nonzero if the file unit is open. If OPEN is zero, the remaining fields in FSTAT will not contain useful information.
- **ISATTY** — Nonzero if the file is actually a terminal instead of a normal file. For example, if you are using an `xterm` window on a UNIX system and you invoke FSTAT on logical unit 0 (standard input), ISATTY will be set to 1.
- **ISAGUI** — Nonzero if the file is actually a Graphical User Interface (for example, a logical unit associated with the IDL Development Environment). Thus, if you are using the IDLDE and you invoke FSTAT on logical unit 0 (standard input), ISAGUI will be set to 1.
- **INTERACTIVE** — Nonzero if *either* ISATTY or ISAGUI is nonzero.
- **XDR** — Nonzero if the file was opened with the XDR keyword, and is therefore considered to contain data in the XDR format.
- **COMPRESS** — Nonzero if the file was opened with the COMPRESS keyword, and is therefore considered to contain compressed data in the GZIP format.
- **READ** — Nonzero if the file is open for read access.

- **WRITE** — Nonzero if the file is open for write access.
- **ATIME, CTIME, MTIME** — The date of last access, date of creation, and date of last modification given in seconds since 1 January 1970 UTC. Use the SYSTIME function to convert these dates into a textual representation.

**Note**

Some file systems do not maintain all of these dates (e.g. MS DOS FAT file systems), and may return 0. On some non-UNIX operating systems, access time is not maintained, and ATIME and MTIME will always return the same date.

- **TRANSFER_COUNT** — The number of scalar IDL data items transferred in the last input/output operation on the unit. This is set by the following IDL routines: READU, WRITEU, PRINT, PRINTF, READ, and READF. TRANSFER_COUNT is useful when attempting to recover from input/output errors.
- **CUR_PTR** — The current position of the file pointer, given in bytes from the start of the file. If the device is a terminal (ISATTY is nonzero), the value of CUR_PTR will not contain useful information. When reporting on file units opened with the COMPRESS keyword to OPEN, the position reported by CUR_PTR is the “logical” position—the position it would be at in the uncompressed version of the same file.
- **SIZE** — The current length of the file in bytes. If the device is a terminal (ISATTY is nonzero), the value of SIZE will not contain useful information. When reporting on file units opened with the COMPRESS keyword to OPEN, the size reported by SIZE is the compressed size of the actual file, and not the logical length of the uncompressed data contained within. This is inconsistent with the position reported by CUR_PTR. The reason for reporting the size in this way is that the logical length of the data cannot be known without reading the entire file from beginning to end and counting the uncompressed bytes, and this would be extremely inefficient.
- **REC_LEN** — This field is obsolete and will always contain zero.

# Arguments

## Unit

The file unit about which information is required. This parameter can be an integer or an associated variable, in which case information about the variable’s associated file is returned.

## Keywords

None.

## Examples

If file unit number 1 is open, the FSTAT information on that unit can be seen by entering:

```
PRINT, FSTAT(1)
```

Specific information can be obtained by referring to single fields within the structure returned by FSTAT. The following code prints the name and length of the file open on unit 1:

```
; Put FSTAT information in variable A:
A = FSTAT(1)

; Print the name and size fields:
PRINT, 'File: ', A.NAME, ' is ', A.SIZE, ' bytes long.'
```

## Version History

Introduced: Original

## See Also

ASSOC, FILE_INFO, FILE_TEST, OPEN

# FULSTR

The FULSTR restores a row-indexed sparse array to full storage mode. If the sparse array was created with the SPRSIN function using the THRESH keyword, any values in the original array that were below the specified threshold are replaced with zeros.

## Syntax

*Result* = FULSTR(*A*)

## Return Value

Returns a given array to full storage mode.

## Arguments

### A

A row-indexed sparse array created by the SPRSIN function.

## Keywords

None.

## Examples

Suppose we have converted an array to sparse storage format with the following commands:

```
A = [[ 5.0, -0.2, 0.1], $
     [ 3.0, -2.0, 0.3], $
     [ 4.0, -1.0, 0.0]]

; Convert to sparse storage mode. All elements of the array A that
; have absolute values less than THRESH are set to zero:
sparse = SPRSIN(A, THRESH=0.5)
```

The variable SPARSE now contains a representation of the array A in structure form. To restore the array from the sparse-format structure:

```
; Restore the array:
result = FULSTR(sparse)

; Print the result:
PRINT, result
```

IDL prints:

```
5.00000      0.00000      0.00000
3.00000     -2.00000      0.00000
4.00000     -1.00000      0.00000
```

Note that the elements with an absolute value less than the specified threshold have been set to zero.

## Version History

Introduced: 4.0

## See Also

LINBCG, SPRSAB, SPRSAX, SPRSIN, SPRSTP, READ_SPR, WRITE_SPR

# FUNCT

The FUNCT procedure evaluates the sum of a Gaussian and a 2nd-order polynomial and optionally returns the value of its partial derivatives. Normally, this function is used by CURVEFIT to fit the sum of a line and a varying background to actual data.

This routine is written in the IDL language. Its source code can be found in the file `funct.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

FUNCT, *X*, *A*, *F* [, *Pder*]

## Arguments

### X

A vector of values for the independent variable.

### A

A vector of coefficients for the equations:

$$F = A_0 e^{-Z^2/2} + A_3 + A_4 X + A_5 X^2$$

$$Z = (X - A_1) / A_2$$

### F

A named variable that will contain the value of the function at each *Xi*.

### Pder

A named variable that will contain an array of the size (N_ELEMENTS(*X*),6) that contains the partial derivatives. *Pder(i,j)* represents the derivative at the $i^{th}$ point with respect to $j^{th}$parameter.

## Version History

Introduced: 4.0

## See Also

CURVEFIT

# FUNCTION

The FUNCTION statement defines a function.

**Note**

For information on using the FUNCTION statement, see Chapter 4, “Procedures and Functions” in the *Building IDL Applications* manual.

## Syntax

FUNCTION *Function_Name*, $parameter_1$, ..., $parameter_n$

## Version History

Introduced: Original

# FV_TEST

The FV_TEST function computes the F-statistic and the probability that two sample populations *X* and *Y* have significantly different variances. *X* and *Y* may be of different lengths. The F-statistic formula for sample populations *x* and *y* with means $\bar{x}$ and $\bar{y}$ is defined as:

$$F = \left(\frac{M-1}{N-1}\right)\frac{\left[\sum_{j=0}^{N-1}(x_j-\bar{x})^2-\frac{1}{N}\left[\sum_{j=0}^{N-1}(x_j-\bar{x})\right]^2\right]}{\left[\sum_{j=0}^{M-1}(y_j-\bar{y})^2-\frac{1}{M}\left[\sum_{j=0}^{M-1}(y_j-\bar{y})\right]^2\right]}$$

where $x = (x_0, x_1, x_2, ..., x_{N-1})$ and $y = (y_0, y_1, y_2 ..., y_{M-1})$

This routine is written in the IDL language. Its source code can be found in the file `fv_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = FV_TEST(*X*, *Y*)

## Return Value

The result is a two-element vector containing the F-statistic and its significance. The significance is a value in the interval [0.0, 1.0]; a small value (0.05 or 0.01) indicates that *X* and *Y* have significantly different variances. This type of test is often referred to as the F-variance test.

## Arguments

### X

An *n*-element integer, single- or double-precision floating-point vector.

### Y

An *m*-element integer, single- or double-precision floating-point vector.

## Keywords

None.

## Examples

```
; Define two n-element sample populations:
X = [257, 208, 296, 324, 240, 246, 267, 311, 324, 323, 263, $
   305, 270, 260, 251, 275, 288, 242, 304, 267]
Y = [201,  56, 185, 221, 165, 161, 182, 239, 278, 243, 197, $
    271, 214, 216, 175, 192, 208, 150, 281, 196]

; Compute the F-statistic (of X and Y) and its significance:
PRINT, FV_TEST(X, Y)
```

IDL prints:

```
2.48578    0.0540116
```

The result indicates that X and Y have significantly different variances.

## Version History

Introduced: 4.0

## See Also

KW_TEST, MOMENT, RS_TEST, S_TEST, TM_TEST

# FX_ROOT

The FX_ROOT function computes a real or complex root of a univariate nonlinear function using an optimal Müller's method.

This routine is written in the IDL language. Its source code can be found in the file `fx_root.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = FX_ROOT(*X*, *Func* [, /DOUBLE] [, ITMAX=*value*] [, /STOP] [, TOL=*value*] )

## Return Value

The return value is the real or complex root of a univariate nonlinear function. Which root results depends on the initial guess provided for this routine.

## Arguments

### X

A 3-element real or complex initial guess vector. Real initial guesses may result in real or complex roots. Complex initial guesses will result in complex roots.

### Func

A scalar string specifying the name of a user-supplied IDL function that defines the univariate nonlinear function. This function must accept the vector argument X.

For example, suppose we wish to find a root of the following function:

$$y = e^{(\sin x^2 + \cos x^2 - 1)} - 1$$

We write a function FUNC to express the function in the IDL language:

```
FUNCTION func, X
  RETURN, EXP(SIN(X)^2 + COS(X)^2 - 1) - 1
END
```

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## ITMAX

The maximum allowed number of iterations. The default is 100.

## STOP

Use this keyword to specify the stopping criterion used to judge the accuracy of a computed root r(*k*). Setting STOP = 0 (the default) checks whether the absolute value of the difference between two successively-computed roots, | r(*k*) - r(*k*+1) | is less than the stopping tolerance TOL. Setting STOP = 1 checks whether the absolute value of the function FUNC at the current root, | FUNC(r(*k*)) |, is less than TOL.

## TOL

Use this keyword to specify the stopping error tolerance. The default is $1.0 \times 10^{-4}$.

# Examples

This example finds the roots of the function FUNC defined above:

```
; First define a real 3-element initial guess vector:
x = [0.0, -!pi/2, !pi]

; Compute a root of the function using double-precision
; arithmetic:
root = FX_ROOT(X, 'FUNC', /DOUBLE)

; Check the accuracy of the computed root:
PRINT, EXP(SIN(ROOT)^2 + COS(ROOT)^2 - 1) - 1
```

IDL prints:

```
0.0000000
```

We can also define a complex 3-element initial guess vector:

```
x = [COMPLEX(-!PI/3, 0), COMPLEX(0, !PI), COMPLEX(0, -!PI/6)]

; Compute the root of the function:
root = FX_ROOT(x, 'FUNC')
```

```
; Check the accuracy of the computed complex root:
PRINT, EXP(SIN(ROOT)^2 + COS(ROOT)^2 - 1) - 1
```

IDL prints:

```
(      0.00000,      0.00000)
```

## Version History

Introduced: Pre 4.0

## See Also

BROYDEN, NEWTON, FZ_ROOTS

# FZ_ROOTS

The FZ_ROOTS function is used to find the roots of an *m*-degree complex polynomial, using Laguerre's method.

FZ_ROOTS is based on the routine `zroots` described in section 9.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = FZ_ROOTS(*C* [, /DOUBLE] [, EPS=*value*] [, /NO_POLISH] )

## Return Value

Returns an *m*-element complex vector containing the roots of an *m*-degree complex polynomial.

## Arguments

### C

A vector of length *m*+1 containing the coefficients of the polynomial, in ascending order (see example). The type can be real or complex.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### EPS

The desired fractional accuracy. The default value is $2.0 \times 10^{-6}$.

### NO_POLISH

Set this keyword to suppress the usual polishing of the roots by Laguerre's method.

# Examples

**Example 1**: Real coefficients yielding real roots.

Find the roots of the polynomial:

$$P(x) = 6x^3 - 7x^2 - 9x - 2$$

The exact roots are -1/2, -1/3, 2.0.

```
coeffs = [-2.0, -9.0, -7.0, 6.0]
roots = FZ_ROOTS(coeffs)
PRINT, roots
```

IDL prints:

```
( -0.500000, 0.00000)( -0.333333, 0.00000)( 2.00000, 0.00000)
```

**Example 2**: Real coefficients yielding complex roots.

Find the roots of the polynomial:

$$P(x) = x^4 + 3x^2 + 2$$

The exact roots are:

$$0.0 - i\sqrt{2.0},\quad 0.0 + i\sqrt{2.0},\quad 0.0 - i,\quad 0.0 + i$$

```
coeffs = [2.0, 0.0, 3.0, 0.0, 1.0]
roots = FZ_ROOTS(coeffs)
PRINT, roots
```

IDL Prints:

```
(0.00000, -1.41421)(0.00000, 1.41421)
(0.00000, -1.00000)(0.00000, 1.00000)
```

**Example 3**: Real and complex coefficients yielding real and complex roots.

Find the roots of the polynomial:

$$P(x) = x^3 + (-4 - i4)x^2 + s(-3 + i4)x + (18 + i24)$$

The exact roots are –2.0, 3.0, (3.0 + *i*4.0)

```
coeffs = [COMPLEX(18,24), COMPLEX(-3,4), COMPLEX(-4,-4), 1.0]
roots = FZ_ROOTS(coeffs)
PRINT, roots
```

IDL Prints:

```
( -2.00000, 0.00000) ( 3.00000, 0.00000) ( 3.00000, 4.00000)
```

## Version History

Introduced: 4.0

## See Also

FX_ROOT, BROYDEN, NEWTON, POLY

# GAMMA

The GAMMA function returns the gamma function of *Z*.

The gamma function is defined as:

$$\Gamma(x) \equiv \int_0^\infty t^{x-1} e^{-t} dt$$

Use the LNGAMMA function to obtain the natural logarithm of the gamma function when there is a possibility of overflow.

## Syntax

*Result* = GAMMA(*Z*)

## Return Value

If *Z* is double-precision, the result is double-precision (either double or double complex), otherwise the result is single-precision (either float or complex).

## Arguments

### Z

The expression for which the gamma function will be evaluated. *Z* may be complex.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established

by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

Plot the gamma function over the range 0.01 to 1.0 with a step size of 0.01 by entering:

```
Z = FINDGEN(99)/100. + 0.01
PLOT, Z, GAMMA(Z)
```

## Version History

Introduced: Original

*Z* argument accepts complex input: 5.6

## See Also

BETA, IBETA, IGAMMA, LNGAMMA

# GAMMA_CT

The GAMMA_CT procedure applies gamma correction to a color table.

This routine is written in the IDL language. Its source code can be found in the file `gamma_ct.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

GAMMA_CT, *Gamma* [, /CURRENT] [, /INTENSITY]

## Arguments

### Gamma

The value of gamma correction. A value of 1.0 indicates a linear ramp (i.e., no gamma correction). Higher values of *Gamma* give more contrast. Values less than 1.0 yield lower contrast.

## Keywords

### CURRENT

Set this keyword to apply correction from the “current” color table (i.e., the values R_CURR, G_CURR, and B_CURR in the COLORS common block). Otherwise, correction is applied from the “original” color table (i.e., the values R_ORIG, G_ORIG, and B_ORIG in the COLORS common block). The gamma corrected color table is always saved in the “current” table (R_CURR, G_CURR, B_CURR) and the new table is loaded.

### INTENSITY

Set this keyword to correct the individual intensities of each color in the colortable. Otherwise, the colors are shifted according to the gamma function.

## Version History

Introduced: Pre 4.0

## See Also

PSEUDO, STRETCH, XLOADCT

# GAUSS_CVF

The GAUSS_CVF function computes the cutoff value *V* in a standard Gaussian (normal) distribution with a mean of 0.0 and a variance of 1.0 such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

This routine is written in the IDL language. Its source code can be found in the file `gauss_cvf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = GAUSS_CVF(*P*)

## Return Value

Returns the cutoff value *V* in a standard Gaussian (normal) distribution with a mean of 0.0 and a variance of 1.0.

## Arguments

### P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

## Keywords

None.

## Examples

Use the following command to compute the cutoff value in a Gaussian distribution such that the probability that a random variable X is greater than the cutoff value is 0.025:

```
PRINT, GAUSS_CVF(0.025)
```

IDL prints:

```
1.95997
```

## Version History

Introduced: 4.0

## See Also

CHISQR_CVF, F_CVF, GAUSS_PDF, T_CVF

# GAUSS_PDF

The GAUSS_PDF function computes the probability *P* that, in a standard Gaussian (normal) distribution with a mean of 0.0 and a variance of 1.0, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

This routine is written in the IDL language. Its source code can be found in the file `gauss_pdf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = GAUSS_PDF(*V*)

## Return Value

This function returns a scalar or array with the same dimensions as *V*. If *V* is double-precision, the result is double-precision, otherwise the result is single-precision.

## Arguments

### V

A scalar or array that specifies the cutoff value(s).

## Keywords

None.

## Examples

### Example 1

Compute the probability that a random variable X, from the standard Gaussian (normal) distribution, is less than or equal to 2.44:

```
PRINT, GAUSS_PDF(2.44)
```

IDL Prints:

```
0.992656
```

### Example 2

Compute the probability that a random variable X, from the standard Gaussian (normal) distribution, is less than or equal to 10.0 and greater than or equal to 2.0:

```
PRINT, GAUSS_PDF(10.0) - GAUSS_PDF(2.0)
```

IDL Prints:

```
0.0227501
```

### Example 3

Compute the probability that a random variable X, from the Gaussian (normal) distribution with a mean of 0.8 and a variance of 4.0, is less than or equal to 2.44:

```
PRINT, GAUSS_PDF( (2.44 - 0.80)/SQRT(4.0) )
```

IDL Prints:

```
0.793892
```

## Version History

Introduced: 4.0

## See Also

BINOMIAL, CHISQR_PDF, F_PDF, GAUSS_CVF, T_PDF

# GAUSS2DFIT

The GAUSS2DFIT function fits a two-dimensional, elliptical Gaussian equation to rectilinearly gridded data.

$$Z = F(x, y)$$

where:

$$F(x, y) = A_0 + A_1 e^{-U/2}$$

And the elliptical function is:

$$U = (x'/a)^2 + (y'/b)^2$$

The parameters of the ellipse *U* are:

- Axis lengths are 2*a* and 2*b*, in the unrotated X and Y axes, respectively.
- Center is at (*h*, *k*).
- Rotation of *T* radians from the X axis, in the *clockwise* direction.

The rotated coordinate system is defined as:

$$x' = (x - h)\cos T - (y - k)\sin T$$

$$y' = (x - h)\sin T + (y - k)\cos T$$

The rotation is optional, and can be forced to 0, making the major and minor axes of the ellipse parallel to the X and Y axes.

Coefficients of the computed fit are returned in argument *A*.

### Procedure Used and Other Notes

The peak/valley is found by first smoothing *Z* and then finding the maximum or minimum, respectively. GAUSSFIT is then applied to the row and column running through the peak/valley to estimate the parameters of the Gaussian in X and Y. Finally, CURVEFIT is used to fit the 2D Gaussian to the data.

Be sure that the 2D array to be fit contains the entire peak/valley out to at least 5 to 8 half-widths, or the curve-fitter may not converge.

This is a computationally-intensive routine. The time required is roughly proportional to the number of elements in *Z*.

This routine is written in the IDL language. Its source code can be found in the file `gauss2dfit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = GAUSS2DFIT( *Z*, *A* [, *X*, *Y*] [, /NEGATIVE] [, /TILT] )

## Arguments

### Z

The dependent variable. *Z* should be a two-dimensional array with dimensions ($N_x$, $N_y$). Gridding in the array must be rectilinear.

### A

A named variable in which the coefficients of the fit are returned. *A* is returned as a seven element vector the coefficients of the fitted function. The meanings of the seven elements in relation to the discussion above is:

- *A*[0] = $A_0$= constant term
- *A*[1] = $A_1$= scale factor
- *A*[2] = *a* = width of Gaussian in the X direction
- *A*[3] = *b* = width of Gaussian in the Y direction
- *A*[4] = *h* = center X location
- *A*[5] = *k* = center Y location.
- *A*[6] = *T* = *Theta*, the rotation of the ellipse from the X axis in radians, *counter-clockwise*.

### X

An optional vector with $N_x$ elements that contains the X values of $Z$ (i.e., $X_i$is the X value for $Z_{i,j}$. If this argument is omitted, a regular grid in X is assumed, and the X location of $Z_{i,j} = i$.

### Y

An optional vector with $N_y$ elements that contains the Y values of Z (i.e., $Y_j$ is the Y value for $Z_{i,j}$. If this argument is omitted, a regular grid in Y is assumed, and the Y location of $Z_{i,j} = j$.

## Keywords

### NEGATIVE

Set this keyword to indicate that the Gaussian to be fitted is a valley (such as an absorption line). By default, a peak is fit.

### TILT

Set this keyword to allow the orientation of the major and minor axes of the ellipse to be unrestricted. The default is that the axes of the ellipse must be parallel to the X and Y axes. Therefore, in the default case, *A*[6] is always returned as 0.

## Examples

This example creates a 2D gaussian, adds random noise and then applies GAUSS2DFIT.

```
; Define array dimensions:
nx = 128 & ny = 100
; Define input function parameters:
A = [ 5., 10., nx/6., ny/10., nx/2., .6*ny]
; Create X and Y arrays:
X = FINDGEN(nx) # REPLICATE(1.0, ny)
Y = REPLICATE(1.0, nx) # FINDGEN(ny)
; Create an ellipse:
U = ((X-A[4])/A[2])^2 + ((Y-A[5])/A[3])^2
; Create gaussian Z:
Z = A[0] + A[1] * EXP(-U/2)
; Add random noise, SD = 1:
Z = Z + RANDOMN(seed, nx, ny)
; Fit the function, no rotation:
yfit = GAUSS2DFIT(Z, B)
; Report results:
```

```
PRINT, 'Should be: ', STRING(A, FORMAT='(6f10.4)')
PRINT, 'Is: ', STRING(B(0:5), FORMAT='(6f10.4)')
```

## Version History

Introduced: 4.0.1

## See Also

COMFIT, GAUSSFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

# GAUSSFIT

The GAUSSFIT function computes a non-linear least-squares fit to a function $f(x)$ with from three to six unknown parameters. $f(x)$ is a linear combination of a Gaussian and a quadratic; the number of terms is controlled by the keyword parameter NTERMS.

This routine is written in the IDL language. Its source code can be found in the file `gaussfit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = GAUSSFIT( *X*, *Y* [, *A*] [, CHISQ=*variable*] [, ESTIMATES=*array*] [, MEASURE_ERRORS=*vector*] [, NTERMS=*integer*{3 to 6}] [, SIGMA=*variable*] [, YERROR=*variable*])

## Return Value

Returns three to six values that are the non-linear least squares fit to a function $f(x)$.

## Arguments

### X

An *n*-element vector of independent variables.

### Y

A vector of dependent variables, the same length as *X*.

### A

A named variable that will contain the coefficients *A* of the fit.

## Keywords

### CHISQ

Set this keyword to a named variable that will contain the value of the chi-square goodness-of-fit.

## ESTIMATES

Set this keyword equal to an array of starting estimates for the parameters of the equation. If the NTERMS keyword is specified, the ESTIMATES array should have NTERMS elements. If NTERMS is not specified, the ESTIMATES array should have six elements. If the ESTIMATES array is not specified, estimates are calculated by first subtracting a constant (if NTERMS >= 4) or a linear term (if NTERMS >= 5), and then forming a simple estimate of the Gaussian coefficients.

## MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[i]. This vector must be the same length as *X* and *Y*.

**Note**

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(*Y*).

## NTERMS

Set this keyword to an integer value between three and six to specify the function to be used for the fit. The values correspond to the functions shown below. In all cases:

$$z = \frac{x - A_1}{A_2}$$

**NTERMS=6**

$$f(x) = A_0 e^{\frac{-z^2}{2}} + A_3 + A_4 x + A_5 x^2$$

**NTERMS=5**

$$f(x) = A_0 e^{\frac{-z^2}{2}} + A_3 + A_4 x$$

**NTERMS=4**

$$f(x) = A_0 e^{\frac{-z^2}{2}} + A_3$$

**NTERMS=3**

$$f(x) = A_0 e^{\frac{-z^2}{2}}$$

NTERMS=6 is the default setting. Here, A0 is the height of the Gaussian, A1 is the center of the Gaussian, A2 is the width (the standard deviation) of the Gaussian, A3 is the constant term, A4 is the linear term, and A5 is the quadratic term.

**Tip**

The full width at half maximum (FWHM) of the Gaussian may be computed as 2*SQRT(2*ALOG(2))*A2.

## SIGMA

Set this keyword to a named variable that will contain the 1-sigma error estimates of the returned parameters.

**Note**

If MEASURE_ERRORS is omitted, then you are assuming that a polynomial is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N***M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See Section 15.2 of *Numerical Recipes in C (Second Edition)* for details.

### YERROR

Set this keyword to a named variable that will contain the standard error between YFIT and Y.

## Examples

The following example shows how to use GAUSSFIT to fit to four different functions, with NTERMS=3,4,5,6. To simulate actual data, random noise has been added to each function.

```
pro ex_gaussfit

   ; Define the independent variable.
   n = 101
   x = (FINDGEN(n)-(n/2))/4

   ; Define the coefficients.
   a = [4.0, 1.0, 2.0, 1.0, 0.25, 0.01]
   print, 'Expected: ', a
   z = (x - a[1])/a[2]    ; Gaussian variable
   !P.MULTI = [0,2,2]     ; set up 2x2 plot window
   seed = 123321          ; Pick a starting seed value

   for nterms=3,6 do begin
      ; Define the dependent variables. Start with random noise.
      y = 0.4*RANDOMN(seed, n)

      ; Use a switch statement so we fall through to each term.
      switch nterms of
         6: y = y + a[5]*x^2
         5: y = y + a[4]*x
         4: y = y + a[3]
         3: y = y + a[0]*exp(-z^2/2)
      endswitch
```

```
      ; Fit the data to the function, storing coefficients in
      ; coeff:
      yfit = GAUSSFIT(x, y, coeff, NTERMS=nterms)
      print, 'Result:   ', coeff[0:nterms-1]
      ; Plot the original data and the fitted curve:
      PLOT, x, y, TITLE='nterms='+STRTRIM(nterms,2)
      OPLOT, x, yfit, THICK=2
   endfor
end
```

When this program is compiled and executed, IDL prints the following results:

```
IDL> ex_gaussfit
Expected: 4.00000 1.00000 2.00000 1.00000 0.250000 0.0500000
Result: 3.95437 1.03176 2.07216
Result: 4.38669 0.948479 1.84426 0.909676
Result: 3.93348 0.839296 2.02112 1.05237 0.249002
Result: 3.80389 0.993375 2.07302 1.16684 0.249051 0.0484357
```

## Version History

Introduced: Original

CHISQ, SIGMA, and YERROR keywords added: 5.6

## See Also

COMFIT, CURVEFIT, GAUSS2DFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

# GAUSSINT

The GAUSSINT function evaluates the integral of the Gaussian probability function.

The Gaussian integral is defined as:

$$\text{Gaussint}(x) \equiv \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-t^2/2} dt$$

## Syntax

*Result* = GAUSSINT(*X*)

## Return Value

Returns the result of the Gaussian probability function integral evaluation. If *X* is double-precision, the result is double-precision, otherwise the argument is converted to floating-point and the result is floating-point. The result has the same structure as the input argument, *X*.

## Arguments

### X

The expression for which the Gaussian integral is to be evaluated.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established

by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

Plot the Gaussian probability function over the range -5 to 5 with a step size of 0.1by entering:

```
X = FINDGEN(101)/10. - 5.
PLOT, X, GAUSSINT(X)
```

## Version History

Introduced: Original

## See Also

GAUSS_CVF, GAUSS_PDF

# GET_DRIVE_LIST

The GET_DRIVE_LIST function returns valid drive or volume names for the file system. Under Microsoft Windows, keywords can be used to specify that only drives of certain types should be returned.

**Note**

The UNIX operating system presents all files within a single unified file hierarchy, and does not support the concept of drive letters or volume names. As such, GET_DRIVE_LIST always returns a scalar null string under UNIX.

## Syntax

*Result* = GET_DRIVE_LIST( [COUNT=*variable*] )

**Windows-Only Keywords:** [, /CDROM] [, /FIXED] [, /REMOTE] [, /REMOVABLE]

## Return Value

Returns a string array of the names of valid drives / volumes for the file system. If GET_DRIVE_LIST has no drives to return, it returns a scalar null string.

## Arguments

None.

## Keywords

**Note**

If a Windows-only keyword is specified, only drives of the specified types are reported.

### CDROM (Windows Only)

If set, compact disk drives are reported. Note that although CDROM devices are removable, they are treated as a special case, and the REMOVABLE keyword does not apply to them.

### COUNT

A named variable into which the number of drives/volumes found is placed. If no drives/volumes are found, a value of zero is returned. Under UNIX, the value returned by this keyword will always be zero.

### FIXED (Windows Only)

If set, hard drives physically attached to the current system are reported.

### REMOTE (Windows Only)

If set, remote (i.e. network) drives are reported.

### REMOVABLE (Windows Only)

If set, removable media devices (e.g. floppy, zip drive) other than CDROMs are reported.

## Examples

Under Windows, the following will report all local hard drives:

```
drives = GET_DRIVE_LIST(/FIXED)
```

This statement obtains the names of all floppy drives, cdroms, and other removable media drives:

```
drives = GET_DRIVE_LIST(/CDROM, /REMOVABLE)
```

## Version History

Introduced: 5.3

# GET_KBRD

The GET_KBRD function returns the next character available from the standard input (IDL file unit 0).

**Note**

GET_KBRD is intended for use in IDL's UNIX command-line mode. While GET_KBRD will return values for some characters when run from the IDL Development Environment (either UNIX or Microsoft Windows), other characters are treated as special cases by the underlying windowing system, and may not be returned by GET_KBRD.

## Syntax

*Result* = GET_KBRD(*Wait*)

## Return Value

Returns a one-character string containing the next available character that is input from the keyboard.

## Arguments

### Wait

If *Wait* is zero, GET_KBRD returns the null string if there are no characters in the terminal type-ahead buffer. If it is nonzero, the function waits for a character to be typed before returning.

## Keywords

None.

## Examples

To wait for keyboard input and store one character in the variable R, enter:

```
R = GET_KBRD(1)
```

Press any key to return to the IDL prompt. To see the character that was typed, enter:

```
PRINT, R
```

The following code fragment reads one character at a time and echoes that character's numeric code. It quits when a "q" is entered:

```
REPEAT BEGIN
   A = GET_KBRD(1)
   PRINT, BYTE(A)
ENDREP UNTIL A EQ 'q'
```

**Note**

The GET_KBRD function can be used to return Windows special characters (in addition to standard keyboard characters), created by holding down the Alt key and entering the character's ANSI equivalent. For example, to return the paragraph marker (¶), ANSI number 0182, enter:

```
C = GET_KBRD(1)
```

While GET_KBRD is waiting, press and hold the Alt key and type 0182 on the numeric keypad. When the IDL prompt returns, enter:

```
PRINT, C
```

IDL prints the paragraph marker,"¶".

GET_KBRD *cannot* be used to return control characters or other editing keys (e.g., Delete, Backspace, etc.). These characters are used for keyboard shortcuts and command line editing only. GET_KBRD can be used to return the Enter key.

## Version History

Introduced: Original

## See Also

READ/READF

# GET_LUN

The GET_LUN procedure allocates a file unit from a pool of free units. Instead of writing routines to assume the use of certain file units, IDL functions and procedures should use GET_LUN to reserve unit numbers in order to avoid conflicts with other routines. Use FREE_LUN to free the file units when finished.

## Syntax

GET_LUN, *Unit*

## Arguments

### Unit

The named variable into which GET_LUN should place the file unit number. *Unit* is converted into a longword integer in the process. The file unit number obtained is in the range 100 to 128.

## Keywords

None.

## Examples

Instead of explicitly specifying a file unit number that may already be used, use GET_LUN to obtain a free one and store the result in the variable U by entering:

```
GET_LUN, U
```

Now U can be used in opening a file:

```
OPENR, U, 'file.dat'
```

Once the data from “file.dat” has been read, the file can be closed and the file unit can be freed with the command:

```
FREE_LUN, U
```

Note also that OPENR has a GET_LUN keyword that allows you to simultaneously obtain a free file unit and open a file. The following command performs the same tasks as the first two commands above:

```
OPENR, U, 'file.dat', /GET_LUN
```

## Version History

Introduced: Original

## See Also

FREE_LUN, OPEN

# GET_SCREEN_SIZE

The GET_SCREEN_SIZE function returns size, measured in device units, of the screen.

## Syntax

*Result* = GET_SCREEN_SIZE( [*Display_name*] [, RESOLUTION=*variable*] )

**X Windows Keywords:** [, DISPLAY_NAME=*string*]

## Return Value

Returns a two-element vector of the form [*width*, *height*] that represents the dimensions, measured in device units, of the screen

## Arguments

### Display_name (X Only)

A string indicating the name of the X Windows display that should be used to determine the screen size.

## Keywords

### DISPLAY_NAME (X Only)

Set this keyword equal to a string indicating the name of the X Windows display that should be used to determine the screen size. Setting this keyword is equivalent to setting the optional *Display_name* argument.

### RESOLUTION

Set this keyword equal to a named variable that will contain a two-element vector, [*xres*, *yres*], specifying the screen resolution in cm/pixel.

## Examples

You can find the dimensions and screen resolution of your screen by entering the following:

```
dimensions = GET_SCREEN_SIZE(RESOLUTION=resolution)
PRINT, dimensions, resolution
```

For the screen on which this was tested, IDL prints:

```
1280.00      1024.00
0.0282031    0.0281250
```

## Version History

Introduced: 5.0

# GETENV

The GETENV function returns the value of one or more specified environment variables from the environment of the IDL process.

### About the Process Environment

Every process has an *environment* consisting of environment variables, each of which has an associated string value. Some environment variables always exist, such as PATH, which tells the shell where to look for programs. Others can be added by the user, either interactively via a shell, via a UNIX startup file such as `.login`, or a via a Windows control panel.

When a process is created, it is given a copy of the environment from its parent process. IDL is no exception to this; when started, it inherits a copy of the environment of its parent process, which may be an interactive shell, the windowing system's desktop environment, or some other process. In turn, any child process created by IDL (such as those from the SPAWN procedure) inherits a copy of IDL's current environment.

**Note**

It is important to realize that environment variables are not an IDL feature; they are part of every process. Although they can serve as a form of global memory, it is best to avoid using them in that way. Instead, IDL heap variables (pointers or object references), IDL system variables, or common blocks should be used in that role. Environment variables should be used for communicating with child processes. One example is setting the value of the SHELL environment variable prior to calling SPAWN to change the shell executed by SPAWN.

## Syntax

*Result* = GETENV( *Name* )

**UNIX-Only Keywords:** [, /ENVIRONMENT]

## Return Value

Returns the value of the environment variable *Name* from the environment of the IDL process, or a null string if *Name* does not exist in the environment. If *Name* is an array, the result has the same structure, with each element containing the value for the corresponding element of *Name*.

# Arguments

## Name

A scalar string or string array variable containing the names of environment variables for which values are desired.

### Special Handling of the IDL_TMPDIR Environment Variable

If you specify `'IDL_TMPDIR'` as the value of *Name*, and an environment variable with that name exists, GETENV returns its defined value as usual. However, if IDL_TMPDIR is *not* defined, GETENV returns the path of the location where IDL's internals believe temporary files should be written on your system:

- On UNIX systems, IDL uses the value of the standard TMPDIR environment variable. If TMPDIR is not defined, IDL chooses a reasonable temporary directory based on operating system and vendor conventions.
- On Windows systems, IDL uses the value provided by Windows, which is the first of the following that is defined: the value of the TMP environment variable, the value of the TEMP environment variable, or the default value for the current Windows version.

Using IDL_TMPDIR in this manner makes it simple for code written in IDL to use the same temporary directory as IDL itself uses, and provides an easy way for the user to override the default.

# Keywords

## ENVIRONMENT (UNIX Only)

If set, returns a string array containing all entries in the current process, one variable per entry, in the SETENV format (Variable=*Value*). If ENVIRONMENT is set, the *Name* argument should not be supplied.

# Examples

To print the name of the current UNIX shell, enter the command:

```
PRINT, 'The current shell is: ', GETENV('SHELL')
```

To store the path to the directory where IDL believes temporary files should be placed in the variable `mytemp`, use the following statement:

```
mytemp = GETENV('IDL_TMPDIR')
```

## See Also

SETENV

## Version History

Introduced: Original

# GOTO

The GOTO statement transfers program control to point specified by a label. The GOTO statement is generally considered to be a poor programming practice that leads to unwieldy programs. Its use should be avoided. However, for those cases in which the use of a GOTO is appropriate, IDL does provide the GOTO statement.

Note that using a GOTO to jump into the middle of a loop results in an error.

**Warning**

You must be careful in programming with GOTO statements. It is not difficult to get into a loop that will never terminate, especially if there is not an escape (or test) within the statements spanned by the GOTO.

For information on using GOTO and other IDL program control statements, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

GOTO, *label*

## Examples

In the following example, the statement at label JUMP1 is executed after the GOTO statement, skipping any intermediate statements:

```
GOTO, JUMP1
PRINT, 'Skip this' ; This statement is skipped
PRINT, 'Skip this' ; This statement is also skipped
JUMP1: PRINT, 'Do this'
```

The label can also occur before the GOTO statement that refers to the label, but you must be careful to avoid an endless loop. GOTO statements are frequently the subjects of IF statements, as in the following statement:

```
IF A NE G THEN GOTO, MISTAKE
```

## Version History

Introduced: Original

# GRID_INPUT

The GRID_INPUT procedure preprocesses and sorts two-dimensional scattered data points, and removes duplicate values. This procedure is also used for converting spherical coordinates to Cartesian coordinates.

## Syntax

GRID_INPUT, *X*, *Y*, *F*, *X1*, *Y1*, *F1* [, DUPLICATES=*string* ] [, EPSILON=*value* ] [, EXCLUDE=*vector* ]

or

GRID_INPUT, *Lon*, *Lat*, *F*, *Xyz*, *F1*, /SPHERE [, /DEGREES] [, DUPLICATES=*string* ] [, EPSILON=*value* ] [, EXCLUDE=*vector* ]

or

GRID_INPUT, *R*, *Theta*, *F*, *X1*, *Y1*, *F1*, /POLAR [, /DEGREES] [, DUPLICATES=*string* ] [, EPSILON=*value* ] [, EXCLUDE=*vector* ]

## Arguments

### X, Y

These are input arguments for scattered data points, where *X*, and *Y* are location. All of these arguments are N point vectors.

### F

The function value at each location in the form of an N point vector.

### Lon, Lat

These are input arguments representing scattered data points on a sphere, specifying location (longitude and latitude). All are N point vectors. *Lon*, *Lat* are in degrees or radians (default).

### R, Theta

These are scattered data point input arguments representing the *R* and *Theta* polar coordinate location in degrees or radians (default). All arguments are N point vectors.

### X1, Y1, F1

These output arguments are processed and sorted single precision floating point data which are passed as the input points to the GRIDDATA function.

### Xyz

Upon return, a named variable that contains a 3-by-*n* array of Cartesian coordinates representing points on a sphere.

## Keywords

### DEGREES

By default, all angular inputs and keywords are assumed to be in radian units. Set the DEGREES keyword to change the angular input units to degrees.

### DUPLICATES

Set this keyword to a string indicating how duplicate data points are handled per the following table. The case (upper or lower) is ignored. The default setting for DUPLICATES is “First”.

| String | Meaning |
|---|---|
| "First" | Retain only the first encounter of the duplicate locations. |
| "Last" | Retain only the last encounter of the duplicate locations. |
| "All" | Retains all locations, which is invalid for any gridding technique that requires a TRIANGULATION. Some methods, such as Inverse Distance or Polynomial Regression with no search criteria can handle duplicates. |
| "Avg" | Retain the average F value of the duplicate locations. |
| "Midrange" | Retain the average of the minimum and maximum duplicate locations ((Max(F) + Min (F)) / 2). |

*Table 27: DUPLICATE Keyword Values*

| String | Meaning |
|---|---|
| "Min" | Retain the minimum of the duplicate locations (Min(F)). |
| "Max" | Retain the maximum of the duplicate locations (Max(F)). |

*Table 27: DUPLICATE Keyword Values (Continued)*

### EPSILON

The tolerance for finding duplicates. Points within EPSILON distance of each other are considered duplicates. For spherical coordinates, EPSILON is in units of angular distance, as set by the DEGREES keyword.

### EXCLUDE

An *N*-point vector specifying the indices of the points to exclude.

### POLAR

Set to indicate inputs are in polar coordinates.

### SPHERE

Set to indicate inputs are in spherical coordinates. In this case, the output argument *Xyz* is set to a 3-by-*n* array containing the spherical coordinates converted to 3-dimensional Cartesian points on a sphere.

## Examples

The following example uses the data from the `irreg_grid1.txt` ASCII file included in the `examples/data` subdirectory of the IDL distribution. This file contains scattered elevation data of a model of an inlet. This scattered elevation data contains two duplicate locations. The GRID_INPUT procedure is used to omit the duplicate locations.

```
; Import the Data:

; Determine the path to the file.
file = FILE_SEARCH(!DIR, 'irreg_grid1.txt')

; Import the data from the file into a structure.
```

```
dataStructure = READ_ASCII(file)

; Get the imported array from the first field of
; the structure.
dataArray = TRANSPOSE(dataStructure.field1)

; Initialize the variables of this example from
; the imported array.
x = dataArray[*, 0]
y = dataArray[*, 1]
data = dataArray[*, 2]

; Display the Data:

; Scale the data to range from 1 to 253 so a color table can be
; applied. The values of 0, 254, and 255 are reserved as outliers.
scaled = BYTSCL(data, TOP = !D.TABLE_SIZE - 4) + 1B

; Load the color table.  If you are on a TrueColor, set the
; DECOMPOSED keyword to the DEVICE command before running a
; color table related routine.
DEVICE, DECOMPOSED = 0
LOADCT, 38

; Open a display window and plot the data points.
WINDOW, 0
PLOT, x, y, /XSTYLE, /YSTYLE, LINESTYLE = 1, $
   TITLE = 'Original Data, Scaled (1 to 253)', $
   XTITLE = 'x', YTITLE = 'y'

; Now display the data values with respect to the color table.
FOR i = 0L, (N_ELEMENTS(x) - 1) DO PLOTS, x[i], y[i], PSYM = -1, $
   SYMSIZE = 2., COLOR = scaled[i]

; Preprocess and sort the data. GRID_INPUT will
; remove any duplicate locations.
GRID_INPUT, x, y, data, xSorted, ySorted, dataSorted

; Display the results from GRID_INPUT:

; Scale the resulting data.
scaled = BYTSCL(dataSorted, TOP = !D.TABLE_SIZE - 4) + 1B

; Open a display window and plot the resulting data points.
WINDOW, 1
PLOT, xSorted, ySorted, /XSTYLE, /YSTYLE, LINESTYLE = 1, $
   TITLE = 'The Data Preprocessed and Sorted, Scaled (1 to 253)', $
   XTITLE = 'x', YTITLE = 'y'
```

```
; Now display the resulting data values with respect to the color
; table.
FOR i = 0L, (N_ELEMENTS(xSorted) - 1) DO PLOTS, $
   xSorted[i], ySorted[i], PSYM = -1, COLOR = scaled[i], $
   SYMSIZE = 2.
```

## Version History

Introduced: 5.5

## See Also

GRIDDATA

# GRID_TPS

The GRID_TPS function uses thin plate splines to interpolate a set of values over a regular two dimensional grid, from irregularly sampled data values. Thin plate splines are ideal for modeling functions with complex local distortions, such as warping functions, which are too complex to be fit with polynomials.

Given *n* points, $(x_i, y_i)$ in the plane, a thin plate spline can be defined as:

$$f(x,y) = a_0 + a_1 x + a_2 y + \frac{1}{2}\sum_{i=0}^{n-1} b_i r_i^2 \log r_i^2$$

with the constraints:

$$\sum_{i=1}^{n-1} b_i = \sum_{i=1}^{n-1} b_i x_i = \sum_{i=0}^{n-1} b_i y_i = 0$$

where $r_i^2 = (x-x_i)^2 + (y-y_i)^2$. A thin plate spline (TPS) is a smooth function, which implies that it has continuous first partial derivatives. It also grows almost linearly when far away from the points $(x_i, y_i)$. The TPS surface passes through the original points: $f(x_i, y_i) = z_i$.

**Note**

GRID_TPS requires at least 7 noncolinear points.

## Syntax

*Result* = GRID_TPS (*Xp, Yp, Values* [, COEFFICIENTS=*variable*] [, NGRID=*[nx, ny]*] [, START=*[x0, y0]*] [, DELTA=*[dx, dy]*] )

## Return Value

An array of dimension (*nx*, *ny*) of interpolated values. If the values argument is a two-dimensional array, the output array has dimensions (*nz*, *nx*, *ny*), where *nz* is the leading dimension of the values array allowing for the interpolation of arbitrarily sized vectors in a single call. Keywords can be used to specify the grid dimensions, size, and location.

**Note**

If the Cholesky factorization used within GRID_TPS fails, then *Result* will be a scalar -1.

# Arguments

## Xp

A vector of *x* points.

## Yp

A vector of *y* points, with the same number of elements as the *Xp* argument.

## Values

A vector or two-dimensional array of values to interpolate. If values are a two-dimensional array, the leading dimension is the number of values for which interpolation is performed.

# Keywords

## COEFFICIENTS

A named variable in which to store the resulting coefficients of the thin plate spline function for the last set of Values. The first *N* elements, where *N* is the number of input points, contain the coefficients $b_i$, in the previous equation. Coefficients with subscripts *n*, *n*+1, and *n*+2, contain the values of $a_0$, $a_1$, and $a_2$, in the above equation.

## DELTA

A two-element array of the distance between grid points ($d_x$, $d_y$). If a scalar is passed, the value is used for both *dx* and *dy*. The default is the range of the *xp* and *yp* arrays divided by ($n_x - 1$, $n_y - 1$).

## NGRID

A two-element array of the size of the grid to interpolate ($n_x$, $n_y$). If a scalar is passed, the value is used for both $n_x$ and $n_y$. The default value is [25, 25].

### START

A two-element array of the location of grid point ($x_0$, $y_0$). If a scalar is passed, the value is used for both $x_0$ and $y_0$. The default is the minimum values in the *xp* and *yp* arrays.

## References

I. Barrodale, et al, “Note: Warping digital images using thin plate splines”, Pattern Recognition, Vol 26, No. 2, pp 375-376, 1993.

M. J. D. Powell, “Tabulation of thin plate splines on a very fine two-dimensional grid”, Report No. DAMTP 1992/NA2, University of Cambridge, Cambridge, U.K. (1992).

## Examples

The following example creates a set of 25 random values defining a surface on a square, 100 units on a side, starting at the origin. Then, we use GRID_TPS to create a regularly gridded surface, with dimensions of 101 by 101 over the square, which is then displayed. The same data set is then interpolated using TRIGRID, and the two results are displayed for comparison.

```
;X values
x = RANDOMU(seed, 25) * 100

;Y values
y = RANDOMU(seed, 25) * 100

;Z values
z = RANDOMU(seed, 25) * 10

z1 = GRID_TPS(x, y, z, NGRID=[101, 101], START=[0,0], DELTA=[1,1])

;Show the result
SHADE_SURF, z1, TITLE='TPS'

;Grid using TRIGRID
TRIANGULATE, x, y, tr, bounds

z2 = TRIGRID(x, y, z, tr, [1,1], [0,0,100, 100], $
   EXTRAPOLATE=bounds)

;Show triangulated surface
SHADE_SURF, z2, TITLE='TRIGRID - Quintic'
```

## Version History

Introduced: 5.2

## See Also

MIN_CURVE_SURF

# GRID3

The GRID3 function fits a smooth function to a set of 3D scattered nodes ($x_i$, $y_i$, $z_i$) with associated data values ($f_i$). The function can be sampled over a set of user-specified points, or over an arbitrary 3D grid which can then be viewed using the SLICER3 procedure.

GRID3 uses the method described in Renka, R. J., "Multivariate Interpolation of Large Sets of Scattered Data," *ACM Transactions on Mathematical Software*, Vol. 14, No. 2, June 1988, Pages 139-148, which has been referred to as the Modified Shepard's Method. The function described by this method has the advantages of being equal to the values of $f_i$, at each ($x_i$, $y_i$, $z_i$), and being smooth (having continuous first partial derivatives).

## Syntax

*Result* = GRID3( *X, Y, Z, F, Gx, Gy, Gz* [, DELTA=*scalar/vector*] [, DTOL=*value*] [, GRID=*value*] [, NGRID=*value*] [, START=*[x, y, z]*] )

## Return Value

If no optional or keyword parameters are supplied, GRID3 produces a regularly-sampled volume with dimensions of (25, 25, 25), made up of single-precision, floating-point values, enclosing the original data points.

## Arguments

### X, Y, Z and F

Arrays containing the locations of the data points, and the value of the variable to be interpolated at that point. *X, Y, Z*, and *F* must have the same number of elements (with a minimum of 10 elements per array) and are converted to floating-point if necessary.

**Note**

For the greatest possible accuracy, the arrays *X, Y,* and *Z* should be scaled to fit in the range [0,1].

### $G_X$, $G_Y$, and $G_Z$

Optional arrays containing the locations within the volume to be sampled (if the GRID keyword is not set), or the locations along each axis of the sampling grid (if the

GRID keyword is set). If these parameters are supplied, the keywords DELTA, NGRID, and START are ignored.

If the keyword GRID is *not* set, the result has the same number of elements as $G_x$, $G_y$, and $G_z$. The *i*th element of the result contains the value of the interpolate at ($G_{xi}$, $G_{yi}$, $G_{zi}$). The result has the same dimensions as $G_x$.

If the GRID keyword is set, the result of GRID3 is a three-dimensional, single-precision, floating-point array with dimensions of ($N_x$, $N_y$, $N_z$), where $N_x$, $N_y$, and $N_z$ are the number of elements in $G_x$, $G_y$, and $G_z$, respectively.

# Keywords

## DELTA

Set this keyword to a three-element vector or a scalar that specifies the grid spacing in the X, Y, and Z dimensions. The default spacing produces NGRID samples within the range of each axis.

## DTOL

The tolerance for detecting an ill-conditioned system of equations. The default value is 0.01, which is appropriate for small ranges of *X*, *Y*, and *Z*. For large ranges of *X*, *Y*, or *Z*, it may be necessary to decrease the value of DTOL. If you receive the error message “GRID3: Ill-conditioned matrix or all nodes co-planar,” try decreasing the value of DTOL.

## GRID

This keyword specifies the interpretation of $G_x$, $G_y$, and $G_z$. The default value for GRID is zero if $G_x$, $G_y$, and $G_z$ are supplied, otherwise a regularly-gridded volume is produced.

## NGRID

The number of samples along each axis. NGRID can be set to a scalar, in which case each axis has the same number of samples, or to a three-element array containing the number of samples for each axis. The default value for NGRID is 25.

## START

A three-element array that specifies the starting value for each grid. The default value for START is the minimum value in the respective X, Y, and Z array.

## Examples

Produce a set random points within the (0,1) unit cube and simulate a function:

```
; Number of irregular samples:
N = 300

; Generate random values between 0 and 1:
X = RANDOMU(SEED, N)
Y = RANDOMU(SEED, N)
Z = RANDOMU(SEED, N)

; The function to simulate:
F = (X-.5)^2 + (Y-.5)^2 + Z

; Return a cube with 25 equal-interval samples along each axis:
Result = GRID3(X, Y, Z, F)

; Return a cube with 11 elements along each dimension, which
; samples each axis at (0, 0.1, ..., 1.0):
Result = GRID3(X, Y, Z, F, START=[0., 0., 0], $
   DELTA=0.1, NGRID=10)
```

The same result is produced by the statements:

```
; Create sample values:
S = FINDGEN(11) / 10.
Result = GRID3(X, Y, Z, F, S, S, S, /GRID)
```

## Version History

Introduced: Pre 4.0

## See Also

SLICER3

# GRIDDATA

The GRIDDATA function interpolates scattered data values and locations sampled on a plane or a sphere to a regular grid. This is accomplished using one of several available methods. The function result is a two-dimensional floating point array. Computations are performed in single precision floating point. Interpolation methods supported by this function are as follows:

- Inverse Distance (default)
- Kriging
- Linear
- Minimum Curvature
- Modified Shepard's
- Natural Neighbor
- Nearest Neighbor
- Polynomial Regression
- Quintic
- Radial Basis Function

## Syntax

### Interleaved

*Result* = GRIDDATA( *X*, *F* )

### Planar

*Result* = GRIDDATA( *X*, *Y*, *F* )

### Sphere From Cartesian Coordinates

*Result* = GRIDDATA( *X*, *Y*, *Z*, *F*, /SPHERE )

### Sphere From Spherical Coordinates

*Result* = GRIDDATA( *Lon*, *Lat*, *F*, /SPHERE )

**Inverse Distance Keywords:**
[, METHOD='*InverseDistance*' | /INVERSE_DISTANCE ]
[, ANISOTROPY=*vector* ] [, /DEGREES ] [, DELTA=*vector* ]
[, DIMENSION=*vector* ] [, TRIANGLES=*array* [, EMPTY_SECTORS=*value* ]
[, MAX_PER_SECTOR=*value* ] [, MIN_POINTS=*value* ]
[, SEARCH_ELLIPSE=*vector* ] ] [, FAULT_POLYGONS=*vector* ]
[, FAULT_XY=*array* ] [, /GRID, XOUT=*vector*, YOUT=*vector* ]
[, MISSING=*value* ] [, POWER=*value* ] [, SECTORS={1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 } ]
[, SMOOTHING=*value* ] [, /SPHERE] [, START=*vector* ]

**Kriging Keywords:** METHOD='*Kriging*' | /KRIGING [, ANISOTROPY=*vector* ] [, DELTA=*vector* ] [, DIMENSION=*vector* ] [, TRIANGLES=*array* [, EMPTY_SECTORS=*value* ] [, MAX_PER_SECTOR=*value* ] [, MIN_POINTS=*value* ] [, SEARCH_ELLIPSE=*vector* ] ] [, FAULT_POLYGONS=*vector* ] [, FAULT_XY=*array* ] [, /GRID, XOUT=*vector*, YOUT=*vector* ] [, MISSING=*value* ] [, SECTORS={1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 } ] [, /SPHERE] [, START=*vector* ] [, VARIOGRAM=*vector* ]

**Linear Interpolation Keywords:**
METHOD='*Linear*' | /LINEAR , TRIANGLES=*array* [, DELTA=*vector* ] [, DIMENSION=*vector* ] [, /GRID, XOUT=*vector*, YOUT=*vector* ] [, MISSING=*value* ] [, START=*vector* ]

**Minimum Curvature Keywords:**
METHOD='*MinimumCurvature*' | /MIN_CURVATURE [, DELTA=*vector* ] [, DIMENSION=*vector* ] [, START=*vector* ]

**Modified Shepard's Keywords:** METHOD='*ModifiedShepards*' | /SHEPARDS, TRIANGLES=*array* [, ANISOTROPY=*vector* ] [, DELTA=*vector* ] [, DIMENSION=*vector* ] [, EMPTY_SECTORS=*value* ] [, FAULT_POLYGONS=*vector* ] [, FAULT_XY=*array* ] [, /GRID, XOUT=*vector*, YOUT=*vector* ] [, MAX_PER_SECTOR=*value* ] [, MIN_POINTS=*value* ] [, MISSING=*value* ] [, NEIGHBORHOOD=*array* ] [, SEARCH_ELLIPSE=*vector* ] [, SECTORS={1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 } ] [, START=*vector* ]

**Natural Neighbor Keywords:**
METHOD='*NaturalNeighbor*' | /NATURAL_NEIGHBOR, TRIANGLES=*array* [, /DEGREES ] [, DELTA=*vector* ] [, DIMENSION=*vector* ] [, /GRID, XOUT=*vector*, YOUT=*vector* ] [, MISSING=*value* ] [, /SPHERE] [, START=*vector* ]

**Nearest Neighbor Keywords:**
METHOD='*NearestNeighbor*' | /NEAREST_NEIGHBOR, TRIANGLES=*array* [, /DEGREES ] [, DELTA=*vector* ] [, DIMENSION=*vector* ] [, FAULT_POLYGONS=*vector* ] [, FAULT_XY=*array* ] [, /GRID, XOUT=*vector*, YOUT=*vector* ] [, MISSING=*value* ] [, /SPHERE] [, START=*vector* ]

**Polynomial Regression Keywords:**
METHOD='*PolynomialRegression*' | /POLYNOMIAL_REGRESSION,
[, DELTA=*vector* ] [, DIMENSION=*vector* ]
[, TRIANGLES=*array* [, EMPTY_SECTORS=*value* ]
[, MAX_PER_SECTOR=*value* ] [, MIN_POINTS=*value* ]
[, SEARCH_ELLIPSE=*vector* ] ] [, FAULT_POLYGONS=*vector* ]
[, FAULT_XY=*array* ] [, /GRID, XOUT=*vector*, YOUT=*vector* ]
[, MISSING=*value* ] [, POWER=*value* ] [, SECTORS={1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 } ]
[, START=*vector* ]

**Quintic Keywords:** METHOD='*Quintic*' | /QUINTIC, TRIANGLES=*array*
[, DELTA=*vector* ] [, DIMENSION=*vector* ] [, MISSING=*value* ]
[, START=*vector* ]

**Radial Basis Function Keywords:**
METHOD='*RadialBasisFunction*' | /RADIAL_BASIS_FUNCTION,
[, ANISOTROPY=*vector* ] [, /DEGREES ] [, DELTA=*vector* ]
[, DIMENSION=*vector* ] [, TRIANGLES=*array* [, EMPTY_SECTORS=*value* ]
[, MAX_PER_SECTOR=*value* ] [, MIN_POINTS=*value* ]
[, SEARCH_ELLIPSE=*vector* ] ] [, FAULT_POLYGONS=*vector* ]
[, FAULT_XY=*array* ] [, FUNCTION_TYPE={ 0 | 1 | 2 | 3 | 4 } ]
[, /GRID, XOUT=*vector*, YOUT=*vector* ] [, MISSING=*value* ]
[, SECTORS={1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 } ] [, SMOOTHING=*value* ] [, /SPHERE]
[, START=*vector* ]

# Return Value

*Result* is a two-dimensional floating point array. Computations are preformed in single precision floating point.

# Arguments

## X [, Y [, Z]]

The point locations. If only one input coordinate parameter is supplied, the points are interleaved; for the Cartesian coordinate system the points are 2-by-*n* dimensions; and 3-by-*n* for a sphere in Cartesian coordinates.

## F

The function value at each location in the form of an *n*-point vector.

**Note**

GRIDDATA will use the minimum number of points specified in any of the X, Y, Z, or F array arguments as the number of input points and function values.

### Lon, Lat

These arguments contain the locations (on a sphere) of the data points (similar to *X*, and *Y*) but are in degrees or radians (default) depending on the use of the keyword DEGREES.

## Keywords

### ANISOTROPY

This keyword is a vector describing an ellipse (see the description for the SEARCH_ELLIPSE keyword). All points on the circumference of the ellipse have an equal influence on a point at the center of the ellipse.

For example, assume that atmospheric data are being interpolated, with one dimension being altitude, and the other dimension representing distance from a point. If the vertical mixing is half that of the horizontal mixing, a point 100 units from an interpolate and at the same level has the same influence as a point 50 units above or below the interpolate at the same horizontal location. This effect requires setting the ANISOTROPY keyword to `[2, 1, 0]` which forms an ellipse with an *X*-axis length twice as long as its *Y*-axis length.

### DEGREES

By default, all angular inputs and keywords are assumed to be in radian units. Set the DEGREES keyword to change the angular input units to degrees.

### DELTA

A two-element array specifying the grid spacing in *X* and *Y*.

If this keyword is not specified, or if either element is set equal to zero, the grid spacing is determined from the values of the DIMENSION and START keywords, according to the following rules:

- DELTA[0] = (max(*x*) - START[0])/(DIMENSION - 1)
- DELTA[1] = (max(*y*) - START[1])/(DIMENSION - 1)

DELTA can also be set to a scalar value to be used for the grid size in both *X* and *Y*.

This keyword is ignored if the GRID, XOUT and YOUT keywords are specified.

## DIMENSION

A two element array specifying the grid dimensions in *X* and *Y*. Default value is 25 for each dimension. This keyword can also be set to a scalar value to be used for the grid spacing in both *X* and *Y*.

This keyword is ignored if the GRID, XOUT and YOUT keywords are specified.

## EMPTY_SECTORS

This keyword defines the search rules for the maximum number of sectors that may be empty when interpolating at each point. If this number or more sectors contain no data points, considering the search ellipse and/or the fault polygons, the resulting interpolant is the missing data value.

**Note**

The TRIANGLES keyword is required when the EMPTY_SECTORS, MAX_PER_SECTOR, MIN_POINTS, or SEARCH_ELLIPSE keywords are used.

## FAULT_POLYGONS

Set this keyword to an array containing one or more polygon descriptions. A polygon description is an integer or longword array of the form: [$n$, $i_0$, $i_1$, ..., $i_{n-1}$], where $n$ is the number of vertices that define the polygon, and $i_0 ... i_{n-1}$ are indices into the FAULT_XY vertices. The FAULT_POLYGON array may contain multiple polygon descriptions that have been concatenated. To have this keyword ignore an entry in the FAULT_POLYGONS array, set the vertex count, $n$, and all associated indices to 0. To end the drawing list, even if additional array space is available, set $n$ to –1. If this keyword is not specified, a single connected polygon is generated from FAULT_XY.

**Note**

FAULT_POLYGONS are not supported with spherical gridding.

## FAULT_XY

The a 2-by-*n* array specifying the coordinates of points on the fault lines/polygons.

**Note**

FAULT_XY is not supported with spherical gridding.

## FUNCTION_TYPE

**Note**

This keyword is only used with the Radial Basis Function method of interpolation.

Set this keyword to one of the values shown in the following table to indicate which basis function to use. Default is 0, the Inverse Multiquadric function.

| Value | Function Type Used | Equation |
|---|---|---|
| 0 | Inverse Multiquadric | $B(h) = 1/(\sqrt{h^2 + R^2})$ |
| 1 | Multilog | $B(h) = \log(h^2 + R^2)$ |
| 2 | Multiquadric | $B(h) = \sqrt{h^2 + R^2}$ |
| 3 | Natural Cubic Spline | $B(h) = (h^2 + R^2)^{3/2}$ |
| 4 | Thin Plate Spline | $B(h) = (h^2 + R^2)\log(h^2 + R^2)$ |

**Note -** In the equations, h = the anisotropically scaled distance from the interpolant to the node, and $R^2$ = the value of the SMOOTHING keyword.

## GRID

The GRID keyword controls how the XOUT and YOUT vectors specify where interpolates are desired.

If GRID is set, XOUT and YOUT must also be specified. Interpolation is performed on a regular or irregular grid specified by the vectors XOUT with *m* elements and YOUT with *n* elements. The *Result* is an *m*-by-*n* grid with point [*i*, *j*] resulting from the interpolation at (XOUT[*i*], YOUT[*j*]). When XOUT and YOUT are used, the DELTA, DIMENSION and START keywords are ignored.

## INVERSE_DISTANCE

Selects the Inverse Distance method of interpolation.

## KRIGING

Selects the Kriging method of interpolation. The variogram type for the Kriging method is set by default, however the VARIOGRAM keyword can be used to set variogram parameters.

## LINEAR

Selects the Linear method of interpolation. The TRIANGLES keyword is required when the LINEAR keyword is used.

## MAX_PER_SECTOR

This keyword defines the search rules for the maximum number of data points to include in each sector when interpolating. Search rules effectively limit the number of data points used in computing each interpolate. For example, to use the nearest *n* nodes to compute each interpolant, specify MAX_PER_SECTOR = *n* and use the TRIANGLES keyword.

**Note**

The TRIANGLES keyword is required when the EMPTY_SECTORS, MAX_PER_SECTOR, MIN_POINTS, or SEARCH_ELLIPSE keywords are used.

## METHOD

A string containing one of the method names as shown in the following table. The default for METHOD is “InverseDistance”.

**Note**

The interpolation method can be chosen using the METHOD keyword set to the specific string, or by setting the corresponding method name keyword.

There are no spaces between words in the method strings and the strings are case insensitive.

| Method String | Meaning |
|---|---|
| "InverseDistance" | Data points closer to the grid points have more effect than those which are further away. |

*Table 28: METHOD Keyword Values*

| Method String | Meaning |
|---|---|
| "Kriging" | Data points and their spatial variance are used to determine trends which are applied to the grid points. |
| "Linear" | Grid points are linearly interpolated from triangles formed by Delaunay triangulation. |
| "MinimumCurvature" | A plane of grid points is conformed to the data points while trying to minimize the amount of bending in the plane. |
| "ModifiedShepards" | Inverse Distance weighted with the least squares method. |
| "NaturalNeighbor" | Each interpolant is a linear combination of the three vertices of its enclosing Delaunay triangle and their adjacent vertices. |
| "NearestNeighbor" | The grid points have the same value as the nearest data point. |
| "PolynomialRegression" | Each interpolant is a least-squares fit of a polynomial in X and Y of the specified power to the specified data points. |
| "Quintic" | Grid points are interpolated with quintic polynomials from triangles formed by Delaunay triangulation. |
| "RadialBasisFunction" | The effects of data points are weighted by a function of their radial distance from a grid point. |

*Table 28: METHOD Keyword Values*

## MIN_CURVATURE

Selects the Minimum Curvature method of interpolation.

**Note**

If the Cholesky factorization used within the Minimum Curvature method fails, then a scalar -1 will be returned instead of the two-dimensional array.

## MIN_POINTS

If fewer than this number of data points are encountered in all sectors, the value of the resulting grid point is set to the value of the MISSING keyword.

The MIN_POINTS keyword also indicates the number of closest points used for each local fit, if SEARCH_ELLIPSE isn't specified.

**Note**

The TRIANGLES keyword is required when the EMPTY_SECTORS, MAX_PER_SECTOR, MIN_POINTS, or SEARCH_ELLIPSE keywords are used.

## MISSING

Set this keyword to the value to use for missing data values. Default is 0.

## NATURAL_NEIGHBOR

Selects the Natural Neighbor method of interpolation.

**Note**

The TRIANGLES keyword is required when the NATURAL_NEIGHBOR keyword is used.

## NEAREST_NEIGHBOR

Selects the Nearest Neighbor method of interpolation.

**Note**

The TRIANGLES keyword is required when the NEAREST_NEIGHBOR keyword is used.

## NEIGHBORHOOD

**Note**

The NEIGHBORHOOD keyword is only used for the Modified Shepard's method of interpolation.

A two-element array, [*Nq*, *Nw*] defining the quadratic fit, *Nq*, and weighting, *Nw*, neighborhood sizes for the Modified Shepard's method. The default for *Nq* is the smaller of 13 and the number of points minus 1, with a minimum of 5. The default for *Nw* is the smaller of 19 and the number of points. The Modified Shepard's method

first computes the coefficients of a quadratic fit for each input point, using its *Nq* closest neighbors.

When interpolating an output point, the quadratic fits from the *Nw* closest input points are weighted inversely by a function of distance and then combined. The size of the neighborhood used for Shepard's method interpolation may also be specified by the search rules keywords.

## POLYNOMIAL_REGRESSION

Selects the Polynomial Regression method for interpolation. The power of the polynomial regression is set to 2 by default, however the POWER keyword can be used to change the power to 1 or 3.

The function fit to each interpolant corresponding to the POWER keyword set equal to 1, 2 (the default), and 3 respectively is as follows:

$$F(x,y) = a_0 + a_1x + a_2y$$

$$F(x,y) = a_0 + a_1x + a_2y + a_3x^2 + a_4y^2 + a_5xy$$

$$F(x,y) = a_0 + a_1x + a_2y + a_3x^2 + a_4y^2 + a_5xy + a_6x^3 + a_7y^3 + a_8x^2y + a_9xy^2$$

By inspection, a minimum of three data points are required to fit the linear polynomial, six data points for the second polynomial equation (where POWER = 2), and ten data points for the third polynomial (POWER = 3). If not enough data points exist for a given interpolant, the missing data values are set to the value of the MISSING keyword.

## POWER

The weighting power of the distance, or the maximum order in the polynomial fitting function. For polynomial regression, this value is either 1, 2 (the default), or 3.

**Note**

The POWER keyword is only used for the Inverse Distance and Polynomial Regression methods of interpolation.

## QUINTIC

Selects the triangulation with Quintic interpolation method.

**Note**

The TRIANGLES keyword is required when the QUINTIC keyword is used.

## RADIAL_BASIS_FUNCTION

Selects the Radial Basis Function method of interpolation.

## SEARCH_ELLIPSE

This keyword defines the search rules as a scalar or vector of from 1 to 3 elements that specify an ellipse or circle in the form [*R1*], [*R1*, *R2*], or [*R1*, *R2*, *Theta*]. *R1* is one radius, *R2* the other radius, and *Theta* describes the angle between the *X*-axis to the *R1*-axis, counterclockwise, in degrees or radians as specified by the DEGREES keyword. Only data points within this ellipse, centered on the location of the interpolate, are considered. If not specified, or 0, this distance test is not applied. Search rules effectively limit the number of data points used in computing each interpolate.

For example, to only consider data points within a distance of 5 units of each interpolant, specify the keyword as SEARCH_ELLIPSE = 5.

**Note**

The TRIANGLES keyword is required when the EMPTY_SECTORS, MAX_PER_SECTOR, MIN_POINTS, or SEARCH_ELLIPSE keywords are used.

## SECTORS

This keyword defines the search rules for the number of sectors used in applying the MAX_SECTOR, EMPTY_SECTORS, and MIN_POINTS tests, an integer from 1 (the default setting) to 8.

## SHEPARDS

Selects the Modified Shepard's method of interpolation. The parameters for the Modified Shepard's method are set by default, however the NEIGHBORHOOD keyword can be used to modify the parameters.

**Note**

The TRIANGLES keyword is required when the SHEPARDS keyword is used.

## SMOOTHING

A scalar value defining the smoothing radius. For the Radial Basis Function method, if SMOOTHING is not specified, the default value is equal to the average point spacing, assuming a uniform distribution. For the Inverse Distance method, the default value is 0, implying no smoothing.

**Note**

The SMOOTHING keyword is used only for the Inverse Distance and Radial Basis Function methods of interpolation.

## SPHERE

If set, data points lie on the surface of a sphere.

## START

A scalar or a two-element array specifying the start of the grid in *X* and *Y*. Default value is [min(*x*), min(*y*)].

This keyword is ignored if the GRID, XOUT and YOUT keywords are specified.

## TRIANGLES

A 3-by-*nt* longword array describing the connectivity of the input points, as returned by TRIANGULATE, where *nt* is the number of triangles. If duplicate point locations are input and the TRIANGLES keyword is present, only one of the points is considered.

**Note**

The TRIANGLES keyword is required for the Natural Neighbor, Nearest Neighbor, Modified Shepard's, Linear, and Quintic Interpolation methods.

**Note**

The TRIANGLES keyword is required when the EMPTY_SECTORS, MAX_PER_SECTOR, MIN_POINTS, or SEARCH_ELLIPSE keywords are used.

## VARIOGRAM

Specifies the variogram type and parameters for the Kriging method. This parameter is a vector of one to four elements in the form of: [ *Type*, *Range*, *Nugget*, *Scale*]. The *Type* is encoded as: 1 for linear, 2 for exponential, 3 for gaussian, 4 for spherical. Defaults values are: *Type* is exponential, *Range* is 8 times the average point spacing assuming a uniform distribution, *Nugget* is zero, and *Scale* is 1.

**Note**

The VARIOGRAM keyword is only used with the Kriging method of interpolation.

The following functions are used to model the variogram functions:

Linear Covariance:

$$\text{Covariance} = \begin{cases} N & \text{if } d = 0 \\ Sd & \text{if } d < R \\ 0 & \text{if } d > R \end{cases}$$

Exponential Covariance:

$$\text{Covariance} = \begin{cases} N + S & \text{if } d = 0 \\ Se^{(-3d/R)} & \text{if } d > 0 \end{cases}$$

Gaussian Covariance:

$$\text{Covariance} = \begin{cases} N + S & \text{if } d = 0 \\ Se^{(-3d^2/R^2)} & \text{if } d > 0 \end{cases}$$

Spherical Covariance:

$$\text{Covariance} = \begin{cases} N + S & \text{if } d = 0 \\ S - 1.5S(d/R) + 0.5(d/R)^3 & \text{if } d < R \\ 0 & \text{if } d > R \end{cases}$$

where *d* is the distance from one point to another, *R* is the range value, *N* is the nugget value, and *S* is the scale value.

## XOUT

If the GRID keyword is set, use XOUT to specify irregularly spaced rectangular output grids. If XOUT is specified, YOUT must also be specified. When XOUT and YOUT are used, the DELTA, DIMENSION and START keywords are ignored.

If GRID is not set (the default), the location vectors XOUT and YOUT directly contain the X and Y values of the interpolates, and must have the same number of elements. The *Result* has the same structure and number of elements as XOUT and YOUT, with point [*i*] resulting from the interpolation at (XOUT[*i*], YOUT[*i*]).

### YOUT

If the GRID keyword is set, use YOUT to specify irregularly spaced rectangular output grids. If YOUT is specified, XOUT must also be specified. When XOUT and YOUT are used, the DELTA, DIMENSION and START keywords are ignored.

If GRID is not set (the default), the location vectors XOUT and YOUT directly contain the X and Y values of the interpolates, and must have the same number of elements. The *Result* has the same structure and number of elements as XOUT and YOUT, with point [*i*] resulting from the interpolation at (XOUT[*i*], YOUT[*i*]).

## Examples

### Example 1

This example interpolates a data set measured on an irregular grid. Various types of the Inverse Distance interpolation method (the default method) are used in this example.

```
; Create a dataset of N points.
n = 100                          ;# of scattered points
seed = -121147L                  ;For consistency
x = RANDOMU(seed, n)
y = RANDOMU(seed, n)

; Create a dependent variable in the form a function of (x,y)
; with peaks & valleys.
f = 3 * EXP(-((9*x-2)^2 + (7-9*y)^2)/4) + $
   3 * EXP(-((9*x+1)^2)/49 - (1-0.9*y)) + $
   2 * EXP(-((9*x-7)^2 + (6-9*y)^2)/4) - $
   EXP(-(9*x-4)^2 - (2-9*y)^2)

; Initialize display.
WINDOW, 0, XSIZE = 512, YSIZE = 768, TITLE = 'Inverse Distance'
!P.MULTI = [0, 1, 3, 0, 0]

; Inverse distance: Simplest default case which produces a 25 x
; 25 grid.
grid = GRIDDATA(x, y, f)
SURFACE, grid, CHARSIZE = 3, TITLE = 'Simple Example'

; Default case, Inverse distance.
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51)
SURFACE, grid, CHARSIZE = 3, TITLE = 'Larger Grid'

; Inverse distance + smoothing.
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
```

```
   SMOOTH = 0.05)
SURFACE, grid, CHARSIZE = 3, TITLE = 'Smoothing'

; Set system variable back to default value.
!P.MULTI = 0
```

## Example 2

This example uses the same data as the previous one, however in this example we use the Radial Basis Function and the Modified Shepard's interpolation methods.

```
; Create a dataset of N points.
n = 100                          ;# of scattered points
seed = -121147L                  ;For consistency
x = RANDOMU(seed, n)
y = RANDOMU(seed, n)

; Create a dependent variable in the form of a function of (x,y)
; with peaks & valleys.
f = 3 * EXP(-((9*x-2)^2 + (7-9*y)^2)/4) + $
   3 * EXP(-((9*x+1)^2)/49 - (1-0.9*y)) + $
   2 * EXP(-((9*x-7)^2 + (6-9*y)^2)/4) - $
   EXP(-(9*x-4)^2 - (2-9*y)^2)

; Initialize display.
WINDOW, 0, XSIZE = 512, YSIZE = 512, $
   TITLE = 'Different Methods of Gridding'
!P.MULTI = [0, 1, 2, 0, 0]

; Use radial basis function with multilog basis function.
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
   /RADIAL_BASIS_FUNCTION, FUNCTION_TYPE = 1)
SURFACE, grid, CHARSIZE = 3, TITLE = 'Radial Basis Function'

; The following example requires triangulation.
TRIANGULATE, x, y, tr

; Use Modified Shepard's method.
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
   TRIANGLES = tr, /SHEPARDS)
SURFACE, grid, CHARSIZE = 3, TITLE = "Modified Shepard's Method"

; Set system variable back to default value.
!P.MULTI = 0
```

## Example 3

This example uses the same data as the previous ones, however in this example we use various types of the Polynomial Regression interpolation method.

```
; Create a dataset of N points.
n = 100                         ;# of scattered points
seed = -121147L                 ;For consistency
x = RANDOMU(seed, n)
y = RANDOMU(seed, n)

; Create a dependent variable in the form a function of (x,y)
; with peaks & valleys.
f = 3 * EXP(-((9*x-2)^2 + (7-9*y)^2)/4) + $
   3 * EXP(-((9*x+1)^2)/49 - (1-0.9*y)) + $
   2 * EXP(-((9*x-7)^2 + (6-9*y)^2)/4) - $
   EXP(-(9*x-4)^2 - (2-9*y)^2)

; Initialize display.
WINDOW, 0, XSIZE = 512, YSIZE = 768, $
   TITLE = 'Polynomial Regression'
!P.MULTI = [0, 1, 3, 0, 0]

; The following examples require the triangulation.
TRIANGULATE, x, y, tr

; Fit with a 2nd degree polynomial in x and y.  This fit considers
; all points when fitting the surface, obliterating the individual
; peaks.
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
   TRIANGLES = tr, /POLYNOMIAL_REGRESSION)
SURFACE, grid, CHARSIZE = 3, TITLE = 'Global Degree 2 Polynomial'

; Fit with a 2nd degree polynomial in x and y, but this time use
; only the 10 closest nodes to each interpolant.  This provides a
; relatively smooth surface, but still shows the individual peaks.
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
   TRIANGLES = tr, /POLYNOMIAL_REGRESSION, MAX_PER_SECTOR = 10)
SURFACE, grid, CHARSIZE = 3, TITLE = 'Local Polynomial, 10 Point'

; As above, but use only the nodes within a distance of 0.4 when
; fitting each interpolant.
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
   TRIANGLES = tr, /POLYNOMIAL_REGRESSION, SEARCH_ELLIPSE = 0.4)
SURFACE, grid, CHARSIZE = 3, $
   TITLE = 'Local Polynomial, Radius = 0.4'

!P.MULTI = 0          ; Set system variable back to default value.
```

## Example 4

This example uses the same data as the previous ones, however in this example we show how to speed up the interpolation by limiting the interpolation to the local area around each interpolate.

```
; Create a dataset of N points.\.
n = 100                          ;# of scattered points
seed = -121147L                  ;For consistency
x = RANDOMU(seed, n)
y = RANDOMU(seed, n)

; Create a dependent variable in the form a function of (x,y)
; with peaks & valleys.
f = 3 * EXP(-((9*x-2)^2 + (7-9*y)^2)/4) + $
   3 * EXP(-((9*x+1)^2)/49 - (1-0.9*y)) + $
   2 * EXP(-((9*x-7)^2 + (6-9*y)^2)/4) - $
   EXP(-(9*x-4)^2 - (2-9*y)^2)

; Note: the inverse distance, kriging, polynomial regression, and
; radial basis function methods are, by default, global methods in
; which each input node affects each output node. With these
; methods, large datasets can require a prohibitively long time to
; compute unless the scope of the interpolation is limited to a
; local area around each interpolate by specifying search rules.
; In fact, the radial basis function requires time proportional to
; the cube of the number of input points.

; For example, with 2,000 input points, a typical workstation
; required 500 seconds to interpolate a 10,000 point grid using
; radial basis functions.  By limiting the size of the fit to the
; 20 closest points to each interpolate, via the MIN_POINTS
; keyword, the time required dropped to less than a second.

; Initialize display.
WINDOW, 0, XSIZE = 512, YSIZE = 512, $
   TITLE = 'Radial Basis Function'
!P.MULTI = [0, 1, 2, 0, 0]

; Slow way:
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
   /RADIAL_BASIS_FUNCTION)
SURFACE, grid, CHARSIZE = 3, TITLE = 'All Points'

; The following example requires triangulation.
TRIANGULATE, x, y, tr

; Faster way:
grid = GRIDDATA(x, y, f, START = 0, DELTA = 0.02, DIMENSION = 51, $
```

```
   /RADIAL_BASIS_FUNCTION, MIN_POINTS = 15, TRIANGLES = tr)
SURFACE, grid, CHARSIZE = 3, TITLE = 'Nearest 15 Points'

; Set system variable back to default value.
!P.MULTI = 0
```

## Example 5

This example interpolates a spherical data set measured on an irregular grid. We use the Kriging and Natural Neighbors interpolation methods in this example.

```
; Create a 100 scattered points on a sphere and form a function
; of their latitude and longitude. Then grid them to a 2 degree
; grid over the sphere, display a Mollweide projection map, and
; overlay the contours of the result on the map.

; Create a dataset of N points.
n = 100
; A 2 degree grid with grid dimensions.
delta = 2
dims = [360, 180]/delta
; Longitude and latitudes
lon = RANDOMU(seed, n) * 360 - 180
lat = RANDOMU(seed, n) * 180 - 90
; The lon/lat grid locations
lon_grid = FINDGEN(dims[0]) * delta - 180
lat_grid = FINDGEN(dims[1]) * delta - 90

; Create a dependent variable in the form of a smoothly varying
; function.
f = SIN(2*lon*!DTOR) + COS(lat*!DTOR) ;

; Initialize display.
WINDOW, 0, XSIZE = 512, YSIZE = 768, TITLE = 'Spherical Gridding'
!P.MULTI = [0, 1, 3, 0, 0]

; Kriging: Simplest default case.
z = GRIDDATA(lon, lat, f, /KRIGING, /DEGREES, START = 0, /SPHERE, $
   DELTA = delta, DIMENSION = dims)
MAP_SET, /MOLLWEIDE, /ISOTROPIC, /HORIZON, /GRID, CHARSIZE = 3, $
   TITLE = 'Sphere: Kriging'
CONTOUR, z, lon_grid, lat_grid, /OVERPLOT, NLEVELS = 10, /FOLLOW

; This example is the same as above, but with the addition of a
; call to QHULL to triangulate the points on the sphere, and to
; then interpolate using the 10 closest points. The gridding
; portion of this example requires about one-fourth the time as
; above.
QHULL, lon, lat, tr, /DELAUNAY, SPHERE = s
```

```
z = GRIDDATA(lon, lat, f, /DEGREES, START = 0, DELTA = delta, $
   DIMENSION = dims, TRIANGLES = tr, MIN_POINTS = 10, /KRIGING, $
   /SPHERE)
MAP_SET, /MOLLWEIDE, /ISOTROPIC, /HORIZON, /GRID, /ADVANCE, $
   CHARSIZE = 3, TITLE = 'Sphere: Kriging, 10 Closest Points'
CONTOUR, z, lon_grid, lat_grid, /OVERPLOT, NLEVELS = 10, /FOLLOW

; This example uses the natural neighbor method, which is about
; four times faster than the above example but does not give as
; smooth a surface.
z = GRIDDATA(lon, lat, f, /DEGREES, START = 0, DELTA = delta, $
   DIMENSION = dims, /SPHERE, /NATURAL_NEIGHBOR, TRIANGLES = tr)
MAP_SET, /MOLLWEIDE, /ISOTROPIC, /HORIZON, /GRID, /ADVANCE, $
   CHARSIZE = 3, TITLE = 'Sphere: Natural Neighbor'
CONTOUR, z, lon_grid, lat_grid, /OVERPLOT, NLEVELS = 10, /FOLLOW

; Set system variable back to default value.
!P.MULTI = 0
```

## Example 6

The following example uses the data from the `irreg_grid1.txt` ASCII file. This file contains scattered elevation data of a model of an inlet. This scattered elevation data contains two duplicate locations.

The GRID_INPUT procedure is used to omit the duplicate locations for the GRIDDATA function. The GRIDDATA function is then used to grid the data using the Radial Basis Function method. This method is specified by setting the METHOD keyword the `RadialBasisFunction` string, although it could easily be done using the RADIAL_BASIS_FUNCTION keyword.

```
; Import the Data:

; Determine the path to the file.
file = FILEPATH('irreg_grid1.txt', $
   SUBDIRECTORY = ['examples', 'data'])

; Import the data from the file into a structure.
dataStructure = READ_ASCII(file)

; Get the imported array from the first field of
; the structure.
dataArray = TRANSPOSE(dataStructure.field1)

; Initialize the variables of this example from
; the imported array.
x = dataArray[*, 0]
y = dataArray[*, 1]
```

```
data = dataArray[*, 2]

; Display the Data:

; Scale the data to range from 1 to 253 so a color table can be
; applied. The values of 0, 254, and 255 are reserved as outliers.
scaled = BYTSCL(data, TOP = !D.TABLE_SIZE - 4) + 1B

; Load the color table.  If you are on a TrueColor, set the
; DECOMPOSED keyword to the DEVICE command before running a
; color table related routine.
DEVICE, DECOMPOSED = 0
LOADCT, 38

; Open a display window and plot the data points.
WINDOW, 0
PLOT, x, y, /XSTYLE, /YSTYLE, LINESTYLE = 1, $
   TITLE = 'Original Data, Scaled (1 to 253)', $
   XTITLE = 'x', YTITLE = 'y'

; Now display the data values with respect to the color table.
FOR i = 0L, (N_ELEMENTS(x) - 1) DO PLOTS, x[i], y[i], PSYM = -1, $
   SYMSIZE = 2., COLOR = scaled[i]

; Grid the Data and Display the Results:

; Preprocess and sort the data. GRID_INPUT will
; remove any duplicate locations.
GRID_INPUT, x, y, data, xSorted, ySorted, dataSorted

; Initialize the grid parameters.
gridSize = [51, 51]

; Use the equation of a straight line and the grid parameters to
; determine the x of the resulting grid.
slope = (MAX(xSorted) - MIN(xSorted))/(gridSize[0] - 1)
intercept = MIN(xSorted)
xGrid = (slope*FINDGEN(gridSize[0])) + intercept

; Use the equation of a straight line and the grid parameters to
; determine the y of the resulting grid.
slope = (MAX(ySorted) - MIN(ySorted))/(gridSize[1] - 1)
intercept = MIN(ySorted)
yGrid = (slope*FINDGEN(gridSize[1])) + intercept

; Grid the data with the Radial Basis Function method.
grid = GRIDDATA(xSorted, ySorted, dataSorted, $
   DIMENSION = gridSize, METHOD = 'RadialBasisFunction')
```

```
; Open a display window and contour the  Radial Basis Function
; results.
WINDOW, 1
scaled = BYTSCL(grid, TOP = !D.TABLE_SIZE - 4) + 1B
CONTOUR, scaled, xGrid, YGrid, /XSTYLE, /YSTYLE, /FILL, $
   LEVELS = BYTSCL(INDGEN(18), TOP = !D.TABLE_SIZE - 4) + 1B, $
   C_COLORS = BYTSCL(INDGEN(18), TOP = !D.TABLE_SIZE - 4) + 1B, $
   TITLE = 'The Resulting Grid with Radial Basis Function', $
   XTITLE = 'x', YTITLE = 'y'
```

## Example 7

The following example uses the data from the `irreg_grid1.txt` ASCII file. This file contains scattered elevation data of a model of an inlet. This scattered elevation data contains two duplicate locations. The same data is used in the previous example.

The GRID_INPUT procedure is used to omit the duplicate locations for the GRIDDATA function. The GRIDDATA function is then used to grid the data using the Radial Basis Function method. This method is specified by setting the METHOD keyword the `RadialBasisFunction` string, although it could easily be done using the RADIAL_BASIS_FUNCTION keyword.

Faulting is also applied in this example. First, a fault area is placed around the right side of the dataset. This fault area contains data points. The data points within this area are gridded separately from the points outside of the fault area.

Then, a fault area is defined within an region that does not contain any data points. Since this fault area does not contain any points, the grid within this region simply results to the value defined by the MISSING keyword. The points outside of the fault area are gridded independent of the fault region.

```
; Import the Data:

; Determine the path to the file.
file = FILEPATH('irreg_grid1.txt', $
   SUBDIRECTORY = ['examples', 'data'])

; Import the data from the file into a structure.
dataStructure = READ_ASCII(file)

; Get the imported array from the first field of
; the structure.
dataArray = TRANSPOSE(dataStructure.field1)

; Initialize the variables of this example from
; the imported array.
x = dataArray[*, 0]
y = dataArray[*, 1]
```

```
data = dataArray[*, 2]

; Grid the Data and Display the Results:

; Preprocess and sort the data. GRID_INPUT will
; remove any duplicate locations.
GRID_INPUT, x, y, data, xSorted, ySorted, dataSorted

; Initialize the grid parameters.
gridSize = [51, 51]

; Use the equation of a straight line and the grid parameters to
; determine the x of the resulting grid.
slope = (MAX(xSorted) - MIN(xSorted))/(gridSize[0] - 1)
intercept = MIN(xSorted)
xGrid = (slope*FINDGEN(gridSize[0])) + intercept

; Use the equation of a straight line and the grid parameters to
; determine the y of the resulting grid.
slope = (MAX(ySorted) - MIN(ySorted))/(gridSize[1] - 1)
intercept = MIN(ySorted)
yGrid = (slope*FINDGEN(gridSize[1])) + intercept

; Initialize display.
DEVICE, DECOMPOSED = 0
LOADCT, 38
WINDOW, 0, XSIZE = 600, YSIZE = 600, $
   TITLE = 'The Resulting Grid from the Radial Basis Function '+ $
   'Method with Faulting'
!P.MULTI = [0, 1, 2, 0, 0]

; Define a fault area, which contains data points.
faultVertices = [[2200, 4000], [2200, 3000], [2600, 2700], $
   [2600, -50], [5050, -50], [5050, 4000], [2200, 4000]]
faultConnectivity = [7, 0, 1, 2, 3, 4, 5, 6, -1]

; Grid the data with faulting using the Radial Basis Function
; method.
grid = GRIDDATA(xSorted, ySorted, dataSorted, $
   DIMENSION = gridSize, METHOD = 'RadialBasisFunction', $
   FAULT_XY = faultVertices, FAULT_POLYGONS = faultConnectivity, $
   MISSING = MIN(dataSorted))

; Display grid results.
CONTOUR, BYTSCL(grid), xGrid, YGrid, /XSTYLE, /YSTYLE, /FILL, $
   LEVELS = BYTSCL(INDGEN(18)), C_COLORS = BYTSCL(INDGEN(18)), $
   TITLE = 'Fault Area Contains Data ' + $
   '(Fault Area in Dashed Lines)', XTITLE = 'x', YTITLE = 'y'
```

```
; Display outline of fault area.
PLOTS, faultVertices, /DATA, LINESTYLE = 2, THICK = 2

; Define a fault area, which does not contain data points.
faultVertices = [[2600, -50], [2800, -50], [2800, 2700], $
   [2400, 3000], [2400, 4000], [2200, 4000], [2200, 3000], $
   [2600, 2700], [2600, -50]]
faultConnectivity = [9, 0, 1, 2, 3, 4, 5, 6, 7, 8, -1]

; Grid the data with faulting using the Radial Basis Function
; method.
grid = GRIDDATA(xSorted, ySorted, dataSorted, $
   DIMENSION = gridSize, METHOD = 'RadialBasisFunction', $
   FAULT_XY = faultVertices, FAULT_POLYGONS = faultConnectivity, $
   MISSING = MIN(dataSorted))

; Display grid results.
CONTOUR, BYTSCL(grid), xGrid, YGrid, /XSTYLE, /YSTYLE, /FILL, $
   LEVELS = BYTSCL(INDGEN(18)), C_COLORS = BYTSCL(INDGEN(18)), $
   TITLE = 'Fault Area Does Not Contain Data '+ $
   '(Fault Area in Dashed Lines)', XTITLE = 'x', YTITLE = 'y'

; Display outline of fault area.
PLOTS, faultVertices, /DATA, LINESTYLE = 2, THICK = 2

; Set system variable back to default value.
!P.MULTI = 0
```

# References

## Kriging

Isaaks, E. H., and Srivastava, R. M., An Introduction to Applied Geostatistics, Oxford University Press, New York, 1989.

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### Modified Shepard's

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Shepard, D., "A Two Dimensional Interpolation Function for Irregularly Spaced Data", Proc. 23rd Nat. Conf. ACM, 1968, pp. 517-523.

### Natural Neighbor

Watson, D. F., Contouring: A Guide to the Analysis and Display of Spatial Data, Pergamon Press, ISBN 0 08 040286 0, 1992.

Watson, D. F., Nngridr - An Implementation of Natural Neighbor Interpolation, David Watson, P.O. Box 734, Clarement, WA 6010, Australia, 1994.

### Quintic

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Renka, R.J., "A Triangle-based C1 Interpolation Method", Rocky Mountain Journal of Mathematics, Vol 14, No. 1, 1984.

### Radial Basis Function

Franke, R., A Critical Comparison of Some Methods for Interpolation of Scattered Data, Naval Postgraduate School, Technical Report, NPS 53-79-003, 1979.

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## Version History

Introduced: 5.5

## See Also

GRID_INPUT

# GS_ITER

The GS_ITER function solves an *n* by *n* linear system of equations using Gauss-Seidel iteration with over- and under-relaxation to enhance convergence.

**Note**

The equations must be entered in *diagonally dominant* form to guarantee convergence. A system is diagonally dominant if the diagonal element in a given row is greater than the sum of the absolute values of the non-diagonal elements in that row.

This routine is written in the IDL language. Its source code can be found in the file `gs_iter.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = GS_ITER( *A*, *B* [, /CHECK] [, /DOUBLE] [, LAMBDA=*value*{0.0 to 2.0}] [, MAX_ITER=*value*] [, TOL=*value*] [, X_0=*vector*] )

## Return Value

Returns the solution to the linear system of equations of the specified dimensions.

## Arguments

### A

An *n* by *n* integer, single-, or double-precision floating-point array. On output, *A* is divided by its diagonal elements. Integer input values are converted to single-precision floating-point values.

### B

A vector containing the right-hand side of the linear system **Ax=b**. On output, *B* is divided by the diagonal elements of *A*.

# Keywords

## CHECK

Set this keyword to check the array *A* for diagonal dominance. If *A* is not in diagonally dominant form, GS_ITER reports the fact but continues processing on the chance that the algorithm may converge.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## LAMBDA

A scalar value in the range: [0.0, 2.0]. This value determines the amount of *relaxation*. Relaxation is a weighting technique used to enhance convergence.

- If LAMBDA = 1.0, no weighting is used. This is the default.
- If 0.0 ≤ LAMBDA < 1.0, convergence improves in oscillatory and non-convergent systems.
- If 1.0 < LAMBDA ≤ 2.0, convergence improves in systems already known to converge.

## MAX_ITER

The maximum allowed number of iterations. The default value is 30.

## TOL

The relative error tolerance between current and past iterates calculated as: $\left|\left(\text{(current-past)/current}\right)\right|$. The default is $1.0 \times 10^{-4}$.

## X_0

An *n*-element vector that provides the algorithm's starting point. The default is [1.0, 1.0, ... , 1.0].

# Example

```
; Define an array A:
A = [[ 1.0,  7.0, -4.0], $
     [ 4.0, -4.0,  9.0], $
     [12.0, -1.0,  3.0]]
```

```
; Define the right-hand side vector B:
B = [12.0, 2.0, -9.0]

; Compute the solution to the system:
RESULT = GS_ITER(A, B, /CHECK)
```

IDL prints:

```
Input matrix is not in Diagonally Dominant form.
Algorithm may not converge.
% GS_ITER: Algorithm failed to converge within given parameters.
```

Since the A represents a system of linear equations, we can reorder it into diagonally dominant form by rearranging the rows:

```
A = [[12.0, -1.0,  3.0], $
     [ 1.0,  7.0, -4.0], $
     [ 4.0, -4.0,  9.0]]

; Make corresponding changes in the ordering of B:
B = [-9.0, 12.0, 2.0]

; Compute the solution to the system:
RESULT = GS_ITER(A, B, /CHECK)
```

IDL prints:

```
-0.999982      2.99988      1.99994
```

## Version History

Introduced: Pre 4.0

## See Also

CRAMER, LU_COMPLEX, CHOLSOL, LUSOL, SVSOL, TRISOL

# H_EQ_CT

The H_EQ_CT procedure histogram-equalizes the color tables for an image or a region of the display. A pixel-distribution histogram is obtained, the cumulative integral is taken and scaled, and the result is applied to the current color table.

This routine is written in the IDL language. Its source code can be found in the file `h_eq_ct.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

H_EQ_CT [, *Image*]

## Arguments

### Image

A two-dimensional byte array representing the image whose histogram is to be used in determining the new color tables. If this value is omitted, the user is prompted to mark the diagonal corners of a region of the display. If *Image* is specified, it is assumed that the image is loaded into the current IDL window. *Image* must be scaled the same way as the image loaded to the display.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

H_EQ_INT

# H_EQ_INT

The H_EQ_INT procedure interactively histogram-equalizes the color tables of an image or a region of the display. By moving the cursor across the screen, the amount of histogram-equalization can be varied.

Either the image parameter or a region of the display marked by the user is used to obtain a pixel-distribution histogram. The cumulative integral is taken and scaled and the result is applied to the current color tables.

This routine is written in the IDL language. Its source code can be found in the file `h_eq_int.pro` in the `lib` subdirectory of the IDL distribution.

### Using the H_EQ_INT Interface

A window is created and the histogram equalization function is plotted. A linear ramp is overplotted. Move the cursor from left to right to vary the amount of histogram equalization applied to the color tables from 0 to 100%. Press the right mouse button to exit.

## Syntax

H_EQ_INT [, *Image*]

## Arguments

### Image

A two-dimensional byte array representing the image whose histogram is to be used in determining the new color tables. If this value is omitted, the user is prompted to mark the diagonal corners of a region of the display. If *Image* is specified, it is assumed that the image is loaded into the current IDL window. *Image* must be scaled the same way as the image loaded to the display.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

H_EQ_CT

# H5_* Routines

For information, see Chapter 3, “Hierarchical Data Format - HDF5” in the *IDL Scientific Data Formats* manual.

# H5_BROWSER

The H5_BROWSER function presents a graphical user interface for viewing and reading HDF5 files. The browser provides a tree view of the HDF5 file or files, a data preview window, and an information window for the selected objects. The browser may be created as either a selection dialog with Open/Cancel buttons, or as a standalone browser that can import data to the IDL main program level.

**Note**

This function is not part of the standard HDF5 interface, but is provided as a programming convenience.

## Syntax

*Result* = H5_BROWSER([*Files*] [, /DIALOG_READ] )

## Return Value

If the DIALOG_READ keyword is specified then the *Result* is a structure containing the selected group or dataset (as described in the H5_PARSE function), or a zero if the Cancel button was pressed. If the DIALOG_READ keyword is not specified then the *Result* is the widget ID of the HDF5 browser.

## Arguments

### Files

An optional scalar string or string array giving the name of the files to initially open. Additional files may be opened interactively. If *Files* is not provided then the user is automatically presented with a File Open dialog upon startup.

## Keywords

### DIALOG_READ

If this keyword is set then the HDF5 browser is created as a modal Open/Cancel dialog instead of a standalone GUI. In this case, the IDL command line is blocked, and no further input is taken until the Open or Cancel button is pressed. If the GROUP_LEADER keyword is specified, then that widget ID is used as the group leader, otherwise a default group leader base is created.

All keywords to WIDGET_BASE, such as GROUP_LEADER and TITLE, are passed on to the top-level base.

# Graphical User Interface Options

## Open HDF5 file

Click on this button to bring up a file selection dialog. Multiple files may be selected for parsing. All selected files are added to the tree view.

## Show preview

If this toggle button is selected, then the data within datasets will be shown in the preview window. One-dimensional datasets will be shown as line plots. Two-dimensional datasets will be shown as images, along with any provided image palettes. For three or higher-dimensional datasets, a two dimensional slice will be shown.

## Fit in window

If this toggle button is selected, then the preview image will be scaled larger or smaller to fit within the preview window. The aspect ratio of the image will be unchanged.

## Flip vertical

If this toggle button is selected, then the preview image will flipped from top to bottom.

## Flip horizontal

If this toggle button is selected, then the preview image will flipped from left to right.

**Note**

If the DIALOG_READ keyword is present then the following options are available:

## Open

Click on this button to close the HDF5 browser, and return an IDL structure containing the selected group or dataset, as described in the H5_PARSE function.

## Cancel

Click on this button to close the HDF5 browser, and return a scalar zero for the result.

**Note**

If the DIALOG_READ keyword is not present then the following options are available:

### Variable name for import

Set this text string to the name of the IDL variable to construct when importing HDF5 data to IDL structures. If the entered name is not a valid IDL identifier, then a valid identifier will be constructed by converting all non-alphanumeric characters to underscores.

### Include data

If this toggle button is selected, then all data within the selected datasets will be read in from the HDF5 file and included in the IDL structure.

### Import to IDL

Click on this button to import the currently selected HDF5 object into the IDL main program level. Imported variables will consist of a nested hierarchy of IDL structures, as described in the H5_PARSE function.

### Done

Click on this button to close the HDF5 browser.

## Example

The following example starts up the HDF5 browser on a sample file:

```
File = FILEPATH('hdf5_test.h5', SUBDIR=['examples','data'])
Result = H5_BROWSER(File)
```

## Version History

Introduced 5.6

## See Also

H5_PARSE

# HANNING

The HANNING function is used to create a “window” for Fourier Transform filtering. It can be used to create both Hanning and Hamming windows.

This routine is written in the IDL language. Its source code can be found in the file `hanning.pro` in the `lib` subdirectory of the IDL distribution.

The Hanning window is defined as:

w(k) = alpha - (1-alpha)*cos(2 pi k/ N),  k = 0,1,...,N-1

where alpha=0.5 for the Hanning, and alpha=0.54 for the Hamming window.

**Note**

Because of the factor of 1/N (rather than 1/(N-1)) in the above equation, the Hanning filter is not exactly symmetric, and does not go to zero at the last point. The factor of 1/N is chosen to give the best behavior for spectral estimation of discrete data.

## Syntax

*Result* = HANNING( $N_1$ [, $N_2$] [, ALPHA=*value*{0.5 to 1.0}] [, /DOUBLE] )

## Return Value

If only *N1* is specified, this function returns an array of dimensions [*N1*]. If both *N1* and *N2* are specified, this function returns an array of dimensions [*N1*, *N2*]. If any of the inputs are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

## Arguments

### $N_1$

The number of columns in the resulting array.

### $N_2$

The number of rows in the resulting array.

# Keywords

## ALPHA

Set this keyword equal to the width parameter of a generalized Hamming window. ALPHA must be in the range of 0.5 to 1.0. If ALPHA = 0.5 (the default) the function is called a “Hanning” window. If ALPHA = 0.54, the result is called a “Hamming” window.

## DOUBLE

Set this keyword to force the computations to be done in double-precision arithmetic.

# Examples

```
; Construct a time series with three sine waves.
n = 1024
dt = 0.02
w = 2*!DPI*dt*DINDGEN(n)
x = -0.3d + SIN(2.8d * w) + SIN(6.25d * w) + SIN(11.0d * w)
; Find the power spectrum with and without the Hanning filter.
han = HANNING(n, /DOUBLE)
powerHan = ABS(FFT(han*x))^2
powerUnfilt = ABS(FFT(x))^2
freq = FINDGEN(n)/(n*dt)
; Plot the results.
PLOT, freq, powerHan, /XLOG, /YLOG, $
    XRANGE=[1,1./(2*dt)], XSTYLE=1, $
    TITLE='Power spectrum with Hanning (solid) and without
(dashed)'
OPLOT, freq, powerUnfilt, LINESTYLE=2
```

# Version History

Introduced: Original

# See Also

FFT

# HDF_* Routines

For information, see Chapter 4, “Hierarchical Data Format” in the *IDL Scientific Data Formats* manual.

# HDF_BROWSER

The HDF_BROWSER function presents a graphical user interface (GUI) that allows the user to view the contents of a Hierarchical Data Format (HDF), HDF-EOS, or NetCDF file, and prepare a template for the extraction of HDF data and metadata into IDL. The output template is an IDL structure that may be used when reading HDF files with the HDF_READ routine. If you have several HDF files of identical form, the returned template from HDF_BROWSER may be reused to extract data from these files with HDF_READ. If you do not need a multi-use template, you may call HDF_READ directly.

## Graphical User Interface Menu Options

The following options are available from the graphical user interface menus.

### Pulldown Menu

The following table shows the options available with the pulldown menu.

| Menu Selection | Description |
|---|---|
| **HDF/NetCDF Summary** | |
| DF24 (24-bit Images) | 24-bit images and their attributes |
| DFR8 (8-bit Images) | 8-bit images and their attributes |
| DFP (Palettes) | Image palettes |
| SD (Variables/Attributes) | Scientific Datasets and attributes |
| AN (Annotations) | Annotations |
| GR (Generic Raster) | Images |
| GR Global (File) Attributes | Image attributes |
| VGroups | Generic data groups |
| VData | Generic data and attributes |
| **HDF-EOS Summary** | |
| Point | EOS point data and attributes |
| Swath | EOS swath data and attributes |

*Table 29: HDF_BROWSER Pulldown Menu Options*

| Menu Selection | Description |
|---|---|
| Grid | EOS grid data and attributes |

*Table 29: HDF_BROWSER Pulldown Menu Options (Continued)*

### Preview Button

If you have selected an image, 2D data set, or 3x*n*x*m* data set from the pulldown menu, click on this button to view the image. If you have selected a data item that can be plotted in two dimensions, click on this button to view a 2D plot of the data (the default) or click on the “Surface” radio button to display a surface plot, click on the “Contour” radio button to display a contour plot, or click on the “Show3” radio button for an image, surface, and contour display. You can also select the “Fit to Window” checkbox to fit the image to the window.

### Read Checkbox

Select this checkbox to extract the current data or metadata item from the HDF file.

### Extract As

Specify a name for the extracted data or metadata item

**Note**

The Read Checkbox must be selected for the item to be extracted. Default names are generated for all data items, but may be changed at any time by the user.

## Syntax

*Template* = HDF_BROWSER([*Filename*] [, CANCEL=*variable*] [, GROUP=*widget_id*] [, PREFIX=*string*])

## Return Value

Returns a template structure containing heap variable references, or 0 if no file was selected. The user is required to clean up the heap variable references when done with them.

# Arguments

## Filename

A string containing the name of an HDF file to browse. If *Filename* is not specified, a dialog allows you to choose a file.

# Keywords

## CANCEL

Set this keyword to a named variable that will contain the byte value 1 (one) if the user clicked the “Cancel” button or the byte value 0 (zero) otherwise.

## GROUP

Set this keyword to the widget ID of a widget that calls HDF_BROWSER. When this ID is specified, a death of the caller results in the death of the HDF_BROWSER. The following example demonstrates how to use the GROUP keyword to properly call HDF_BROWSER from within a widget application. To run this example, save the following code as `browser_example.pro`:

```
PRO BROWSER_EXAMPLE_EVENT,ev

   WIDGET_CONTROL,ev.id,GET_VALUE=val
      CASE val of
         'Browser':BEGIN
            a=HDF_BROWSER(GROUP=ev.top)
            HELP,a,/st
         END
         'Exit': WIDGET_CONTROL,ev.top,/DESTROY
      ENDCASE

END

PRO BROWSER_EXAMPLE

   a=WIDGET_BASE(/ROW)
   b=WIDGET_BUTTON(a,VALUE='Browser')
   c=WIDGET_BUTTON(a,VALUE='Exit')
   WIDGET_CONTROL,a,/REALIZE
   XMANAGER,'browser_example',a

END
```

### PREFIX

When HDF_BROWSER reviews the contents of an HDF file, it creates default output names for the various data elements. By default these default names begin with a prefix derived from the filename. Set this keyword to a string value to be used in place of the default prefix.

## Examples

```
template = HDF_BROWSER('test.hdf')
output_structure = HDF_READ(TEMPLATE=template)
```

or,

```
output_structure = HDF_READ('test.hdf', TEMPLATE=template)
```

## Version History

Introduced: 5.1

## See Also

HDF_READ

# HDF_READ

The HDF_READ function allows extraction of Hierarchical Data Format (HDF), HDF-EOS, and NetCDF data and metadata into an output structure based upon information provided through a graphical user interface or through a file template generated by HDF_BROWSER. The output structure is a single level structure corresponding to the data elements and names specified by HDF_BROWSER or its output template. Templates generated by HDF_BROWSER may be re-used for HDF files of identical format.

## Graphical User Interface Menu Options

The following options are available from the graphical user interface menus.

### Pulldown Menu

The following table shows the options available with the pulldown menu.

| Menu Selection | Description |
|---|---|
| **HDF/NetCDF Summary** | |
| DF24 (24-bit Images) | 24-bit images and their attributes |
| DFR8 (8-bit Images) | 8-bit images and their attributes |
| DFP (Palettes) | Image palettes |
| SD (Variables/Attributes) | Scientific Datasets and attributes |
| AN (Annotations) | Annotations |
| GR (Generic Raster) | Images |
| GR Global (File) Attributes | Image attributes |
| VGroups | Generic data groups |
| VData | Generic data and attributes |
| **HDF-EOS Summary** | |
| Point | EOS point data and attributes |
| Swath | EOS swath data and attributes |

*Table 30: HDF_BROWSER Pulldown Menu Options*

| Menu Selection | Description |
|---|---|
| Grid | EOS grid data and attributes |

*Table 30: HDF_BROWSER Pulldown Menu Options (Continued)*

### Preview Button

If you have selected an image, 2D data set, or 3x*n*x*m* data set from the pulldown menu, click on this button to view the image. If you have selected a data item that can be plotted in two dimensions, click on this button to view a 2D plot of the data (the default) or click on the “Surface” radio button to display a surface plot, click on the “Contour” radio button to display a contour plot, or click on the “Show3” radio button for an image, surface, and contour display. You can also select the “Fit to Window” checkbox to fit the image to the window.

### Read Checkbox

Select this checkbox to extract the current data or metadata item from the HDF file.

### Extract As

Specify a name for the extracted data or metadata item

**Note**

The Read Checkbox must be selected for the item to be extracted. Default names are generated for all data items, but may be changed at any time by the user.

## Syntax

*Result* = HDF_READ( [*Filename*] [, DFR8=*variable*] [, DF24=*variable*] [, PREFIX=*string*] [, TEMPLATE =*value*] )

## Return Value

Returns an output structure containing the specified Hierarchical Data Format (HDF), HDF-EOS, and NetCDF data and metadata.

# Arguments

## Filename

A string containing the name of a HDF file to extract data from. If Filename is not specified, a dialog allows you to specify a file. Note that if a template is specified, the template must match the HDF file selected.

# Keywords

## DFR8

Set this keyword to a named variable that will contain a 2 x *n* string array of extracted DFR8 images and their palettes. The first column will contain the extracted DFR8 image names, while the second column will contain the extracted name of the associated palette. If no palette is associated with a DFR8 image the palette name will be set to the null string. If no DFR8 images were extracted from the HDF file, this returned string will be the null string array ['', ''].

## DF24

Set this keyword to a named variable that will contain a string array of the names of all the extracted DF24 24-bit images. This is useful in determining whether a (3,*n*,*m*) extracted data element is a 24-bit image or another type of data. If no DF24 24-bit images were extracted from the HDF file, the returned string will be the null string ('').

## PREFIX

When HDF_READ is called without a template, it calls HDF_BROWSER to review the contents of an HDF file and create the default output names for the various data elements. By default, these names begin with a prefix derived from the filename. Set this keyword to a string value to be used in place of the default prefix.

## TEMPLATE

Set this keyword to specify the HDF file template (generated by the function HDF_BROWSER), that defines which data elements to extract from the selected HDF file. Templates may be used on any files that have a format identical to the file the template was created from.

## Examples

```
template = HDF_BROWSER('my.hdf')
output_structure = HDF_READ(TEMPLATE=template)
```

or,

```
output_structure = HDF_READ('my.hdf')
```

or,

```
;Select'my.hdf' with the file locator
output_structure = HDF_READ()
```

or,

```
output_structure = HDF_READ('just_like_my.hdf', TEMPLATE=template)
```

## Version History

Introduced: 5.1

## See Also

HDF_BROWSER

# HEAP_FREE

The HEAP_FREE procedure recursively frees all heap variables (pointers or objects) referenced by its input argument. This routine examines the input variable, including all array elements and structure fields. When a valid pointer or object reference is encountered, that heap variable is marked for removal, and then is recursively examined for additional heap variables to be freed. In this way, all heap variables that are referenced directly or indirectly by the input argument are located. Once all such heap variables are identified, HEAP_FREE releases them in a final pass. Pointers are released as if the PTR_FREE procedure was called. Objects are released as with a call to OBJ_DESTROY.

As with the related HEAP_GC procedure, there are some disadvantages to using HEAP_FREE:

- When freeing object heap variables, HEAP_FREE calls OBJ_DESTROY without supplying any plain or keyword arguments. Depending on the objects being released, this may not be sufficient. In such cases, call OBJ_DESTROY explicitly with the proper arguments rather than using HEAP_FREE.
- HEAP_FREE releases the referenced heap variables in an unspecified order which depends on the current state of the internal data structure used by IDL to hold them. This can be confusing for object destructor methods that expect all of their contained data to be present. If your application requires a specific order for the release of its heap variables, you must explicitly free them in the correct order. HEAP_FREE cannot be used in such cases.
- The algorithm used by HEAP_FREE to release variables requires examination of every existing heap variable (that is, it is an O(n) algorithm). This may be slow if an IDL session has thousands of current heap variables.

For these reasons, RSI recommends that applications keep careful track of their heap variable usage, and explicitly free them at the proper time (for example, using the object destructor method) rather than resorting to simple-looking but potentially expensive expedients such as HEAP_FREE or HEAP_GC.

HEAP_FREE is recommended when:

- The data structures involved are highly complex, nested, or variable, and writing cleanup code is difficult and error prone.
- The data structures are opaque, and the code cleaning up does not have knowledge of the structure.

# Syntax

HEAP_FREE, *Var* [, /OBJ] [, /PTR] [, /VERBOSE]

# Arguments

## Var

The variable whose data is used as the starting point for heap variables to be freed.

# Keywords

## OBJ

Set this keyword to free object heap variables only.

## PTR

Set this keyword to free pointer heap variables only.

**Note**

Setting both the PTR and OBJ keywords is the same as setting neither.

## VERBOSE

If this keyword is set, HEAP_FREE writes a one line description of each heap variable, in the format used by the HELP procedure, as the variable is released. This is a debugging aid that can be used by program developers to check for heap variable leaks that need to be located and eliminated.

# Examples

```
; Create a structure variable.
mySubStructure = {pointer:PTR_NEW(INDGEN(100)), $
   obj:OBJ_NEW('Idl_Container')}
myStructure ={substruct:mySubStructure, $
   ptrs:[PTR_NEW(INDGEN(10)), PTR_NEW(INDGEN(11))]}

;Look at the heap.
HELP, /HEAP_VARIABLES

; Now free the heap variables contained in myStructure.
HEAP_FREE, myStructure, /VERBOSE
HELP, /HEAP_VARIABLES
```

## Version History

Introduced: 5.3

## See Also

HEAP_GC

# HEAP_GC

The HEAP_GC procedure performs *garbage collection* on heap variables. It searches all current IDL variables (including common blocks, widget user values, etc.) for pointers and object references and determines which heap variables have become inaccessible. Pointer heap variables are freed (via PTR_FREE) and all memory used by the heap variable is released. Object heap variables are destroyed (via OBJ_DESTROY), also freeing all used memory.

The default action is to perform garbage collection on all heap variables regardless of type. Use the POINTER and OBJECT keywords to remove only specific types.

**Note**

Garbage collection is an expensive operation. When possible, applications should be written to avoid losing pointer and object references and avoid the need for garbage collection.

**Warning**

HEAP_GC uses a recursive algorithm to search for unreferenced heap variables. If HEAP_GC is used to manage certain data structures, such as large linked lists, a potentially large number of operations may be pushed onto the system stack. If so many operations are pushed that the stack runs out of room, IDL will crash.

## Syntax

HEAP_GC [, /OBJ | , /PTR] [, /VERBOSE]

## Arguments

None.

## Keywords

### OBJ

Set this keyword to perform garbage collection on object heap variables only.

### PTR

Set this keyword to perform garbage collection on pointer heap variables only.

**Note**

Setting *both* the PTR and OBJ keywords is the same as setting neither.

### VERBOSE

If this keyword is set, HEAP_GC writes a one line description of each heap variable, in the format used by the HELP procedure, as the variable is destroyed. This is a debugging aid that can be used by program developers to check for heap variable leaks that need to be located and eliminated.

## Version History

Introduced: 5.0

## See Also

HEAP_FREE

# HELP

The HELP procedure gives the user information on many aspects of the current IDL session. The specific area for which help is desired is selected by specifying the appropriate keyword. If no arguments or keywords are specified, the default is to show the current nesting of procedures and functions, all current variables at the current program level, and open files. Only one keyword can be specified at a time.

## Syntax

HELP, *Expression*$_1$, ..., *Expression*$_n$ [, /ALL_KEYS] [, /BREAKPOINTS] [, /BRIEF] [, CALLS=*variable*] [, /DEVICE] [, /DLM] [, /FILES] [, /FULL] [, /FUNCTIONS] [, /HEAP_VARIABLES] [, /KEYS] [, /LAST_MESSAGE] [, /MEMORY] [, /MESSAGES] [, NAMES=*string_of_variable_names*] [, /OBJECTS] [, OUTPUT=*variable*] [, /PATH_CACHE] [, /PROCEDURES] [, /RECALL_COMMANDS] [, /ROUTINES] [, /SHARED_MEMORY] [, /SOURCE_FILES] [, /STRUCTURES] [, /SYSTEM_VARIABLES] [, /TRACEBACK]

## Arguments

### Expression(s)

The arguments are interpreted differently depending on the keyword selected. If no keyword is selected, HELP displays basic information for its parameters. For example, to see the type and structure of the variable A, enter:

```
HELP, A
```

## Keywords

Note that the use of some of the following keywords causes any arguments to HELP to be ignored and HELP provides other types of information instead. If the description of the keyword does not explicitly mention the arguments, the arguments are ignored.

### ALL_KEYS

Set this keyword to show current function-key definitions as set by DEFINE_KEY. If no arguments are supplied, information on all function keys is displayed. If arguments are provided, they must be scalar strings containing the names of function keys, and information on the specified keys is given. Under UNIX, this keyword is

different from KEYS because every key is displayed, no matter what its current programming. Setting ALL_KEYS is equivalent to setting both KEYS and FULL. Under Windows, every key is always displayed; setting KEYS produces the same result as setting ALL_KEYS.

## BREAKPOINTS

Set this keyword to display the breakpoint table which shows the program module and location for each breakpoint.

## BRIEF

If set in conjunction with one of the following keywords, BRIEF produces very terse summary style output instead of the output normally displayed by those keywords:

- DLM
- HEAP_VARIABLES
- MESSAGES
- OBJECTS
- ROUTINES
- SOURCE_FILES
- STRUCTURES
- SYSTEM_VARIABLES

## CALLS

Set this keyword to a named variable in which to store the procedure call stack. Each string element contains the name of the program module, source file name, and line number. Array element zero contains the information about the caller of HELP, element one contains information about its caller, etc. This keyword is useful for programs that require traceback information.

## DEVICE

Set this keyword to show information about the currently selected graphics device. This information is dependent on the abilities of the current device, but the name of the device is always given. Arguments to HELP are ignored when DEVICE is specified.

## DLM

Set this keyword to display all known dynamically loadable modules and their state (loaded or not loaded).

## FILES

Set this keyword to display information about file units. If no arguments are supplied in the call to HELP, information on all open file units (except the special units 0, -1, and -2) is displayed. If arguments are provided, they are taken to be integer file unit numbers, and information on the specified file units is given.

For example, the command:

```
HELP, /FILES, -2, -1, 0
```

gives information below about the default file units:

```
Unit Attributes Name
-2   Write, Truncate, Tty, Reserved   <stderr>
-1   Write, Truncate, Tty, Reserved   <stdout>
0   Read, Tty, Reserved              <stdin>
```

The attributes column tells about the characteristics of the file. For instance, the file connected to logical file unit 2 is called “stderr” and is the standard error file. It is opened for write access (Write), is a new file (Truncate), is a terminal (Tty), and cannot be closed by the CLOSE command (Reserved).

## FULL

By default, HELP filters its output in an attempt to only display information likely to be of use to the IDL end user. Specify FULL to see all available information on a given topic without any such filtering. The filtering applied by default depends on the type of information being requested:

- **Function keys:** By default, IDL will not display undefined function keys.
- **Structure Definitions And Objects:** Structures and objects that have had their definition hidden using the STRUCT_HIDE procedure are not usually listed.
- **Functions and Procedures:** Functions and procedures compiled with the `COMPILE_OPT HIDDEN` directive are not usually included in HELP output.

## FUNCTIONS

Normally, the ROUTINES or SOURCE_FILES keywords produce information on both functions and procedures. If FUNCTIONS is specified, only output on functions is produced. If FUNCTIONS is used without either ROUTINES or SOURCE_FILES, ROUTINES is assumed.

## HEAP_VARIABLES

Set this keyword to display help information for all the current heap variables.

## KEYS

Set this keyword to show current function key definitions as set by DEFINE_ KEY, for those function keys that are currently programmed to perform a function. If no arguments are supplied, information on all function keys is displayed. If arguments are provided, they must be scalar strings containing the names of function keys, and information on the specified keys is given. Under UNIX, this keyword is different from ALL_KEYS because that keyword displays every key, no matter what its current programming. Under Windows, every key is always displayed; setting KEYS produces the same result as setting ALL_KEYS.

## LAST_MESSAGE

Set this keyword to display the last error message issued by IDL.

## MEMORY

Set this keyword to see a report on the amount of dynamic memory (in bytes) currently in use by the IDL session; the maximum amount of dynamic memory allocated since the last call to HELP, /MEMORY; and the number of times dynamic memory has been allocated and deallocated. Arguments to HELP are ignored when MEMORY is specified.

## MESSAGES

Set this keyword to display all known message blocks and the error space range into which they are loaded.

## NAMES

A string used to determine the names of the variables, whose values are to be printed. A string match (equivalent to the STRMATCH function with the FOLD_CASE keyword set) is used to decide if a given variable will be displayed. The match string can contain any wildcard expression supported by STRMATCH, including “*” and “?”.

For example, to print only the values of variables beginning with “A”, use the command `HELP,/NAME='a*'`. Similarly, `HELP,NAME='?'` prints the values of all variables with a single-character name.

NAMES also works with the output from the following keywords:

- DLM
- HEAP_VARIABLES
- MESSAGES
- OBJECTS

- ROUTINES
- SOURCE_FILES
- STRUCTURES
- SYSTEM_VARIABLES

## OBJECTS

Set this keyword to display information on defined object classes. If no arguments are provided, all currently-defined object classes are shown. If no arguments are provided, and the information you are looking for is not displayed, use the FULL keyword to prevent HELP from filtering the output. If arguments are provided, the definition of the object class for the heap variables referred to is displayed.

Information is provided on inherited superclasses and all *known methods*. A method is known to IDL only if it has been compiled in the current IDL session and called by its own class or a subclass. Methods that have not been compiled yet will not be shown. Thus, the list of methods displayed by HELP is not necessarily a complete list of all possible method for the object class.

If called within a class' method, the OBJECTS keyword also displays the instance data of the object on which it was called.

## OUTPUT

Set this keyword equal to a named variable that will contain a string array containing the formatted output of the HELP command. Each line of formatted output becomes a single element in the string array.

**Warning**

The OUTPUT keyword is primarily for use in capturing HELP output in order to display it someplace else, such as in a text widget. This keyword is *not* intended to be used in obtaining programmatic information about the IDL session, and is formatted to be human readable. RSI reserves the right to change the format and content of this text *at any time, without warning*. If you find yourself using OUTPUT for a non-display purpose, consider using the STRUCTURE keyword to the SIZE function.

## PATH_CACHE

Set this keyword to display a list of directories currently included in the IDL path cache, along with the number of `.pro` or `.sav` files found in those directories. See PATH_CACHE for details.

## PROCEDURES

Normally, the ROUTINES or SOURCE_FILES keywords produce information on both functions and procedures. If PROCEDURES is specified, only output on procedures is produced. If PROCEDURES is used without either ROUTINES or SOURCE_FILES, ROUTINES is assumed.

## RECALL_COMMANDS

Set this keyword to display the saved commands in the command input buffer. By default, IDL saves the last 20 lines of input in a buffer from which they can be recalled for command line editing. Arguments to HELP are ignored when RECALL is specified.

The number of lines saved can be changed by assigning the desired number of lines to the environment variable !EDIT_INPUT in the IDL startup file. See "!EDIT_INPUT" on page 3905 for details.

## ROUTINES

Set this keyword to show a list of all compiled procedures and functions with their parameter names. Keyword parameters accepted by each module are shown to the right of the routine name. If no arguments are provided, and the information you are looking for is not displayed, use the FULL keyword to prevent HELP from filtering the output.

## SHARED_MEMORY

Set this keyword to display information about all current shared memory and memory mapped file segments mapped into the current IDL process via the SHMMAP procedure.

## SOURCE_FILES

Set this keyword to display information on procedures and functions written in the IDL language that have been compiled during the current IDL session. Full path names (relative to the current directory) of compiled `.pro` files are displayed. If no arguments are provided, and the information you are looking for is not displayed, use the FULL keyword to prevent HELP from filtering the output.

## STRUCTURES

Set this keyword to display information on structure-type variables. If no arguments are provided, all currently-defined structures are shown. If no arguments are provided, and the information you are looking for is not displayed, use the FULL

keyword to prevent HELP from filtering the output. If arguments are provided, the structure definition for those expressions is displayed. It is often more convenient to use `HELP, /STRUCTURES` instead of `PRINT` to look at the contents of a structure variable because it shows the names of the fields as well as the data.

### SYSTEM_VARIABLES

Set this keyword to display information on all system variables. Arguments are ignored.

### TRACEBACK

Set this keyword to display the current nesting of procedures and functions.

## Examples

To see general information on the current IDL session, enter:

```
HELP
```

To see information on the structure definition of the system variable !D, enter:

```
HELP, !D, /STRUCTURES
```

## Version History

Introduced: Original

SHARED_MEMORY keyword added: 5.6

# HILBERT

The HILBERT function outputs a series that has all periodic terms phase-shifted by 90 degrees. This transform has the interesting property that the correlation between a series and its own Hilbert transform is mathematically zero.

This routine is written in the IDL language. Its source code can be found in the file `hilbert.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = HILBERT(*X* [, *D*])

## Return Value

The return value is a complex-valued vector with the same size as the input vector. HILBERT generates the fast Fourier transform using the FFT function, and shifts the first half of the transform products by +90 degrees and the second half by -90 degrees. The constant elements in the transform are not changed. Angle shifting is accomplished by multiplying or dividing by the complex number, *i* = (0.0000, 1.0000). The shifted vector is then submitted to FFT for transformation back to the "time" domain and the output is divided by the number elements in the vector to correct for multiplication effect peculiar to the FFT algorithm.

**Note**

Because HILBERT uses FFT, it exhibits the same side effects with respect to input arguments as that function.

## Arguments

### X

An *n*-element floating-point or complex-valued vector.

### D

A flag for rotation direction. Set D = +1 for a positive rotation (the default). Set D = -1 for a negative rotation.

## Keywords

None.

## Version History

Introduced: Original

## See Also

FFT

# HIST_2D

The HIST_2D function returns the two dimensional density function (histogram) of two variables.

This routine is written in the IDL language. Its source code can be found in the file `hist_2d.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = HIST_2D( $V_1$, $V_2$ [, BIN1=*width*] [, BIN2=*height*] [, MAX1=*value*] [, MAX2=*value*] [, MIN1=*value*] [, MIN2=*value*] )

## Return Value

Returns a longword array of dimensions (MAX(*V1*)+1, MAX(*V2*)+1). Result(*i*,*j*) is equal to the number of simultaneous occurrences of *V1* = *i* and *V2* = *j* at the specified element.

## Arguments

### V1, V2

The arguments are arrays containing the variables. *V1* and *V2* may be of any numeric type except complex. If *V1* and *V2* do not contain the same number of elements, then the extra elements in the longer array are ignored.

## Keywords

### BIN1

Set this keyword equal to the size of each bin in the *V1* direction (column width). If this keyword is not specified, the size is set to 1.

### BIN2

Set this keyword equal to the size of each bin in the *V2* direction (row height). If this keyword is not specified, the size is set to 1.

### MAX1

Set this keyword equal to the maximum *V1* value to consider. If this keyword is not specified, then *V1* is searched for its largest value.

### MAX2

Set this keyword equal to the maximum *V2* value to consider. If this keyword is not specified, then *V2* is searched for its largest value.

### MIN1

Set this keyword to the minimum *V1* value to consider. If this keyword is not specified and if the smallest value of *V1* is greater than zero, then MIN1=0 is used, otherwise the smallest value of *V1* is used.

### MIN2

Set this keyword to the minimum *V2* value to consider. If this keyword is not specified and if the smallest value of *V2* is greater than zero, then MIN2=0 is used; otherwise, the smallest value of *V2* is used.

## Examples

To return the 2D histogram of two byte images:

```
R = HIST_2D(image1, image2)
```

To display the 2D histogram made from two floating point images, restricting the range from -1 to +1, and with 101 bins:

```
F1 = RANDOMN(seed, 256, 256)
F2 = RANDOMN(seed, 256, 256)
Result = HIST_2D(F1, F2, MIN1=-1, MAX1=1, $
   MIN2=-1, MAX2=1, BIN1=0.02, BIN2=0.02)
TVSCL, Result
```

## Version History

Introduced: Pre 4.0

## See Also

H_EQ_CT, H_EQ_INT, HIST_EQUAL, HISTOGRAM

# HIST_EQUAL

The HIST_EQUAL function returns a histogram-equalized byte array.

The HISTOGRAM function is used to obtain the density distribution of the input array. The histogram is integrated to obtain the cumulative density-probability function and finally the lookup function is used to transform to the output image.

**Note**

The first element of the histogram is always zeroed to remove the background.

This routine is written in the IDL language. Its source code can be found in the file `hist_equal.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = HIST_EQUAL( *A* [, BINSIZE=*value*] [, FCN=*vector*] [, /HISTOGRAM_ONLY] [, MAXV=*value*] [, MINV=*value*] [, OMAX=*variable*] [, OMIN=*variable*] [, PERCENT=*value*] [, TOP=*value*] )

## Return Value

This function returns a histogram-equalized array of type byte, with the same dimensions as the input array. If the HISTOGRAM_ONLY keyword is set, then the output will be a vector of type LONG.

## Arguments

### A

The array to be histogram-equalized.

## Keywords

### BINSIZE

Set this keyword to the size of the bin to use. The default is BINSIZE=1 if *A* is a byte array, or, for other input types, the default is (MAXV – MINV)/5000.

## FCN

Set this keyword to the desired cumulative probability distribution function in the form of a 256-element vector. If a probability distribution function is not supplied, IDL uses a linear ramp, which yields equal probability bin results. This function is later normalized, so magnitude is inconsequential; the function should, however, increase monotonically.

## HISTOGRAM_ONLY

Set this keyword to return a vector of type LONG containing the cumulative distribution histogram, rather than the histogram equalized array.

## MAXV

Set this keyword to the maximum value to consider. The default is 255 if *A* is a byte array, otherwise the maximum data value is used. Input elements greater than or equal to MAXV are output as 255.

## MINV

Set this keyword to the minimum value to consider. The default is 0 if *A* is a byte array, otherwise the minimum data value is used. Input elements less than or equal to MINV are output as 0.

## OMAX

Set this keyword to a named variable that, upon exit, will contain the maximum data value used in constructing the histogram.

## OMIN

Set this keyword to a named variable that, upon exit, will contain the minimum data value used in constructing the histogram.

## PERCENT

Set this keyword to a value between 0 and 100 to stretch the image histogram. The histogram will be stretched linearly between the limits that exclude the PERCENT fraction of the lowest values, and the PERCENT fraction of the highest values. This is an automatic, semi-robust method of contrast enhancement.

### TOP

The maximum value of the scaled result. If TOP is not specified, 255 is used. Note that the minimum value of the scaled result is always 0.

## Example

Create a sample image using the DIST function and display it:

```
image = DIST(100)
TV, image
```

Create a histogram-equalized version of the byte array, `image`, and display the new version. Use a minimum input value of 10, a maximum input value of 200, and limit the top value of the output array to 220:

```
new = HIST_EQUAL(image, MINV = 10, MAXV = 200, TOP = 220)
TV, new
```

## Version History

Introduced: Original

## See Also

ADAPT_HIST_EQUAL, H_EQ_CT, H_EQ_INT, HIST_2D, HISTOGRAM

# HISTOGRAM

The HISTOGRAM function computes the density function of *Array*. In the simplest case, the density function, at subscript *i*, is the number of *Array* elements in the argument with a value of *i*.

Let $F_i$= the value of element *i*, $0 \le i < n$. Let $H_v$ = result of histogram function, an integer vector. The definition of the histogram function becomes:

$$H_v = \sum_{i=0}^{n-1} P(F_i, v), \qquad v = 0, 1, 2, ..., \left\lfloor \frac{Max - Min}{Binsize} \right\rfloor$$

$$P(F_i, v) = \begin{cases} 1, & v \le (F_i - Min)/Binsize < v + 1 \\ 0, & \text{Otherwise} \end{cases}$$

**Warning**

There may not always be enough virtual memory available to find the density functions of arrays that contain a large number of bins.

For bivariate probability distributions, use the HIST_2D function.

HISTOGRAM can optionally return an array containing a list of the original array subscripts that contributed to each histogram bin. This list, commonly called the reverse (or backwards) index list, efficiently determines which array elements are accumulated in a set of histogram bins. A typical application of the reverse index list is reverse histogram or scatter plot interrogation—a histogram bin or 2D scatter plot location is marked with the cursor and the original data items within that bin are highlighted.

# Syntax

*Result* = HISTOGRAM( *Array* [, BINSIZE=*value*] [, INPUT=*variable*]
[, LOCATIONS=*variable*] [, MAX=*value*] [, MIN=*value*] [, /NAN]
[, NBINS=*value*] [, OMAX=*variable*] [, OMIN=*variable*]
[, /L64 | REVERSE_INDICES=*variable*] )

# Return Value

Returns a 32-bit or a 64-bit integer vector equal to the density function of the input *Array*.

# Arguments

## Array

The vector or array for which the density function is to be computed.

# Keywords

## BINSIZE

Set this keyword to the size of the bin to use. If this keyword is not specified, and NBINS is not set, then a bin size of 1 is used. If NBINS is set, the default is BINSIZE = (MAX – MIN) / (NBINS – 1).

**Note**

The data type of the value specified for BINSIZE should match the data type of the *Array* argument. Since BINSIZE is converted to the data type of *Array*, specifying mismatched data types may produce undesired results.

## INPUT

Set this keyword to a named variable that contains an array to be added to the output of HISTOGRAM. The density function of *Array* is added to the existing contents of INPUT and returned as the result. The array is converted to longword type if necessary and must have at least as many elements as are required to form the histogram. Multiple histograms can be efficiently accumulated by specifying partial sums via this keyword.

## L64

By default, the return value of HISTOGRAM is 32-bit integer when possible, and 64-bit integer if the number of elements being processed requires it. Set L64 to force 64-bit integers to be returned in all cases. L64 controls the type of *Result* as well as the output from the REVERSE_INDICES keyword.

**Note**

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit result. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

## LOCATIONS

Set this keyword to a named variable in which to return the starting locations for each bin. The starting locations are given by MIN + *v**BINSIZE, with *v* = 0,1,...,NBINS-1. LOCATIONS has the same number of elements as the Result, and has the same type as the input Array.

## MAX

Set this keyword to the maximum value to consider. If this keyword is not specified, *Array* is searched for its largest value. If this keyword is not specified, and *Array* is of type byte, 255 is used.

**Note**

The data type of the value specified for MAX should match the data type of the input array. Since MAX is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

**Note**

If NBINS is specified, the value for MAX will be adjusted to NBINS*BINSIZE + MIN. This ensures that the last bin has the same width as the other bins.

## MIN

Set this keyword to the minimum value to consider. If this keyword is not specified, and *Array* is of type byte, 0 is used. If this keyword is not specified and *Array* is not of byte type, *Array* is searched for its smallest value.

**Note**

The data type of the value specified for MIN should match the data type of the input array. Since MIN is converted to the data type of the input array, specifying mismatched data types may produce undesired results.

## NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN (not a number) in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## NBINS

Set this keyword to the number of bins to use. If BINSIZE is specified, the number of bins in *Result* is NBINS, starting at MIN and ending at MIN+(NBINS–1)*BINSIZE. If MAX is specified, the bins will be evenly spaced between MIN and MAX. It is an error to specify NBINS with both BINSIZE and MAX.

## OMAX

Set this keyword to a named variable that will contain the maximum data value used in constructing the histogram.

## OMIN

A named variable that, upon exit, contains the minimum data value used in constructing the histogram.

## REVERSE_INDICES

Set this keyword to a named variable in which the list of reverse indices is returned. When possible, this list is returned as a 32-bit integer vector whose number of elements is the sum of the number of elements in the histogram, *N*, and the number of array elements included in the histogram, plus one. If the number of elements is too large to be contained in a 32-bit integer, or if the L64 keyword is set, REVERSE_INDICES is returned as a 64-bit integer.

The subscripts of the original array elements falling in the $i^{th}$ bin, $0 \le i < N$, are given by the expression: R(R[i] : R[i+1]-1), where R is the reverse index list. If R[i] is equal to R[i+1], no elements are present in the $i^{th}$ bin.

For example, make the histogram of array A:

```
H = HISTOGRAM(A, REVERSE_INDICES = R)

;Set all elements of A that are in the ith bin of H to 0.
IF R[i] NE R[i+1] THEN A[R[R[I] : R[i+1]-1]] = 0
```

The above is usually more efficient than the following:

```
bini = WHERE(A EQ i, count)
IF count NE 0 THEN A[bini] = 0
```

## Examples

```
; Create a simple, 2D dataset:
D = DIST(200)
; Plot the histogram of D with a bin size of 1 and the default
; minimum and maximum:
PLOT, HISTOGRAM(D)
; Plot a histogram considering only those values from 10 to 50
; using a bin size of 4:
PLOT, HISTOGRAM(D, MIN = 10, MAX = 50, BINSIZE = 4)
```

The HISTOGRAM function can also be used to increment the elements of one vector whose subscripts are contained in another vector. To increment those elements of vector A indicated by vector B, use the command:

```
A = HISTOGRAM(B, INPUT=A, MIN=0, MAX=N_ELEMENTS(A)-1)
```

This method works for duplicate subscripts, whereas the following statement never adds more than 1 to any element, even if that element is duplicated in vector B:

```
A[B] = A[B]+1
```

For example, for the following commands:

```
A = LONARR(5)
B = [2,2,3]
PRINT, HISTOGRAM(B, INPUT=A, MIN=0, MAX=4)
```

IDL prints:

```
      0  0  2  1  0
```

The commands:

```
A = LONARR(5)
A[B] = A[B]+1
PRINT, A
```

give the result:

```
      0  0  1  1  0
```

The following example demonstrates how to use HISTOGRAM:

```
PRO t_histogram
data = [[-5,  4,   2,  -8,  1], $
        [ 3,  0,   5,  -5,  1], $
        [ 6, -7,   4,  -4, -8], $
        [-1, -5, -14,   2,  1]]
hist = HISTOGRAM(data)
bins = FINDGEN(N_ELEMENTS(hist)) + MIN(data)
PRINT, MIN(hist)
PRINT, bins
PLOT, bins, hist, YRANGE = [MIN(hist)-1, MAX(hist)+1], PSYM = 10, $
   XTITLE = 'Bin Number', YTITLE = 'Density per Bin'
END
```

IDL prints:

```
0

-14.0000   -13.0000   -12.0000   -11.0000   -10.0000   -9.00000
-8.00000   -7.00000   -6.00000   -5.00000   -4.00000   -3.00000
-2.00000   -1.00000    0.00000    1.00000    2.00000    3.00000
 4.00000    5.00000    6.00000
```

## Version History

Introduced: Original

LOCATIONS keyword added: 5.6

## See Also

H_EQ_CT, H_EQ_INT, HIST_2D, HIST_EQUAL

# HLS

The HLS procedure creates a color table based on the HLS (Hue, Lightness, Saturation) color system.

Using the input parameters, a spiral through the double-ended HLS cone is traced. Points along the cone are converted from HLS to RGB. The current colortable (and the COLORS common block) contains the new colortable on exit.

This routine is written in the IDL language. Its source code can be found in the file `hls.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

HLS, *Litlo*, *Lithi*, *Satlo*, *Sathi*, *Hue*, *Loops* [, *Colr*]

## Arguments

### Litlo

Starting lightness, from 0 to 100%.

### Lithi

Ending lightness, from 0 to 100%.

### Satlo

Starting saturation, from 0 to 100%.

### Sathi

Ending saturation, from 0 to 100%.

### Hue

Starting Hue, from 0 to 360 degrees. Red = 0 degs, green = 120, blue = 240.

### Loops

The number of loops through the color spiral. This parameter does not have to be an integer. A negative value causes the loops to traverse the spiral in the opposite direction.

### Colr

An optional (256,3) integer array in which the new R, G, and B values are returned. Red = *Colr*[*,0], green = *Colr*[*,1], blue = *Colr*[*,2].

## Keywords

None.

## Version History

Introduced: Original

## See Also

COLOR_CONVERT, HSV, PSEUDO

# HOUGH

The HOUGH function implements the Hough transform, used to detect straight lines within a two-dimensional image. This function can be used to return either the Hough transform, which transforms each nonzero point in an image to a sinusoid in the Hough domain, or the Hough backprojection, where each point in the Hough domain is transformed to a straight line in the image.

## Hough Transform Theory

The Hough transform is defined for a function $A(x, y)$ as:

$$H(\theta, \rho) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} A(x,y)\, \delta(\rho - x\cos\theta - y\sin\theta)\, dx\, dy$$

where $\delta$ is the Dirac delta-function. With $A(x, y)$, each point $(x, y)$ in the original image, $A$, is transformed into a sinusoid $\rho = x\cos\theta - y\sin\theta$, where $\rho$ is the perpendicular distance from the origin of a line at an angle $\theta$ (The angle $\theta$ will be limited to $0 <= \theta < \pi$ which could result in negative $\rho$ values.):

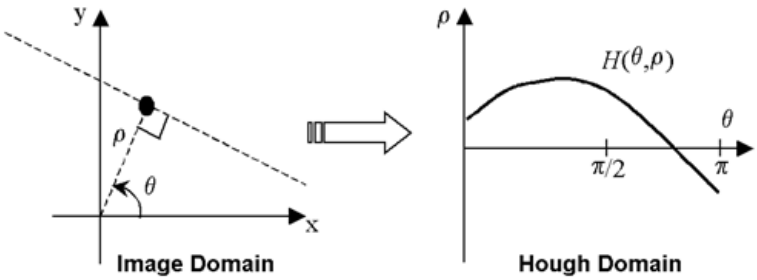



*Figure 9: Hough Transform*

Points that lie on the same line in the image will produce sinusoids that all cross at a single point in the Hough transform. For the inverse transform, or backprojection, each point in the Hough domain is transformed into a straight line in the image.

Usually, the Hough function is used with binary images, in which case $H(\theta, \rho)$ gives the total number of sinusoids that cross at point $(\theta, \rho)$, and hence, the total number of points making up the line in the original image. By choosing a threshold $T$ for $H(\theta, \rho)$, and using the inverse Hough function, you can filter the original image to keep only lines that contain at least $T$ points.

### How IDL Implements the Hough Transform

Consider an image $A_{mn}$ of dimensions $M$ by $N$, with array indices $m = 0,..., M–1$ and $n = 0,..., N–1$.

The discrete formula for the HOUGH function for $A_{mn}$ is:

$$H(\theta,\rho) = \sum_{m}\sum_{n} A_{mn}\ \delta(\rho, [\rho'])$$

where the brackets [ ] indicate rounding to the nearest integer, and

$$\rho' = (m\Delta x + x_{\min})\cos\theta + (n\Delta y + y_{\min})\sin\theta$$

The pixels are assumed to have spacing $\Delta x$ and $\Delta y$ in the x and y directions. The delta-function is defined as:

$$\delta(\rho,[\rho']) = \begin{cases} 1 & \rho = [\rho'] \\ 0 & \text{otherwise} \end{cases}$$

### How IDL Implements the Hough Backprojection

The backprojection, $B_{mn}$, contains all of the straight lines given by the $(\theta, \rho)$ points given in $H(\theta, \rho)$. The discrete formula is

$$B_{mn} = \begin{cases} \sum_{\theta}\sum_{\rho} H(\theta,\rho)\,\delta(n,[am+b]) & |\sin\theta| > \frac{\sqrt{2}}{2} \\ \sum_{\theta}\sum_{\rho} H(\theta,\rho)\,\delta(m,[a'n+b']) & |\sin\theta| \le \frac{\sqrt{2}}{2} \end{cases}$$

where the slopes and offsets are given by:

$$a = -\frac{\Delta x}{\Delta y}\frac{\cos\theta}{\sin\theta} \qquad b = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta y \sin\theta}$$

$$a' = \frac{1}{a} \qquad b' = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta x \cos\theta}$$

# Syntax

**Hough Transform:**

*Result* = HOUGH( *Array* [, /DOUBLE] [, DRHO=*scalar*] [, DX=*scalar*] [, DY=*scalar*] [, /GRAY] [, NRHO=*scalar*] [, NTHETA=*scalar*] [, RHO=*variable*] [, RMIN=*scalar*] [, THETA=*variable*] [, XMIN=*scalar*] [, YMIN=*scalar*] )

**Hough Backprojection:**

*Result* = HOUGH( *Array*, /BACKPROJECT, RHO=*variable*, THETA=*variable* [, /DOUBLE] [, DX=*scalar*] [, DY=*scalar*] [, NX=*scalar*] [, NY=*scalar*] [, XMIN=*scalar*] [, YMIN=*scalar*] )

# Return Value

The result of this function is a two-dimensional floating-point array, or a complex array if the input image is complex. If *Array* is double-precision, or if the DOUBLE keyword is set, the result is double-precision, otherwise, the result is single-precision.

# Arguments

## Array

The two-dimensional array of size *M* by *N* which will be transformed. If the keyword GRAY is not set, then, for the forward transform, *Array* is treated as a binary image with all nonzero pixels considered as 1.

# Keywords

## BACKPROJECT

If set, the backprojection is computed, otherwise, the forward transform is computed. When BACKPROJECT is set, *Result* will be an array of dimension *NX* by *NY*.

**Note**

The Hough transform is not one-to-one: each point (*x*, *y*) is not mapped to a single (θ, ρ). Therefore, instead of the original image, the backprojection, or inverse transform, returns an image containing the set of all lines given by the (θ, ρ) points.

## DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

## DRHO

Set this keyword equal to a scalar specifying the spacing Δρ between ρ coordinates, expressed in the same units as *Array*. The default is 1/SQRT(2) times the diagonal distance between pixels, $[(DX^2 + DY^2)/2]^{1/2}$. A larger value produces a coarser resolution by mapping multiple pixels onto a single ρ; this is useful for images that do not contain perfectly straight lines. A smaller value may produce undersampling by trying to map fractional pixels onto ρ, and is not recommended. If BACKPROJECT is specified, this keyword is ignored.

## DX

Set this keyword equal to a scalar specifying the spacing between the horizontal (X) coordinates. The default is 1.0.

## DY

Set this keyword equal to a scalar specifying the spacing between the vertical (Y) coordinates. The default is 1.0.

## GRAY

Set this keyword to perform a weighted Hough transform, with the weighting given by the pixel values. If GRAY is not set, the image is treated as a binary image with all nonzero pixels considered as 1. If BACKPROJECT is specified, this keyword is ignored.

## NRHO

Set this keyword equal to a scalar specifying the number of ρ coordinates to use. The default is 2 CEIL([MAX($X^2$ + $Y^2$)]$^{1/2}$ / DRHO) + 1. If BACKPROJECT is specified, this keyword is ignored.

## NTHETA

Set this keyword equal to a scalar specifying the number of θ coordinates to use over the interval [0,π]. The default is CEIL(π [MAX($X^2$ + $Y^2$)]$^{1/2}$ / DRHO). A larger value will produce smoother results, and is useful for filtering before backprojection. A smaller value will result in broken lines in the transform, and is not recommended. If BACKPROJECT is specified, this keyword is ignored.

## NX

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of horizontal coordinates in the output array. The default is FLOOR(2 MAX(|RHO|)($DX^2$ + $DY^2$)$^{-1/2}$ + 1). For the forward transform this keyword is ignored.

## NY

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of vertical coordinates in the output array. The default is FLOOR(2 MAX(|RHO|)($DX^2$ + $DY^2$)$^{-1/2}$ + 1). For the forward transform, this keyword is ignored.

## RHO

For the forward transform, set this keyword to a named variable that, on exit, will contain the radial (ρ) coordinates. If BACKPROJECT is specified, this keyword must contain the ρ coordinates of the input *Array*.

## RMIN

Set this keyword equal to a scalar specifying the minimum ρ coordinate to use for the forward transform. The default is –0.5(NRHO – 1) DRHO. If BACKPROJECT is specified, this keyword is ignored.

## THETA

For the forward transform, set this keyword to a named variable containing a vector of angular (θ) coordinates to use for the transform. If NTHETA is specified instead, and THETA is set to a named variable, then on exit THETA will contain the θ

coordinates. If BACKPROJECT is specified, this keyword must contain the θ coordinates of the input *Array*. HOUGH returns θ in [0,π)

### XMIN

Set this keyword equal to a scalar specifying the X coordinate of the lower-left corner of the input *Array*. The default is –(*M*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the X coordinate of the lower-left corner of the *Result*. In this case the default is –DX (NX–1)/2.

### YMIN

Set this keyword equal to a scalar specifying the Y coordinate of the lower-left corner of the input *Array*. The default is –(*N*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the Y coordinate of the lower-left corner of the *Result*. In this case the default is –DY (NY–1)/2.

## Examples

This example computes the Hough transform of a random set of pixels:

```
PRO hough_example

  ;Create an image with a random set of pixels
  seed = 12345   ; remove this line to get different random images
  array = RANDOMU(seed,128,128) GT 0.95

  ;Draw three lines in the image
  x = FINDGEN(32)*4
  array[x,0.5*x+20] = 1b
  array[x,0.5*x+30] = 1b
  array[-0.5*x+100,x] = 1b

  ;Create display window, set graphics properties
  WINDOW, XSIZE=330,YSIZE=630, TITLE='Hough Example'
  !P.BACKGROUND = 255  ; white
  !P.COLOR = 0 ; black
  !P.FONT=2
  ERASE

  XYOUTS, .1, .94, 'Noise and Lines', /NORMAL
  ;Display the image. 255b changes black values to white:
  TVSCL, 255b - array, .1, .72, /NORMAL

  ;Calculate and display the Hough transform
```

```
    result = HOUGH(array, RHO=rho, THETA=theta)
    XYOUTS, .1, .66, 'Hough Transform', /NORMAL
    TVSCL, 255b - result, .1, .36, /NORMAL

    ;Keep only lines that contain more than 20 points:
    result = (result - 20) > 0

    ;Find the Hough backprojection and display the output
    backproject = HOUGH(result, /BACKPROJECT, RHO=rho, THETA=theta)
    XYOUTS, .1, .30, 'Hough Backprojection', /NORMAL
    TVSCL, 255b - backproject, .1, .08, /NORMAL

END
```

The following figure displays the output of this example. The top image shows three lines drawn within a random array of pixels that represent noise. The center image shows the Hough transform, displaying sinusoids for points that lie on the same line in the original image. The bottom image shows the Hough backprojection, after setting the threshold to retain only those lines that contain more than 20 points. The

Hough inverse transform, or backprojection, transforms each point in the Hough domain into a straight line in the image.

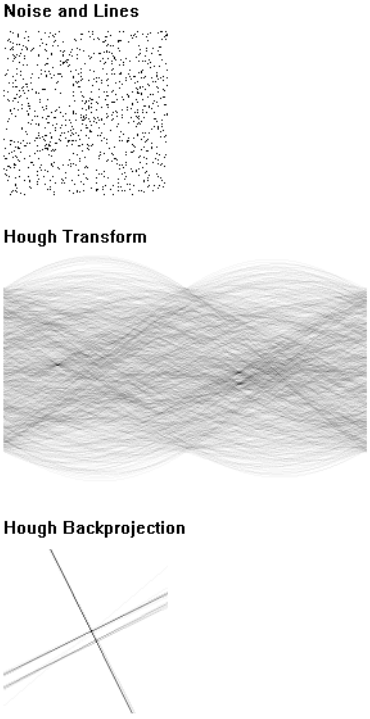



*Figure 10: HOUGH example showing random pixels (top), Hough transform (center) and Hough backprojection (bottom)*

# References

1. Gonzalez, R.C., and R.E. Woods. *Digital Image Processing*. Reading, MA: Addison Wesley, 1992.
2. Jain, Anil K. *Fundamentals of Digital Image Processing*. Englewood Cliffs, NJ: Prentice-Hall, 1989.
3. Toft, Peter. *The Radon Transform: Theory and Implementation*. Denmark: Technical University; 1996. Ph.D. Thesis.
4. Weeks, Arthur. R. *Fundamentals of Electronic Image Processing*. New York: SPIE Optical Engineering Press, 1996.

## Version History

Introduced: 5.4

## See Also

RADON

# HQR

The HQR function returns all eigenvalues of an upper Hessenberg array. Using the output produced by the ELMHES function, this function finds all eigenvalues of the original real, nonsymmetric array.

HQR is based on the routine `hqr` described in section 11.6 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_HQR function.

## Syntax

*Result* = HQR( *A* [, /COLUMN] [, /DOUBLE] )

## Return Value

The result is an *n*-element complex vector.

## Arguments

### A

An *n* by *n* upper Hessenberg array. Typically, *A* would be an array resulting from an application of ELMHES.

## Keywords

### COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

To compute the eigenvalues of a real, non-symmetric unbalanced array, first define the array *A*:

```
A = [[ 1.0, 2.0, 0.0, 0.0, 0.0], $
     [-2.0, 3.0, 0.0, 0.0, 0.0], $
     [ 3.0, 4.0, 50.0, 0.0, 0.0], $
     [-4.0, 5.0, -60.0, 7.0, 0.0], $
     [-5.0, 6.0, -70.0, 8.0, -9.0]]

; Compute the upper Hessenberg form of the array:
hes = ELMHES(A)
; Compute the eigenvalues:
evals = HQR(hes)

; Sort the eigenvalues into ascending order based on their
; real components:
evals = evals(SORT(FLOAT(evals)))

;Print the result.
PRINT, evals
```

IDL prints:

```
  ( -9.00000, 0.00000)( 2.00000, -1.73205)
  (  2.00000, 1.73205)( 7.00000,  0.00000)
  ( 50.0000,  0.00000)
```

This is the exact solution vector to five-decimal accuracy.

## Version History

Introduced: 4.0

## See Also

EIGENVEC, ELMHES, LA_HQR, TRIQL, TRIRED

# HSV

The HSV procedure creates a color table based on the HSV (Hue and Saturation Value) color system.

Using the input parameters, a spiral through the single-ended HSV cone is traced. Points along the cone are converted from HLS to RGB. The current colortable (and the COLORS common block) contains the new colortable on exit.

This routine is written in the IDL language. Its source code can be found in the file `hsv.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

HSV, *Vlo*, *Vhi*, *Satlo*, *Sathi*, *Hue*, *Loops* [, *Colr*]

## Arguments

### Vlo

Starting value, from 0 to 100%.

### Vhi

Ending value, from 0 to 100%.

### Satlo

Starting saturation, from 0 to 100%.

### Sathi

Ending saturation, from 0 to 100%.

### Hue

Starting Hue, from 0 to 360 degrees. Red = 0 degs, green = 120, blue = 240.

### Loops

The number of loops through the color spiral. This parameter does not have to be an integer. A negative value causes the loops to traverse the spiral in the opposite direction.

### Colr

An optional (256,3) integer array in which the new R, G, and B values are returned. Red = *Colr*[*,0], green = *Colr*[*,1], blue = *Colr*[*,2].

## Keywords

None.

## Version History

Introduced: Original

## See Also

COLOR_CONVERT, HLS, PSEUDO

# IBETA

The IBETA function computes the incomplete beta function.

$$I_x(a, b) \equiv \frac{\int_0^x t^{a-1}(1-t)^{b-1}dt}{\int_0^1 t^{a-1}(1-t)^{b-1}dt}$$

This routine is written in the IDL language. Its source code can be found in the file `ibeta.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = IBETA( *A, B, Z* [, /DOUBLE] [, EPS=*value*] [, ITER=*variable*] [, ITMAX=*value*] )

## Return Value

If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of *A*, *B*, and *Z*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other arguments are arrays, the function uses the scalar value with each element of the arrays, and returns an array with the same dimensions as the smallest input array.

If any of the arguments are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

## Arguments

### A

A scalar or array that specifies the parametric exponent of the integrand. *A* may be complex.

### B

A scalar or array that specifies the parametric exponent of the integrand. *B* may be complex.

### Z

A scalar or array, in the interval [0, 1], that specifies the upper limit of integration. *Z* may be complex. If *Z* is not complex then the values must be in the range [0, 1].

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double precision.

### EPS

Set this keyword to the desired relative accuracy, or tolerance. The default tolerance is 3.0e-7 for single precision, and 3.0d-12 for double precision.

### ITER

Set this keyword to a named variable that will contain the actual number of iterations performed.

### ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 100.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

## Example 1

Compute the incomplete beta function for the corresponding elements of A, B, and Z.

```
; Define an array of parametric exponents:
A = [0.5, 0.5, 1.0, 5.0, 10.0, 20.0]
B = [0.5, 0.5, 0.5, 5.0, 5.0, 10.0]

; Define the upper limits of integration:
Z = [0.01, 0.1, 0.1, 0.5, 1.0, 0.8]
; Compute the incomplete beta functions:
result = IBETA(A, B, Z)
PRINT, result
```

IDL prints:

```
[0.0637686, 0.204833, 0.0513167, 0.500000, 1.00000, 0.950736]
```

## Example 2

This example shows the difference in accuracy between the incomplete beta function computed with a low tolerance and the incomplete beta function computed with a high tolerance. The resulting surfaces show the relative errors of each. The relative error of the low tolerance ranges from 0 to 0.002 percent. The relative error of the high tolerance ranges from 0 to 0.0000000004 percent.

```
PRO UsingIBETAwithEPS

; Define an array of parametric exponents.
parameterA = (DINDGEN(101)/100. + 1.D) # REPLICATE(1.D, 101)
parameterB = REPLICATE(1.D, 101) # (DINDGEN(101)/10. + 1.D)

; Define the upper limits of integration.
upperLimits = REPLICATE(0.1D, 101, 101)

; Compute the incomplete beta functions.
betaFunctions = IBETA(parameterA, parameterB, upperLimits)

; Compute the incomplete beta functions with a less
; accurate tolerance set.
laBetaFunctions = IBETA(parameterA, parameterB, $
   upperLimits, EPS = 3.0e-4)

; Compute relative error.
relativeError = 100.* $
   ABS((betaFunctions - laBetaFunctions)/betaFunctions)
```

```
; Display resulting relative error.
WINDOW, 0, TITLE = 'Compare IBETA with Less Accurate EPS'
SURFACE, relativeError, parameterA, parameterB, $
   /XSTYLE, /YSTYLE, TITLE = 'Relative Error', $
   XTITLE = 'Parameter A', YTITLE = 'Parameter B', $
   ZTITLE = 'Percent Error (%)', CHARSIZE = 1.5

; Compute the incomplete beta functions with a more
; accurate tolerance set..
maBetaFunctions = IBETA(parameterA, parameterB, $
   upperLimits, EPS = 3.0e-10)

; Compute relative error.
relativeError = 100.* $
   ABS((maBetaFunctions - betaFunctions)/maBetaFunctions)

; Display resulting relative error.
WINDOW, 1, TITLE = 'Compare IBETA with More Accurate EPS'
SURFACE, relativeError, parameterA, parameterB, $
   /XSTYLE, /YSTYLE, TITLE = 'Relative Error', $
   XTITLE = 'Parameter A', YTITLE = 'Parameter B', $
   ZTITLE = 'Percent Error (%)', CHARSIZE = 1.5

in = ''
READ,"Press enter",in
WDELETE, 0, 1

END
```

## Version History

Introduced: 4.0

*A*, *B*, and *Z* arguments accept complex input: 5.6

## See Also

BETA, GAMMA, IGAMMA, LNGAMMA

# ICONTOUR

The ICONTOUR procedure creates an iTool and associated user interface (UI) configured to display and manipulate contour data.

**Note**

If no arguments are specified, the ICONTOUR procedure creates an empty Contour tool.

This routine is written in the IDL language. Its source code can be found in the file `icontour.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Using Palettes

Contour colors can be specified in several ways. By default, all contour levels are black. The COLOR keyword can be used to change the color of all contour levels. For example, you can change contour levels to red by setting COLOR = [255, 0, 0]. Individual color levels can be specified when the iContour tool is in palette color mode, which allows a color table to be used. You can activate the palette color mode from the IDL Command Line by setting either of the RGB_TABLE or RGB_INDICES keywords, or from the iContour tool's property sheet by changing the **Use palette color** setting to `True`.

**Note**

If you are not in the palette color mode, the colors of individual levels may be modified in the contour level properties dialog. If you are in the palette color mode, the ability to edit individual colors in the contour level properties dialog is disabled. However, changing the **Use palette color** setting to `False` does not switch you back to previously set colors. It simply converts the colors referenced by indices to direct color values that can be individually modified. A common practice is to switch to palette color mode, select a palette, then change **Use palette color** to `False`. The colors of the palette are now loaded as individual contour colors that can each be edited in the contour level properties dialog.

If the iContour tool is in palette color mode, a colorbar can be inserted through the **Insert** menu. The colorbar displays a sample of the current palette associated with the contour display. The data values of the axis of the colorbar are based on the data range of the *Z* argument and the contour level values.

The minimum value of the colorbar axis represents the minimum of the data range. The maximum value of the axis is the greater of than the maximum of the data range and the highest contour level value.

**Note**

When IDL computes default contour levels, the highest contour level may be above the maximum value of the data.

# Syntax

ICONTOUR[, *Z*[, *X*, *Y*]]

**iTool Common Keywords:** [, DIMENSIONS=[*x*, *y*]] [, IDENTIFIER=*variable*] [, LOCATION=[*x*, *y*]] [, NAME=*string*] [, OVERPLOT=*iToolID*] [, TITLE=*string*] [, VIEW_GRID=[*columns*, *rows*]] [, /VIEW_NEXT] [, VIEW_NUMBER=*integer*] [, {X | Y | Z}RANGE=[*min*, *max*]]

**iTool Contour Keywords:** [, RGB_INDICES=*vector of indices*] [, RGB_TABLE=*byte array of 256 by 3 or 3 by 256 elements*] [, ZVALUE=*value*]

**Contour Object Keywords:** [, AM_PM=*vector of two strings*] [, ANISOTROPY=[*x*, *y*, *z*]] [, C_COLOR=*color array*] [, C_FILL_PATTERN=*array of IDLgrPattern objects*] [, C_LABEL_INTERVAL=*vector*] [, C_LABEL_NOGAPS=*vector*] [, C_LABEL_OBJECTS=*array of object references*] [, C_LABEL_SHOW=*vector of integers*] [, C_LINESTYLE=*array of linestyles*] [, C_THICK=*float array*{each element 1.0 to 10.0}] [, C_USE_LABEL_COLOR=*vector of values*] [, C_USE_LABEL_ORIENTATION=*vector of values*] [, C_VALUE=*scalar or vector*] [, CLIP_PLANES=*array*] [, COLOR=*RGB vector*] [, DAYS_OF_WEEK=*vector of seven strings*] [, DEPTH_OFFSET=*value*] [, /DOWNHILL] [, /FILL] [, /HIDE] [, LABEL_FONT=*objref*] [, LABEL_FORMAT=*string*] [, LABEL_FRMTDATA=*value*] [, LABEL_UNITS=*string*] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, MONTHS=*vector of 12 values*] [, N_LEVELS=*value*] [, /PLANAR] [, SHADE_RANGE=[*min*, *max*] ] [, SHADING={0 |1}] [, TICKINTERVAL=*value*] [, TICKLEN=*value*] [, USE_TEXT_ALIGNMENTS=*value*]

**Axis Object Keywords:** [, {X | Y | Z}GRIDSTYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}]
[, {X | Y | Z}MAJOR=*integer*] [, {X | Y | Z}MINOR=*integer*]
[, {X | Y | Z}SUBTICKLEN=*ratio*] [, {X | Y | Z}TEXT_COLOR=*RGB vector*]
[, {X | Y | Z}TICKFONT_INDEX={0 | 1 | 2 | 3 | 4}]
[, {X | Y | Z}TICKFONT_SIZE=*integer*]
[, {X | Y | Z}TICKFONT_STYLE={0 | 1 | 2 | 3}]
[, {X | Y | Z}TICKFORMAT=*string or string array*]
[, {X | Y | Z}TICKINTERVAL=*value*] [, {X | Y | Z}TICKLAYOUT={0 | 1 | 2}]
[, {X | Y | Z}TICKLEN=*value*] [, {X | Y | Z}TICKNAME=*string array*]
[, {X | Y | Z}TICKUNITS=*string*] [, {X | Y | Z}TICKVALUES=*vector*]
[, {X | Y | Z}TITLE=*string*]

# Arguments

## X

A vector or two-dimensional array specifying the *x*-coordinates for the contour surface. If *X* is a vector, each element of *X* specifies the *x*-coordinate for a column of *Z* (e.g., X[0] specifies the *x*-coordinate for Z[0, *]). If X is a two-dimensional array, each element of X specifies the *x*-coordinate of the corresponding point in Z (i.e., $X_{ij}$ specifies the *x*-coordinate for $Z_{ij}$).

## Y

A vector or two-dimensional array specifying the *y*-coordinates for the contour surface. If *Y* is a vector, each element of *Y* specifies the *y*-coordinate for a row of Z (e.g., Y[0] specifies the *y*-coordinate for Z[*,0]). If *Y* is a two-dimensional array, each element of *Y* specifies the *y*-coordinate of the corresponding point in Z ($Y_{ij}$ specifies the *y*-coordinate for $Z_{ij}$).

## Z

A vector or two-dimensional array containing the values to be contoured. If the *X* and *Y* arguments are provided, the contour is plotted as a function of the (*x*, *y*) locations specified by their contents. Otherwise, the contour is generated as a function of the two-dimensional array index of each element of *Z*.

# Keywords

**Note**

Keywords to the ICONTOUR routine that correspond to the names of *registered properties* of the iContour tool must be specified in full, without abbreviation.

## AM_PM

Set this keyword to a vector of 2 strings indicating the names of the AM and PM strings when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the LABEL_FORMAT keyword. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual for more information on format codes.

## ANISOTROPY

Set this keyword equal to a three-element vector [*x*, *y*, *z*] that represents the multipliers to be applied to the internally computed correction factors along each axis that account for anisotropic geometry. Correcting for anisotropy is particularly important for the appropriate representations of downhill tickmarks.

By default, IDL will automatically compute correction factors for anisotropy based on the [XYZ] range of the contour geometry. If the geometry (as provided via the GEOMX, GEOMY, and GEOMZ keywords) falls within the range [*xmin*, *ymin*, *zmin*] to [*xmax*, *ymax*, *zmax*], then the default correction factors are computed as follows:

```
dx = xmax - xmin
dy = ymax - ymin
dz = zmax - zmin
; Get the maximum of the ranges:
maxRange = (dx > dy) > dz
IF (dx EQ 0) THEN xcorrection = 1.0 ELSE $
   xcorrection = maxRange / dx
IF (dy EQ 0) THEN ycorrection = 1.0 ELSE $
   ycorrection = maxRange / dy
IF (dz EQ 0) THEN zcorrection = 1.0 ELSE $
   zcorrection = maxRange / dz
```

This internally computed correction is then multiplied by the corresponding [*x*, *y*, *z*] values of the ANISOTROPY keyword. The default value for this keyword is [1,1,1]. IDL converts, maintains, and returns this data as double-precision floating-point.

## C_COLOR

Set this keyword to a 3 by *N* array of RGB colors representing the colors to be applied at each contour level. If there are more contour levels than elements in this vector, the colors will be cyclically repeated. If C_COLOR is set to 0, all contour levels will be drawn in the color specified by the COLOR keyword (this is the default).

However, the C_COLOR keyword does not activate the palette color mode, which is recommended when working with contour levels and color. This mode can be activated with the RGB_INDICES and RGB_TABLE keywords. See "Using Palettes" on page 840 for more details.

## C_FILL_PATTERN

Set this keyword to an array of IDLgrPattern objects representing the patterns to be applied at each contour level if the FILL keyword is non-zero. If there are more contour levels than fill patterns, the patterns will be cyclically repeated. If this keyword is set to 0, all contour levels are filled with a solid color (this is the default).

## C_LABEL_INTERVAL

Set this keyword to a vector of values indicating the distance (measured parametrically relative to the length of each contour path) between labels for each contour level. If the number of contour levels exceeds the number of provided intervals, the C_LABEL_INTERVAL values will be repeated cyclically. The default is 0.4.

## C_LABEL_NOGAPS

Set this keyword to a vector of values indicating whether gaps should be computed for the labels at the corresponding contour value. A zero value indicates that gaps will be computed for labels at that contour value; a non-zero value indicates that no gaps will be computed for labels at that contour value. If the number of contour levels exceeds the number of elements in this vector, the C_LABEL_NOGAPS values will be repeated cyclically. By default, gaps for the labels are computed for all levels (so that a contour line does not pass through the label).

## C_LABEL_OBJECTS

Set this keyword to an array of object references to provide examples of labels to be drawn for each contour level. The objects specified via this keyword must inherit from one of the following classes:

- IDLgrSymbol
- IDLgrText

If a single object is provided, and it is an IDLgrText object, each of its strings will correspond to a contour level. If a vector of objects is used, any IDLgrText objects should have only a single string; each object will correspond to a contour level.

By default, with C_LABEL_OBJECTS set equal to a null object, IDL computes text labels that are the string representations of the corresponding contour level values.

**Note**

The objects specified via this keyword are used as descriptors only. The actual objects drawn as labels are generated by IDL.

The contour labels will have the same color as their contour level (see C_COLOR) unless the C_USE_LABEL_COLOR keyword is specified. The orientation of the label will be automatically computed unless the C_USE_LABEL_ORIENTATION keyword is specified. The horizontal and vertical alignment of any text labels will default to 0.5 (i.e., centered) unless the USE_TEXT_ALIGNMENTS keyword is specified.

**Note**

The object(s) set via this keyword will not be destroyed automatically when the contour is destroyed.

## C_LABEL_SHOW

Set this keyword to a vector of integers. For each contour value, if the corresponding value in the C_LABEL_SHOW vector is non-zero, the contour line for that contour value will be labeled. If the number of contour levels exceeds the number of elements in this vector, the C_LABEL_SHOW values will be repeated cyclically. The default is 0 indicating that no contour levels will be labeled.

## C_LINESTYLE

Set this keyword to an array of linestyles representing the linestyles to be applied at each contour level. The array may be either a vector of integers representing pre-defined linestyles, or an array of 2-element vectors representing a stippling pattern specification. If there are more contour levels than linestyles, the linestyles will be cyclically repeated. If this keyword is set to 0, all levels are drawn as solid lines (this is the default).

To use a pre-defined line style, set the C_LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

## C_THICK

Set this keyword to an array of line thicknesses representing the thickness to be applied at each contour level, where each element is a value between 1.0 and 10.0 points. If there are more contour levels than line thicknesses, the thicknesses will be cyclically repeated. If this keyword is set to 0, all contour levels are drawn with a line thickness of 1.0 points (this is the default).

## C_USE_LABEL_COLOR

Set this keyword to a vector of values (0 or 1) to indicate whether the COLOR property value for each of the label objects (for the corresponding contour level) is to be used to draw that label. If the number of contour levels exceeds the number of elements in this vector, the C_USE_LABEL_COLOR values will be repeated cyclically. By default, this value is zero, indicating that the COLOR properties of the label objects will be ignored, and the C_COLOR property for the contour object will be used instead.

## C_USE_LABEL_ORIENTATION

Set this keyword to a vector of values (0 or 1) to indicate whether the orientation for each of the label objects (for the corresponding contour level) is to be used when drawing the label. For text, the orientation of the object corresponds to the BASELINE and UPDIR property values; for a symbol, this refers to the default (un-rotated) orientation of the symbol. If the number of contour levels exceeds the number of elements in this vector, the C_USE_LABEL_ORIENTATION values will be repeated cyclically. By default, this value is zero, indicating that orientation of the label object(s) will be set to automatically computed values (to correspond to the direction of the contour paths).

## C_VALUE

Set this keyword to a scalar value or a vector of values for which contour values are to be drawn. If this keyword is set to 0, contour levels will be evenly sampled across the range of the *Z* argument, using the value of the N_LEVELS keyword to determine the number of samples. IDL converts, maintains, and returns this data as double-precision floating-point.

## CLIP_PLANES

Set this keyword to an array of dimensions [4, *N*] specifying the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where $Ax + By + Cz + D = 0$. Portions of this object that fall in the half space $Ax + By + Cz + D > 0$ will be clipped. By default, the value of this keyword is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

A window is only able to support a limited number of clipping planes. Some of these clipping planes may already be in use by the tool to support specific data

display features. If the total number of clipping planes exceeds the limit, an informational message is displayed.

## COLOR

Set this keyword to the color to be used to draw the contours. This color is specified as an RGB vector. The default is [0, 0, 0]. This value will be ignored if the C_COLOR keyword is set to a vector.

## DAYS_OF_WEEK

Set this keyword to a vector of 7 strings to indicate the names to be used for the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the LABEL_FORMAT keyword. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual for more information on format codes.

## DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the dimensions of the drawing area of the specific tool in units specified by the UNITS keyword. If no value is provided, a default value of one half the screen size is used. The minimum width of the window correlates to the width of the menubar. The minimum window height is 100 pixels.

## DOWNHILL

Set this keyword to indicate that downhill tick marks should be rendered as part of each contour level to indicate the downhill direction relative to the contour line.

## FILL

Set this keyword to indicate that the contours should be filled. The default is to draw the contour levels as lines without filling. Filling contours may produce less than satisfactory results if your data contains NaNs, or if the contours are not closed.

## HIDE

Set this keyword to a boolean value to indicate whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

## IDENTIFIER

Set this keyword to a named variable that will contain the iToolID for the created tool. This value can then be used to reference this tool during overplotting operations or command-line-based tool management operations.

## LABEL_FONT

Set this keyword to an instance of an IDLgrFont object to describe the default font to be used for contour labels. This font will be used for all text labels automatically generated by IDL (i.e., if C_LABEL_SHOW is set but the corresponding C_LABEL_OBJECTS text object is not provided), or for any text label objects provided via C_LABEL_OBJECTS that do not already have the font property set. The default value for this keyword is a NULL object reference, indicating that 12 pt. Helvetica will be used.

## LABEL_FORMAT

Set this keyword to a string that represents a format string or the name of a function to be used to format the contour labels. If the string begins with an open parenthesis, it is treated as a standard format string. (Refer to the Format Codes in the IDL Reference Guide.) If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate contour level labels.

The callback function is called with three parameters: *Axis*, *Index*, and *Value* and an optional DATA keyword, where:

- *Axis* is simply the value 2 to indicate that values along the Z axis are being formatted, which allows a single callback routine to be used for both axis labeling and contour labeling.
- *Index* is the contour level index (indices start at 0).
- *Value* is the data value of the current contour level.
- DATA is the optional keyword allowing any user-defined value specified through the LABEL_FRMTDATA keyword to ICONTOUR.

## LABEL_FRMTDATA

Set this keyword to a value of any type. It will be passed via the DATA keyword to the user-supplied formatting function specified via the LABEL_FORMAT keyword, if any. By default, this value is 0, indicating that the DATA keyword will not be set (and furthermore, need not be supported by the user-supplied function).

## LABEL_UNITS

Set this keyword to a string indicating the units to be used for default contour level labeling.

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the contour levels correspond to time values; IDL will determine the appropriate label format based upon the range of values covered by the contour Z data.
- "" - The empty string is equivalent to the "Numeric" unit. This is the default.

If any of the time units are utilized, then the contour values are interpreted as Julian date/time values.

**Note**

The singular form of each of the time unit strings is also acceptable (for example, LEVEL_UNITS='Day' is equivalent to LEVEL_UNITS='Days').

## LOCATION

Set this keyword to a two-element vector of the form [*x*, *y*] to specify the location of the upper left-hand corner of the tool relative to the display screen, in units specified by the UNITS keyword.

## MAX_VALUE

Set this keyword to the maximum value to be plotted. Data values greater than this value are treated as missing data. The default is the maximum value of the input Z data. IDL converts, maintains, and returns this data as double-precision floating-point.

## MONTHS

Set this keyword to a vector of 12 strings indicating the names to be used for the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the C_LABEL_FORMAT keyword. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual for more information on format codes.

## MIN_VALUE

Set this keyword to the minimum value to be plotted. Data values less than this value are treated as missing data. The default is the minimum value of the input Z data. IDL converts, maintains, and returns this data as double-precision floating-point.

## NAME

Set this keyword to a string that specifies the name of this visualization.

## N_LEVELS

Set this keyword to the number of contour levels to generate. This keyword is ignored if the C_VALUE keyword is set to a vector, in which case, the number of levels is derived from the number of elements in that vector. Set this keyword to zero to indicate that IDL should compute a default number of levels based on the range of data values. This is the default.

## OVERPLOT

Set this keyword to an iToolID to direct the graphical output of the particular tool to the tool specified by the provided iToolID.

Set this keyword to 1 (one) to place the graphical output for the command in the current tool. If no current tool exists, a new tool is created.

## PLANAR

Set this keyword to indicate that the contoured data is to be projected onto a plane. Unlike the underlying IDLgrContour object, the default for ICONTOUR is planar (PLANAR = 1), which displays the contoured data in a plane. See the ZVALUE keyword to specify the Z value at which to display the planar Contour plot if it is displayed in a three dimensional data space.

## RGB_INDICES

Set this keyword to a vector of indices into the color table to select colors to use for contour level colors. Setting the RGB_INDICES keyword activates the palette color mode, which allows colors from a specified color table to be used for the contour levels. The values set for RGB_INDICES are indices into the RGB_TABLE array of colors. If the number of colors selected using RGB_INDICES is less than the number of contour levels, the colors are repeated cyclically. If indices are not specified with the RGB_INDICES keyword, a default vector is constructed based on the values of the contour levels within the contour data range scaled to the byte range of RGB_TABLE.

See “Using Palettes” on page 840 for more details on the palette color mode.

## RGB_TABLE

Set this keyword to either a 3 by 256 or 256 by 3 array containing color values to use for contour level colors. Setting the RGB_TABLE keyword activates the palette color mode, which allows colors from a specified color table to be used for the contour levels. The colors for each level are selected from RGB_TABLE using the RGB_INDICES vector. If indices are not specified with the RGB_INDICES keyword then a default vector is constructed based on the values of the contour levels within the contour data range scaled to the byte range of RGB_TABLE.

If the visualization is in palette color mode, but colors have not been specified with the RGB_TABLE keyword, the contour plot uses a default grayscale ramp.

See “Using Palettes” on page 840 for more details on the palette color mode.

## SHADE_RANGE

Set this keyword to a two-element array that specifies the range of pixel values (color indices) to use for shading. The first element is the color index for the darkest pixel. The second element is the color index for the brightest pixel. This value is ignored when the contour is drawn to a graphics destination that uses the RGB color model.

## SHADING

Set this keyword to an integer representing the type of shading to use:

- 0 = Flat (default): The color has a constant intensity for each face of the contour, based on the normal vector.
- 1 = Gouraud: The colors are interpolated between vertices, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

## TICKINTERVAL

Set this keyword equal to a number indicating the distance between downhill tickmarks, in data units. If TICKINTERVAL is not set, or if you explicitly set it to zero, IDL will compute the distance based on the geometry of the contour. IDL converts, maintains, and returns this data as double-precision floating-point.

## TICKLEN

Set this keyword equal to a number indicating the length of the downhill tickmarks, in data units. If TICKLEN is not set, or if you explicitly set it to zero, IDL will compute the length based on the geometry of the contour. IDL converts, maintains, and returns this data as double-precision floating-point

## TITLE

Set this keyword to a string to specify a title for the tool. The title is displayed in the title bar of the tool and is used for tool-related display purposes only – as the root of the hierarchy shown in the Tool Browser, for example.

## USE_TEXT_ALIGNMENTS

Set this keyword to indicate that, for any IDLgrText labels (as specified via the C_LABEL_OBJECTS keyword), the ALIGNMENT and VERTICAL_ALIGNMENT property values for the given IDLgrText object(s) are to be used to draw the corresponding labels. By default, this value is zero, indicating that the ALIGNMENT and VERTICAL_ALIGNMENT properties of the label IDLgrText object(s) will be set to default values (0.5 for each, indicating centered labels).

## VIEW_GRID

Set this keyword to a two-element vector of the form [columns, rows] to specify the view layout within the new tool. This keyword is only used if a new tool is being created (for example, if OVERPLOT, VIEW_NEXT, or VIEW_NUMBER are specified then VIEW_GRID is ignored).

## VIEW_NEXT

Set this keyword to change the view selection to the next view following the currently-selected view before issuing any graphical commands. If the currently-selected view is the last one in the layout, then /VIEW_NEXT will cause the first view in the layout to become selected. This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## VIEW_NUMBER

Set this keyword to change the currently-selected view to the view specified by the VIEW_NUMBER before issuing any graphical commands. The view number starts at 1, and corresponds to the position of the view within the graphics container (not necessarily the position on the screen). This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## [XYZ]MAJOR

Set this keyword to an integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely. ZMAJOR is ignored unless PLANAR is set to 0.

## [XYZ]MINOR

Set this keyword to an integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely. ZMINOR is ignored unless PLANAR is set to 0.

## [XYZ]RANGE

Set this keyword to the desired data range of the axis, a 2-element vector. The first element is the axis minimum, and the second is the maximum. ZRANGE is ignored unless PLANAR is set to 0.

## [XYZ]SUBTICKLEN

Set this keyword to a floating-point scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark. ZSUBTICKLEN is ignored unless PLANAR is set to 0.

## [XYZ]TEXT_COLOR

Set this keyword to an RGB value specifying the color for the axis text. The default value is [0, 0, 0] (black). ZTEXT_COLOR is ignored unless PLANAR is set to 0.

## [XYZ]TICKFONT_INDEX

Set this keyword equal to one of the following integers, which represent the type of font to be used for the axis text:

- 0 = Helvetica
- 1 = Courier
- 2 = Times
- 3 = Symbol
- 4 = Hershey

ZTICKFONT_INDEX is ignored unless PLANAR is set to 0.

## [XYZ]TICKFONT_SIZE

Set this keyword to an integer representing the point size of the font used for the axis text. The default is 12.0 points. ZTICKFONT_SIZE is ignored unless PLANAR is set to 0.

## [XYZ]TICKFONT_STYLE

Set this keyword equal to one of the following integers, which represent the style of font to be used for the axis text:

- 0 = Normal
- 1 = Bold
- 2 = Italic
- 3 = Bold Italic

ZTICKFONT_STYLE is ignored unless PLANAR is set to 0.

## [XYZ]TICKFORMAT

Set this keyword to a string, or an array of strings, in which each string represents a format string or the name of a function to be used to format the tick mark labels. If an array is provided, each string corresponds to a level of the axis. The TICKUNITS keyword determines the number of levels for an axis.

If the string begins with an open parenthesis, it is treated as a standard format string. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual.

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels.

### If TICKUNITS are not specified:

- The callback function is called with three parameters: *Axis*, *Index*, and *Value*, where:
- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis
- *Index* is the tick mark index (indices start at 0)
- *Value* is the data value at the tick mark (a double-precision floating point value)

### If TICKUNITS are specified:

The callback function is called with four parameters: *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled. (Level indices start at 0.)

Used with the LABEL_DATE function, this property can easily create axes with date/time labels.

ZTICKFORMAT is ignored unless PLANAR is set to 0.

## [XYZ]TICKINTERVAL

Set this keyword to a floating-point scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis [XYZ]RANGE and the number of major tick marks ([XYZ]MAJOR). The value of this keyword takes precedence over the value set for the [XYZ]MAJOR keyword.

For example, if TICKUNITS = ['S', 'H', 'D'], and TICKINTERVAL = 30, then the interval between major ticks for the first axis level will be 30 seconds.

ZTICKINTERVAL is ignored unless PLANAR is set to 0.

## [XYZ]TICKLAYOUT

Set this keyword to integer scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

ZTICKLAYOUT is ignored unless PLANAR is set to 0.

**Note**

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

## [XYZ]TICKLEN

Set this keyword to a floating-point value that specifies the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point. ZTICKLEN is ignored unless PLANAR is set to 0.

## [XYZ]TICKNAME

Set this keyword to a string array of up to 30 elements that controls the annotation of each tick mark. ZTICKNAME is ignored unless PLANAR is set to 0.

## [XYZ]TICKUNITS

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling. If more than one unit is provided, the axis will be drawn in multiple levels, one level per unit.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- ""- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the "Numeric" unit. This is the default setting.

If any of the time units are utilized, then the tick values are interpreted as Julian date/time values. Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS = 'Day' is equivalent to TICKUNITS = 'Days').

ZTICKUNITS is ignored unless PLANAR is set to 0.

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000hidd, respectively.

### [XYZ]TICKVALUES

Set this keyword to a floating-point vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point. ZTICKVALUES is ignored unless PLANAR is set to 0.

### [XYZ]TITLE

Set this keyword to a string representing the title of the specified axis. ZTITLE is ignored unless PLANAR is set to 0.

### ZVALUE

For a planar contour plot, the height of the Z plane onto which the contour plot is projected.

**Note**

This keyword will not have any visual effect unless PLANAR is true and the plot is in a 3D dataspace, for example by selecting the **Surface** operation to add a surface plot to the dataspace along with the contour plot.

## Examples

In the IDL Intelligent Tools system, data can be imported from the IDL Command Line (as described in Example 1), or data can be imported via the **File** menu in the iTool window (as described in Examples 2 and 3). For detailed information on importing data via the iTool file menu, refer to "Data Import Methods" in Chapter 2 of the *iTool User's Guide* manual.

### Example 1

This example shows how to use the IDL Command Line to bring contour data into the iContour tool.

At the IDL Command Line, enter:

```
file = FILEPATH('convec.dat', SUBDIRECTORY = ['examples', 'data'])
data = READ_BINARY(file, DATA_DIMS = [248, 248])
ICONTOUR, data
```

Double-click on a contour to display the contour properties. Change the **Number of levels** setting to `20`, change **Use palette color** to `True`, and use the **Levels Color Table** setting to load the `EOS B` predefined color table through the **Load Predefined** button in the Palette Editor. Then, change the **Fill contours** setting to `True`.

The following figure displays the output of this example:

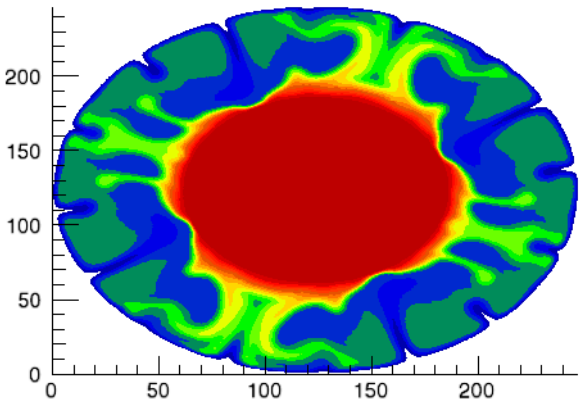



*Figure 3-7: Earth Mantle Convection iContour Example*

## Example 2

This example shows how to use the iTool **File** → **Open** command to load DICOM data into the iContour tool.

At the IDL Command Line, enter:

```
ICONTOUR
```

Select **File** → **Open** to display the Open dialog, then browse to find `mr_brain.dcm` in the `examples/data` directory in the IDL distribution, and click **Open**.

Double-click on a contour to display the contour properties. Then, change **Use palette color** to `True` and the **Fill contours** setting to `True`.

Smooth the data by selecting **Operations** → **Filter** → **Smooth**.

The following figure displays the output of this example:

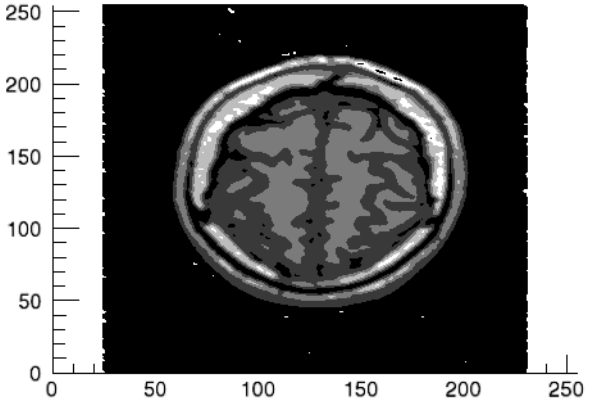



*Figure 3-8: Smoothed Brain MRI iContour Example*

## Example 3

This example shows how to use the **File** → **Import** command to load binary data into the iContour tool.

At the IDL Command Line, enter:

```
ICONTOUR
```

Select **File** → **Import** to display the IDL Import Data wizard.

1. At Step 1, select **From a File** and click **Next>>**.
2. At Step 2, under **File Name:**, browse to find `idemosurf.dat` in the `examples/data` directory in the IDL distribution, and click **Next**>>.
3. At Step 3, select **Contour** and click **Finish**.

The Binary Template wizard is displayed. In the Binary Template, change **File's byte ordering** to `Little Endian`. Then, click **New Field**, and enter the following information in the New Field dialog:

- **Field Name:** `data` (or a name of your choosing)
- **Type:** `Float (32 bit)`
- **Number of Dimensions:** `2`

- **1st Dimension Size:** `200`
- **2nd Dimension Size:** `200`

Click **OK** to close the New Field dialog and the Binary Template dialog, and the contours are displayed.

Double-click on a contour to display the contour properties. Change the **Number of levels** setting to `10`, change **Use palette color** to `True`, and use the **Levels Color Table** setting to load the `Rainbow18` predefined color table through the **Load Predefined** button in the Palette Editor. Then, change the **Fill contours** setting to `True`.

Change the **Projection** setting from `Planar` to `Three-D`.

The following figure displays the output of this example:

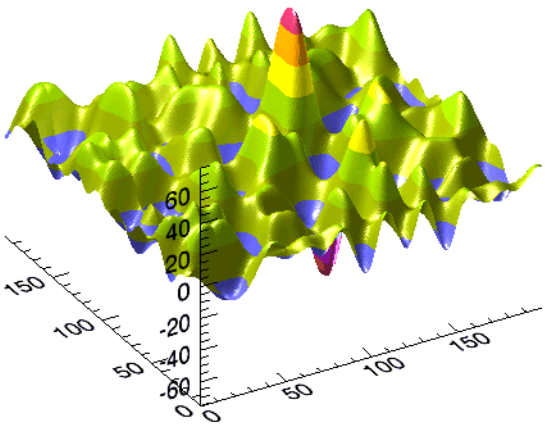



*Figure 3-9: Filled Three-DImensional iContour Example*

## Version History

Introduced: 6.0

# IDENTITY

The IDENTITY function returns an identity array (an array with ones along the main diagonal and zeros elsewhere) of the specified dimensions.

This routine is written in the IDL language. Its source code can be found in the file `identity.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = IDENTITY( *N* [, /DOUBLE] )

## Return Value

Returns an *n* by *n* identity array.

## Arguments

### N

The desired column and row dimensions.

## Keywords

### DOUBLE

Set this keyword to return a double-precision identity array.

## Examples

```
; Define an array, A:
A = [[ 2.0,  1.0,  1.0, 1.5], $
     [ 4.0, -6.0,  0.0, 0.0], $
     [-2.0,  7.0,  2.0, 2.5], $
     [ 1.0,  0.5,  0.0, 5.0]]

; Compute the inverse of A using the INVERT function:
inverse = INVERT(A)
```

```
; Verify the accuracy of the computed inverse using the
; mathematical identity, A x A^-1 - I(4) = 0, where A^-1 is the
; inverse of A, I(4) is the 4 by 4 identity array and 0 is a 4 by 4
; array of zeros:
PRINT, A ## inverse - IDENTITY(4)
```

## Version History

Introduced: 5.0

## See Also

FINDGEN, FLTARR

# IDL_Container Object Class

See Appendix , “TrackBall”.

# IDL_VALIDNAME

The IDL_VALIDNAME function determines whether a string may be used as a valid IDL variable name or structure tag name. Optionally, the routine can convert non-valid characters into underscores, returning a valid name string.

## Syntax

*Result* = IDL_VALIDNAME(*String* [, /CONVERT_ALL] [, /CONVERT_SPACES])

## Return Value

Returns the input string, optionally converting all spaces or non-alphanumeric characters to underscores. If the input string cannot be used as a valid variable or structure tag name, a null string is returned.

## Arguments

### String

A string representing the IDL variable or structure tag name to be checked.

## Keywords

### CONVERT_ALL

If this keyword is set, then *String* is converted into a valid IDL variable name using the following rules:

- All non-alphanumeric characters (except ‘_’, ‘!’ and ‘$’) are converted to underscores
- If the first character of *String* is a number or a ‘$’, then an underscore is prepended to the string
- If the first character of *String* is not a valid character (‘_’, ‘!’, ‘A’…’Z’) then that character is converted to an underscore
- If *String* is an empty string or a reserved word (such as “AND”) then an underscore is prepended to the string

**Tip**

The CONVERT_ALL keyword guarantees that a valid variable name is returned. It is useful in converting user-supplied strings into valid IDL variable names.

### CONVERT_SPACES

If this keyword is set, then all spaces within *String* are converted to underscores. If *String* contains any other non-alphanumeric characters, then a null string is returned, indicating that the string cannot be used as a valid variable name.

**Note**

CONVERT_SPACES behaves the same as CREATE_STRUCT when checking structure tag names.

## Examples

The following table provides IDL_VALIDNAME examples and their results.

| Example | Result |
|---|---|
| `result = IDL_VALIDNAME('abc')` | `'abc'` |
| `result = IDL_VALIDNAME(' a b c ')` | `''` |
| `result = IDL_VALIDNAME(' a b c ', /CONVERT_SPACES)` | `'_a_b_c_'` |
| `result = IDL_VALIDNAME('$var')` | `''` |
| `result = IDL_VALIDNAME('$var', /CONVERT_ALL)` | `'_$VAR'` |
| `result = IDL_VALIDNAME('and')` | `''` |
| `result = IDL_VALIDNAME('and', /CONVERT_ALL)` | `'_AND'` |

*Table 3-1: IDL_VALIDNAME Examples*

## Version History

Introduced: 6.0

## See Also

CREATE_STRUCT

# IDLan* Object Class

The following IDLan* object classes are documented in Appendix , “Analysis Object Classes”:

- IDLanROI
- IDLanROIGroup

# IDLcom* Object Class

The following IDLcom* object classes are documented in Appendix , “Miscellaneous Object Classes”:

- IDLcomActiveX
- IDLcomIDispatch

# IDLff* Object Class

The following IDLff* object classes are documented in Appendix , “File Format Object Classes”:

- IDLffDICOM
- IDLffDXF
- IDLffLanguageCat
- IDLffShape
- IDLffXMLSAX

# IDLgr* Object Classes

The following IDLgr* object classes are documented in Appendix , “Graphics Object Classes”:

- IDLgrAxis
- IDLgrBuffer
- IDLgrClipboard
- IDLgrColorbar
- IDLgrColorbar
- IDLgrFont
- IDLgrImage
- IDLgrLegend
- IDLgrLight
- IDLgrModel
- IDLgrMPEG
- IDLgrPalette
- IDLgrPattern
- IDLgrPlot
- IDLgrPolygon
- IDLgrPolyline
- IDLgrPrinter
- IDLgrROI
- IDLgrROIGroup
- IDLgrScene
- IDLgrSurface
- IDLgrSymbol
- IDLgrTessellator
- IDLgrText
- IDLgrView
- IDLgrViewgroup
- IDLgrVolume
- IDLgrVRML
- IDLgrWindow

# IDLit* Object Classes

The following IDLit* object classes are documented in "iTools Object Classes" in Chapter 7:

IDLitCommand
IDLitCommandSet
IDLitComponent
IDLitContainer
IDLitData
IDLitDataContainer
IDLitDataOperation
IDLitIMessaging
IDLitManipulator
IDLitManipulatorContainer
IDLitManipulatorManager
IDLitManipulatorVisual
IDLitOperation
IDLitParameter
IDLitParameterSet
IDLitReader
IDLitTool
IDLitUI
IDLitVisualization
IDLitWindow
IDLitWriter

# IDLITSYS_CREATETOOL

The IDLITSYS_CREATETOOL function creates an instance of the specified tool registered within the IDL Intelligent Tools system.

This routine is written in the IDL language. Its source code can be found in the file `idlitsys_createtool.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

*Result* = IDLITSYS_CREATETOOL(*StrTool*[, INITIAL_DATA=*data*]
[, OVERPLOT=*iToolID*] [, PANEL_LOCATION={0 | 1 | 2 | 3}]
[, VIEW_GRID=*vector*] [, /VIEW_NEXT] [, VIEW_NUMBER=*number*]
[, VISUALIZATION_TYPE=*vistype*] )

## Return Value

Returns an iToolID that can be used to reference the created tool at a later time.

## Arguments

### StrTool

The name of a tool that has been registered with the iTools system via the ITREGISTER routine.

## Keywords

**Note**

Additional keywords/properties associated with the target visualization at the command line are passed to the underlying system to be applied to the created tool and visualizations.

### INITIAL_DATA

Set this keyword to the data objects that are used to create the initial visualizations in the created tool.

## OVERPLOT

Set this keyword to the iToolID of the tool in which the visualization is to be created. This iToolID can be obtained during the creation of a previous tool or from the ITGETCURRENT routine.

## PANEL_LOCATION

Set this keyword to an integer value to control where a user interface panel should be displayed. Possible values are:

| | |
|---|---|
| 0 | position the panel above the iTool window |
| 1 | position the panel below the iTool window |
| 2 | position the panel to the left of the iTool window. |
| 3 | position the panel to the right of the iTool window (this is the default). |

## VIEW_GRID

Set this keyword to a two-element vector of the form [*columns*, *rows*] to specify the view layout within the new tool. This keyword is only used if a new tool is being created; it is ignored if OVERPLOT, VIEW_NEXT, or VIEW_NUMBER are specified.

## VIEW_NEXT

Set this keyword to change the view selection to the next view following the currently-selected view before issuing any graphical commands. If the currently-selected view is the last one in the layout, then /VIEW_NEXT will cause the first view in the layout to become selected. This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

### VIEW_NUMBER

Set this keyword to change the currently-selected view to the view specified by the VIEW_NUMBER before issuing any graphical commands. The view number starts at 1, and corresponds to the position of the view within the graphics container (not necessarily the position on the screen). This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

### VISUALIZATION_TYPE

Set this keyword to a string containing the name of a registered visualization type that should be used to visualize any data specified by the INITIAL_DATA keyword. If this keyword is not specified, the iTool will select a visualization type based on the data type of the input data.

## Examples

See Chapter 5, “Example: Simple iTool” in the *iTool Developer’s Guide* manual.

## Version History

Introduced: 6.0

## See Also

ITREGISTER, Chapter 5, “Creating an iTool Launch Routine” in the *iTool Developer’s Guide* manual

# IF...THEN...ELSE

The IF...THEN...ELSE statement conditionally executes a statement or block of statements.

**Note**

For information on using IF...THEN...ELSE and other IDL program control statements, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

IF *expression* THEN *statement* [ ELSE *statement* ]

or

IF *expression* THEN BEGIN

*statements*

ENDIF [ ELSE BEGIN

*statements*

ENDELSE ]

## Examples

The following example illustrates the use of the IF statement using the ELSE clause. Notice that the IF statement is ended with ENDIF, and the ELSE statement is ended with ENDELSE. Also notice that the IF statement can be used with or without the BEGIN...END block:

```
A = 2
B = 4

IF (A EQ 2) AND (B EQ 3) THEN BEGIN
   PRINT, 'A = ', A
   PRINT, 'B = ', B
ENDIF ELSE BEGIN
   IF A NE 2 THEN PRINT, 'A <> 2' ELSE PRINT, 'B <> 3'
ENDELSE
```

IDL Prints:

```
B <> 3
```

## Version History

Introduced: Original

# IGAMMA

The IGAMMA function computes the incomplete gamma function.

$$P_x(a) \equiv \frac{\int_0^x e^{-t} t^{a-1} dt}{\int_0^\infty e^{-t} t^{a-1} dt}$$

IGAMMA uses either a power series representation or a continued fractions method. If *Z* is less than or equal to *A*+1, a power series representation is used. If *Z* is greater than *A*+1, a continued fractions method is used.

This routine is written in the IDL language. Its source code can be found in the file `igamma.pro` in the `lib` subdirectory of the IDL distribution.

This routine can also be used with the GAMMA function to calculate the following other variations of the incomplete gamma function.

- $\gamma_x(a) = P_x(a)\Gamma(a) = \int_0^x e^{-t} t^{a-1} dt$, which can be calculated with IGAMMA and GAMMA:

  ```
  igmaVariant1 = IGAMMA(A, Z)*GAMMA(A)
  ```

- $\Gamma_x(a) = \Gamma(a) - \gamma(a) = \int_x^\infty e^{-t} t^{a-1} dt$, which can be calculated with IGAMMA and GAMMA:

  ```
  igmaVariant2 = GAMMA(A)*(1 - IGAMMA(A, Z))
  ```

- $\gamma_x^*(a) = x^{-a} P_x(a) = (x^{-a} / (\Gamma(a))) \int_0^x e^{-t} t^{a-1} dt$, which can be calculated with IGAMMA:

  ```
  igmaVariant3 = x^(-A)*IGAMMA(A, Z)
  ```

## Syntax

*Result* = IGAMMA( *A*, *Z* [, /DOUBLE] [, EPS=*value*] [, ITER=*variable*] [, ITMAX=*value*] [, METHOD=*variable*] )

# Return Value

If both arguments are scalar, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *A* and *Z*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If any of the arguments are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

# Arguments

## A

A scalar or array that specifies the parametric exponent of the integrand. *A* may be complex.

## Z

A scalar or array that specifies the upper limit of integration. *Z* may be complex. If *Z* is not complex then the values must be greater than or equal to zero.

# Keywords

## DOUBLE

Set this keyword to return a double-precision result.

## EPS

Set this keyword to the desired relative accuracy, or tolerance. The default tolerance is 3.0e-7 for single precision, and 3.0d-12 for double precision.

## ITER

Set this keyword to a named variable that will contain the actual number of iterations performed.

## ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 100,000.

### METHOD

This keyword is obsolete. METHOD will still be accepted, but will always return 0.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

### Example 1

Compute the incomplete gamma function for the corresponding elements of A and Z.

```
; Define an array of parametric exponents:
A = [0.10, 0.50, 1.00, 1.10, 6.00, 26.00]

; Define the upper limits of integration:
Z = [0.0316228, 0.0707107, 5.00000, 1.04881, 2.44949, 25.4951]

; Compute the incomplete gamma functions:
result = IGAMMA(A, Z)

PRINT, result
```

IDL prints:

```
[0.742026, 0.293128, 0.993262, 0.607646, 0.0387318, 0.486387]
```

## Version History

Introduced: 4.0

*A* and *Z* arguments accepts complex input: 5.6

## See Also

BETA, GAMMA, IBETA, LNGAMMA

# IIMAGE

The IIMAGE procedure creates an iTool and associated user interface (UI) configured to display and manipulate image data.

**Note**

If no arguments are specified, the IIMAGE procedure creates an empty Image tool.

This routine is written in the IDL language. Its source code can be found in the file `iimage.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

IIMAGE[, *Image*[, *X*, *Y*]]

**iTool Common Keywords:** [, DIMENSIONS=[*x*, *y*]] [, IDENTIFIER=*variable*] [, LOCATION=[*x*, *y*]] [, NAME=*string*] [, OVERPLOT=*iToolID*] [, TITLE=*string*] [, VIEW_GRID=[*columns*, rows]] [, /VIEW_NEXT] [, VIEW_NUMBER=*integer*] [, {X | Y}RANGE=[*min*, *max*]]

**iTool Image Keywords:** [, ALPHA_CHANNEL=*2-D array*] [, BLUE_CHANNEL=*2-D array*] [, GREEN_CHANNEL=*2-D array*] [, IMAGE_DIMENSIONS=[*width*, *height*]] [, IMAGE_LOCATION=[*x*, *y*]] [, RED_CHANNEL=*2-D array*] [, RGB_TABLE=*array of 256 by 3 or 3 by 256 elements*]

**Image Object Keywords**: [, CHANNEL=*hexadecimal bitmask*] [, CLIP_PLANES=*array*] [, /HIDE] [, /INTERPOLATE] [, /ORDER]

**Axis Object Keywords:** [, {X | Y}GRIDSTYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}] [, {X | Y}MAJOR=*integer*] [, {X | Y}MINOR=*integer*] [, {X | Y}SUBTICKLEN=*ratio*] [, {X | Y}TEXT_COLOR=*RGB vector*] [, {X | Y}TICKFONT_INDEX={0 | 1 | 2 | 3 | 4}] [, {X | Y}TICKFONT_SIZE=*integer*] [, {X | Y}TICKFONT_STYLE={0 | 1 | 2 | 3}] [, {X | Y}TICKFORMAT=*string or string array*] [, {X | Y}TICKINTERVAL=*value*] [, {X | Y}TICKLAYOUT={0 | 1 | 2}] [, {X | Y}TICKLEN=*value*] [, {X | Y}TICKNAME=*string array*] [, {X | Y}TICKUNITS=*string*] [, {X | Y}TICKVALUES=*vector*] [, {X | Y}TITLE=*string*]

# Arguments

## Image

Either a vector, a two-dimensional, or a three-dimensional array representing the sample values to be displayed as an image.

If *Image* is a vector:

- The *X* and *Y* arguments must also be present and contain the same number of elements. In this case, a dialog will be presented that offers the option of gridding the data to a regular grid (the results of which will be displayed as a color-indexed image).

If *Image* is a two-dimensional array:

- If either dimension is 3:

  *Image* represents an array of *x*, *y*, and *z* values (either $[[x_0, y_0, z_0], [x_1, y_1, z_1], ..., [x_n, y_n, z_n]]$ or $[[x_0, x_1, ..., x_n], [y_0, y_1, ..., y_n], [z_0, z_1, ..., z_n]]$ where *n* is the length of the other dimension). In this case, the *X* and *Y* arguments, if present, will be ignored. A dialog will be presented that allows the option of gridding the data to a regular grid (the results of which will be displayed as a color-indexed image, using the *z* values as the image data values).

- If neither dimension is 3:

  *Image* represents an array of sample values to be displayed as a color-indexed image. If *X* and *Y* are provided, the sample values are defined as a function of the corresponding (*x*, *y*) locations; otherwise, the sample values are implicitly treated as a function of the array indices of each element of *Image*.

If *Image* is a three-dimensional array:

- If one of the dimensions is 3:

  *Image* is a 3 x *n* x *m*, *n* x 3 x *m*, or *n* x *m* x 3 array representing the red, green, and blue channels of the image to be displayed.

- If one of the dimensions is 4:

  *Image* is a 4 x *n* x *m*, *n* x 4 x *m*, or *n* x *m* x 4 array representing the red, green, blue, and alpha channels of the image to be displayed.

## X

Either a vector or a two-dimensional array representing the *x*-coordinates of the image grid.

If the *Image* argument is a vector:

- *X* must be a vector with the same number of elements as *Image*.

If the *Image* argument is a two-dimensional array (for which neither dimension is 3):

- If *X* is a vector:

  Each element of *X* specifies the *x*-coordinates for a column of *Image* (e.g., *X*[0] specifies the *x*-coordinate for *Image*[0, *]).

- If *X* is a two-dimensional array:

  Each element of *X* specifies the *x*-coordinate of the corresponding point in *Image* ($X_{ij}$ specifies the *x*-coordinate of $Image_{ij}$).

## Y

Either a vector or a two-dimensional array representing the *y*-coordinates of the image grid.

If the *Image* argument is a vector:

- *Y* must be a vector with the same number of elements.

If the *Image* argument is a two-dimensional array:

- If *Y* is a vector:

  Each element of *Y* specifies the *y*-coordinates for a column of *Image* (e.g., *Y*[0] specifies the *y*-coordinate for *Image*[*, 0]).

- If *Y* is a two-dimensional array:

  Each element of *Y* specifies the *y*-coordinate of the corresponding point in *Image* ($Y_{ij}$ specifies the y-coordinate of $Image_{ij}$).

# Keywords

**Note**

Keywords to the IIMAGE routine that correspond to the names of *registered properties* of the iImage tool must be specified in full, without abbreviation.

## ALPHA_CHANNEL

Set this keyword to a two-dimensional array representing the alpha channel pixel values for the image to be displayed. This keyword is ignored if the *Image* argument is present, and is intended to be used in conjunction with some combination of the RED_CHANNEL, GREEN_CHANNEL, and BLUE_CHANNEL keywords.

## BLUE_CHANNEL

Set this keyword to a two-dimensional array representing the blue channel pixel values for the image to be displayed. This keyword is ignored if the *Image* argument is present, and is intended to be used in conjunction with some combination of the RED_CHANNEL, GREEN_CHANNEL, and ALPHA_CHANNEL keywords.

## CHANNEL

Set this keyword to a hexadecimal bitmask that defines which color channel(s) to draw. Each bit that is a 1 is drawn; each bit that is a 0 is not drawn. For example, 'ff0000'X represents a Blue channel write. The default is to draw all channels, and is represented by the hexadecimal value 'ffffff'X.

## CLIP_PLANES

Set this keyword to an array of dimensions [4, *N*] specifying the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this keyword is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

A window is only able to support a limited number of clipping planes. Some of these clipping planes may already be in use by the tool to support specific data display features. If the total number of clipping planes exceeds the limit, an informational message is displayed.

## DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the dimensions of the drawing area of the specific tool in device units. The minimum width of the window correlates to the width of the menubar. The minimum window height is 100 pixels.

## GREEN_CHANNEL

Set this keyword to a two-dimensional array representing the green channel pixel values for the image to be displayed. This keyword is ignored if the *Image* argument is present, and is intended to be used in conjunction with some combination of the RED_CHANNEL, BLUE_CHANNEL, and ALPHA_CHANNEL keywords.

## HIDE

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

## IDENTIFIER

Set this keyword to a named IDL variable that will contain the iToolID for the created tool. This value can then be used to reference this tool during overplotting operations or command-line-based tool management operations.

## IMAGE_DIMENSIONS

Set this keyword to a 2-element vector, [*width*, *height*], to specify the image dimensions (in data units). By default, the dimensions match the pixel width of the image.

## IMAGE_LOCATION

Set this keyword to a 2-element vector, [*x*, *y*], to specify the image location (in data units). By default, the location is [0, 0].

## INTERPOLATE

Set this keyword to one (1) to display the iImage tool using bilinear interpolation. The default is to use nearest neighbor interpolation.

## LOCATION

Set this keyword to a two-element vector of the form [*x*, *y*] to specify the location of the upper left-hand corner of the tool relative to the display screen, in device units.

## NAME

Set this keyword to a string to specify the name for this particular tool. The name is used for tool-related display purposes only–as the root of the hierarchy shown in the Tool Browser, for example.

## ORDER

Set this keyword to force the rows of the image data to be drawn from top to bottom. By default, image data is drawn from the bottom row up to the top row.

## OVERPLOT

Set this keyword to an iToolID to direct the graphical output of the particular tool to the tool specified by the provided iToolID.

Set this keyword to 1 (one) to place the graphical output for the command in the current tool. If no current tool exists, a new tool is created.

## RED_CHANNEL

Set this keyword to a two-dimensional array representing the red channel pixel values for the image to be displayed. This keyword is ignored if the *Image* argument is present, and is intended to be used in conjunction with some combination of the GREEN_CHANNEL, BLUE_CHANNEL, and ALPHA_CHANNEL keywords.

## RGB_TABLE

Set this keyword to a 3 by 256 or 256 by 3 byte array of RGB color values. If no color tables are supplied, the tool will provide a default 256-entry linear grayscale ramp.

## TITLE

Set this keyword to a string to specify a title for the tool. The title is displayed in the title bar of the tool.

## VIEW_GRID

Set this keyword to a two-element vector of the form [*columns*, *rows*] to specify the view layout within the new tool. This keyword is only used if a new tool is being created (for example, if OVERPLOT, VIEW_NEXT, or VIEW_NUMBER are specified then VIEW_GRID is ignored).

## VIEW_NEXT

Set this keyword to change the view selection to the next view following the currently-selected view before issuing any graphical commands. If the currently-selected view is the last one in the layout, then /VIEW_NEXT will cause the first view in the layout to become selected. This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## VIEW_NUMBER

Set this keyword to change the currently-selected view to the view specified by the VIEW_NUMBER before issuing any graphical commands. The view number starts at 1, and corresponds to the position of the view within the graphics container (not necessarily the position on the screen). This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## [XY]MAJOR

Set this keyword to an integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely.

## [XY]MINOR

Set this keyword to an integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely.

## [XY]RANGE

Set this keyword to the desired data range of the axis, a 2-element vector. The first element is the axis minimum, and the second is the maximum.

## [XY]SUBTICKLEN

Set this keyword to a floating-point scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark.

## [XY]TEXT_COLOR

Set this keyword to an RGB value specifying the color for the axis text. The default value is [0, 0, 0] (black).

## [XY]TICKFONT_INDEX

Set this keyword equal to one of the following integers, which represent the type of font to be used for the axis text:

- 0 = Helvetica
- 1 = Courier
- 2 = Times
- 3 = Symbol
- 4 = Hershey

## [XY]TICKFONT_SIZE

Set this keyword to an integer representing the point size of the font used for the axis text. The default is 12.0 points.

## [XY]TICKFONT_STYLE

Set this keyword equal to one of the following integers, which represent the style of font to be used for the axis text:

- 0 = Normal
- 1 = Bold
- 2 = Italic
- 3 = Bold Italic

## [XY]TICKFORMAT

Set this keyword to a string, or an array of strings, in which each string represents a format string or the name of a function to be used to format the tick mark labels. If an array is provided, each string corresponds to a level of the axis. The TICKUNITS keyword determines the number of levels for an axis.

If the string begins with an open parenthesis, it is treated as a standard format string. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual.

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels.

### If TICKUNITS are not specified:

- The callback function is called with three parameters: *Axis*, *Index*, and *Value*, where:
- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis
- *Index* is the tick mark index (indices start at 0)
- *Value* is the data value at the tick mark (a double-precision floating point value)

### If TICKUNITS are specified:

The callback function is called with four parameters: *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled. (Level indices start at 0.)

Used with the LABEL_DATE function, this property can easily create axes with date/time labels.

## [XY]TICKINTERVAL

Set this keyword to a floating-point scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis [XYZ]RANGE and the number of major tick marks ([XYZ]MAJOR). The value of this keyword takes precedence over the value set for the [XYZ]MAJOR keyword.

For example, if TICKUNITS = ['S', 'H', 'D'], and TICKINTERVAL = 30, then the interval between major ticks for the first axis level will be 30 seconds.

## [XY]TICKLAYOUT

Set this keyword to integer scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

**Note**

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

## [XY]TICKLEN

Set this keyword to a floating-point value that specifies the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point.

## [XY]TICKNAME

Set this keyword to a string array of up to 30 elements that controls the annotation of each tick mark.

## [XY]TICKUNITS

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling. If more than one unit is provided, the axis will be drawn in multiple levels, one level per unit.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- ""- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the "Numeric" unit. This is the default setting.

If any of the time units are utilized, then the tick values are interpreted as Julian date/time values. Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS = 'Day' is equivalent to TICKUNITS = 'Days').

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000hidd, respectively.

## [XY]TICKVALUES

Set this keyword to a floating-point vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point.

## [XY]TITLE

Set this keyword to a string representing the title of the specified axis.

# Examples

In the IDL Intelligent Tools system, data can be imported from the IDL Command Line (as described in Example 1), or data can be imported via the **File** menu in the iTool window (as described in Examples 2 and 3). For detailed information on importing data via the iTool file menu, refer to "Data Import Methods" in Chapter 2 of the *iTool User's Guide* manual.

## Example 1

This example shows how use the IDL Command Line to load data into the iImage tool.

At the IDL Command Line, enter:

```
file = FILEPATH('mineral.png', $
   SUBDIRECTORY = ['examples', 'data'])
data = READ_PNG(file)
IIMAGE, data, TITLE = 'Electron Image of Mineral Deposits'
```

Double-click the image to display image properties, and use the **Image Palette** setting to load the `Stern Special` predefined color table through the **Load Predefined** button in the Palette Editor.

Use the Text Annotation tool to insert a title at the top of the image. Select **Insert** → **Colorbars** to insert a color bar at the bottom of the image. Double-click on the colorbar to display its properties, and change the **Title** setting to `Stern Special`.

The following figure displays the output of this example:

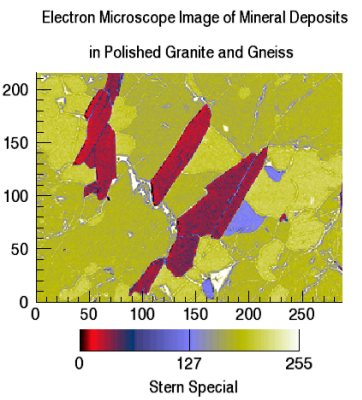



*Figure 3-10: Mineral iImage Example with Sterns Color Table*

## Example 2

This example shows how to use the iTool **File** → **Open** command to load binary data into the iImage tool.

At the IDL Command Line, enter:

```
IIMAGE
```

Select **File** → **Open** to display the Open dialog, then browse to find `worldelv.dat` in the `examples/data` directory in the IDL distribution, and click **Open**.

In the Binary Template dialog, click **New Field**, and enter the following information in the New Field dialog:

- **Field Name:** `data` (or a name of your choosing)
- **Type:** `Byte (unsigned 8-bits)`
- **Number of Dimensions:** `2`
- **1st Dimension Size:** `360`
- **2nd Dimension Size:** `360`

Click **OK** to close the New Field dialog and the Binary Template dialog, and the image is displayed.

**Note**

For more information on using the Binary Template to import data, see "Using the BINARY_TEMPLATE Function" in Chapter 15 of the *Using IDL* manual.

Double-click the image to display image properties, and use the **Image Palette** setting to load the `STD GAMMA-II` predefined color table through the **Load Predefined** button in the Palette Editor.

The following figure displays the output of this example:

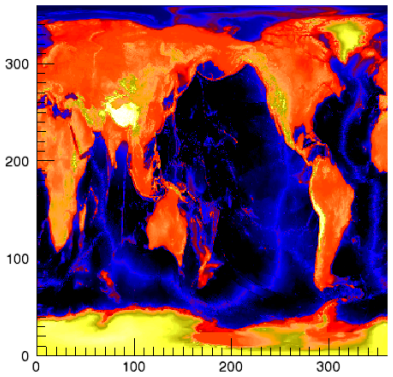



*Figure 3-11: World Elevation iImage Example*

## Example 3

This example shows how to use the IDL Import Data Wizard to load image data into the iImage tool.

At the IDL Command Line, enter:

```
IIMAGE
```

Select **File** → **Import** to display the IDL Import Data wizard.

1. At Step 1, select **From a File** and click **Next>>**.
2. At Step 2, under **File Name:**, browse to find `n_vasinfecta.jpg` in the `examples/data` directory in the IDL distribution, and click **Next>>**.
3. At Step 3, select **Image** and click **Finish**.

Define the edges within the image by selecting **Operations** → **Filter** → **Sobel Filter**.

The following figure displays the output of this example:

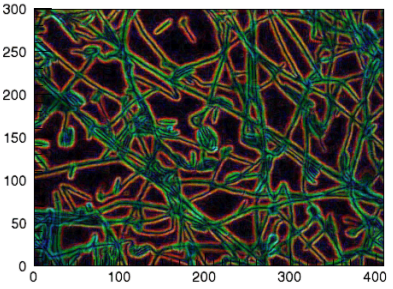



*Figure 3-12: Sobel FIltered Neocosmospora Vasinfecta iImage Example*

## Version History

Introduced: 6.0

# IMAGE_CONT

The IMAGE_CONT procedure overlays an image with a contour plot.

This routine is written in the IDL language. Its source code can be found in the file `image_cont.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

IMAGE_CONT, *A* [, /ASPECT] [, /INTERP] [, /WINDOW_SCALE]

## Arguments

### A

The two-dimensional array to display and overlay.

## Keywords

### ASPECT

Set this keyword to retain the image's aspect ratio. Square pixels are assumed. If WINDOW_SCALE is set, the aspect ratio is automatically retained.

### INTERP

If this keyword is set, bilinear interpolation is used if the image is resized.

### WINDOW_SCALE

Set this keyword to scale the window size to the image size. Otherwise, the image size is scaled to the window size. This keyword is ignored when outputting to devices with scalable pixels (e.g., PostScript).

## Examples

```
; Create an image to display:
A = BYTSCL(DIST(356))

; Display image and overplot contour lines:
IMAGE_CONT, A, /WINDOW
```

## Version History

Introduced: Original

## See Also

CONTOUR, ICONTOUR, IIMAGE, TV

# IMAGE_STATISTICS

The IMAGE_STATISTICS procedure computes sample statistics for a given array of values. An optional mask may be specified to restrict computations to a spatial subset of the input data.

## Syntax

IMAGE_STATISTICS, *Data*
[, /LABELED | [, /WEIGHTED] [, WEIGHT_SUM=*variable*]] [, /VECTOR]
[, LUT=*array*] [, MASK=*array*] [, COUNT=*variable*] [, MEAN=*variable*]
[, STDDEV=*variable*] [, DATA_SUM=*variable*] [, SUM_OF_SQUARES=*variable*]
[, MINIMUM=*variable*] [, MAXIMUM=*variable*] [, VARIANCE=*variable*]

## Arguments

### Data

An *N*-dimensional input data array.

## Keywords

### COUNT

Set this keyword to a named variable to contain the number of samples that correspond to nonzero values within the mask.

### DATA_SUM

Set this keyword to a named variable to contain the sum of the samples that lie within the mask.

### LABELED

When set, this keyword indicates values in the mask representing region labels, where each pixel of the mask is set to the index of the region in which that pixel belongs (see the LABEL_REGION function in the *IDL Reference Guide*). If the LABELED keyword is set, each statistic's value is computed for each region index. Thus, a vector containing the results is provided for each statistic with one element per region. By default, this keyword is set to zero, indicating that all samples with a corresponding nonzero mask value are used to form a scalar result for each statistic.

**Note**

The LABELED keyword cannot be used with either the WEIGHT_SUM or the WEIGHTED keywords.

## LUT

Set this keyword to a one-dimensional array. For non-floating point input *Data*, the pixel values are looked up through this table before being used in any of the statistical computations. This allows an integer image array to be calibrated to any user specified intensity range for the sake of calculations. The length of this array must include the range of the input array. This keyword may not be set with floating point input data. When signed input data types are used, they are first cast to the corresponding IDL unsigned type before being used to access this array. For example, the integer value –1 looks up the value 65535 in the LUT array.

## MASK

An array of *N*, or *N*–1 (when the VECTOR keyword is used) dimensions representing the mask array. If the LABELED keyword is set, MASK contains the region indices of each pixel; otherwise statistics are only computed for data values where the MASK array is non-zero.

## MAXIMUM

Set this keyword to a named variable to contain the maximum value of the samples that lie within the mask.

## MEAN

Set this keyword to a named variable to contain the mean of the samples that lie within the mask.

## MINIMUM

Set this keyword to a named variable to contain the minimum value of the samples that lie within the mask.

## STDDEV

Set this keyword to a named variable to contain the standard deviation of the samples that lie within the mask.

### SUM_OF_SQUARES

Set this keyword to a named variable to contain the sum of the squares of the samples that lie within the mask.

### VARIANCE

Set this keyword to a named variable to contain the variance of the samples that lie within the mask.

### VECTOR

Set this keyword to specify that the leading dimension of the input array is not to be considered spatial but consists of multiple data values at each pixel location. In this case, the leading dimension is treated as a vector of samples at the spatial location determined by the remainder of the array dimensions.

### WEIGHT_SUM

Set the WEIGHT_SUM keyword to a named variable to contain the sum of the weights in the mask.

**Note**

The WEIGHT_SUM keyword cannot be used if the LABELED keyword is specified.

### WEIGHTED

If the WEIGHTED keyword is set, the values in the MASK array are used to weight individual pixels with respect to their count value. If a MASK array is not provided, all pixels are assigned a weight of 1.0.

**Note**

The WEIGHTED keyword cannot be used if the LABELED keyword is specified.

## Version History

Introduced: 5.3

# IMAGINARY

The IMAGINARY function returns the imaginary part of its complex-valued argument.

## Syntax

*Result* = IMAGINARY(*Complex_Expression*)

## Return Value

If the complex-valued argument is double-precision, the result will be double-precision, otherwise the result will be single-precision floating-point.

## Arguments

### Complex_Expression

The complex-valued expression for which the imaginary part is desired.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

```
; Create an array of complex values:
C = COMPLEX([1,2,3],[4,5,6])

; Print just the imaginary parts of each element in C:
PRINT, IMAGINARY(C)
```

IDL prints:

```
 4.00000 5.00000 6.00000
```

## Version History

Introduced: Original

## See Also

COMPLEX, DCOMPLEX, REAL_PART

# INDGEN

The INDGEN function returns an integer array with the specified dimensions.

## Syntax

*Result* = INDGEN(*$D_1$ [, ..., $D_8$]* [, /BYTE | , /COMPLEX | , /DCOMPLEX | , /DOUBLE | , /FLOAT | , /L64 | , /LONG | , /STRING | , /UINT | , /UL64 | , /ULONG] [, TYPE=*value*] )

## Return Value

Each element of the returned integer array is set to the value of its one-dimensional subscript.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### BYTE

Set this keyword to create a byte array.

### COMPLEX

Set this keyword to create a complex, single-precision, floating-point array.

### DCOMPLEX

Set this keyword to create a complex, double-precision, floating-point array.

### DOUBLE

Set this keyword to create a double-precision, floating-point array.

### FLOAT

Set this keyword to create a single-precision, floating-point array.

### L64

Set this keyword to create a 64-bit integer array.

### LONG

Set this keyword to create a longword integer array.

### STRING

Set this keyword to create a string array.

### TYPE

The type code to set the type of the result. See the description of the SIZE function for a list of IDL type codes.

### UINT

Set this keyword to create an unsigned integer array.

### UL64

Set this keyword to create an unsigned 64-bit integer array.

### ULONG

Set this keyword to create an unsigned longword integer array.

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Create *I*, a 5-element vector of integer values with each element set to the value of its subscript by entering:

```
I = INDGEN(5)
```

## Version History

Introduced: Original

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# INT_2D

The INT_2D function computes the double integral of a bivariate function using iterated Gaussian quadrature. The algorithm's transformation data is provided in tabulated form with 15 decimal accuracy.

This routine is written in the IDL language. Its source code can be found in the file `int_2d.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = INT_2D( *Fxy*, *AB_Limits*, *PQ_Limits*, *Pts* [, /DOUBLE] [, /ORDER] )

## Return Value

Returns a double value containing the integral.

## Arguments

### Fxy

A scalar string specifying the name of a user-supplied IDL function that defines the bivariate function to be integrated. For dy/dx integration (the default, or if the ORDER keyword is explicitly set to zero), the Fxy function must be able to accept a scalar value for X and a vector for Y, and must return a vector of the same length as Y. For dx/dy integration (if the ORDER keyword is set), the Fxy function must be able to accept a vector for X and a scalar value for Y, and must return a vector of the same length as X.

For example, if we wish to integrate the following function:

$$f(x, y) = e^{-x^2 - y^2}$$

We define a function FXY to express this relationship in the IDL language:

```
FUNCTION fxy, X, Y
   RETURN, EXP(-X^2. -Y^2.)
END
```

### AB_Limits

A two-element vector containing the lower (A) and upper (B) limits of integration with respect to the variable *x*.

### PQ_Limits

A scalar string specifying the name of a user-supplied IDL function that defines the lower (P(*x*)) and upper (Q(*x*)) limits of integration with respect to the variable *y*. The function must accept *x* and return a two-element vector result.

For example, we might write the following IDL function to represent the limits of integration with respect to *y*:

```
FUNCTION PQ_limits, X
   RETURN, [-SQRT(16.0 - X^2), SQRT(16.0 - X^2)]
END
```

### Pts

The number of transformation points used in the computation. Possible values are: 6, 10, 20, 48, or 96.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### ORDER

A scalar value of either 0 or 1. If set to 0, the integral is computed using a dy-dx order of integration. If set to 1, the integral is computed using a dx-dy order of integration.

## Examples

### Example 1

Compute the double integral of the bivariate function.

$$I = \int_{x = 0.0}^{x = 2.0} \int_{y = 0.0}^{y = x^2} y \cdot \cos(x^5) dy dx$$

```
; Define the Fxy function.
FUNCTION Fxy, x, y
```

```
   RETURN, y*COS(x^5)
END

; Define the limits of integration for y as a function of x:
FUNCTION PQ_Limits, x
   RETURN, [0.0, x^2]
END

; Define limits of integration for x:
AB_Limits = [0.0, 2.0]

; Using the function and limits defined above, integrate with 48
; and 96 point formulas using a dy-dx order of integration and
; double-precision arithmetic:
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 48, /DOUBLE)
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 96, /DOUBLE)
```

INT_2D with 48 transformation points yields: 0.055142668

INT_2D with 96 transformation points yields: 0.055142668

## Example 2

Compute the double integral of the bivariate function:

$$I = \int_{x = 0.0}^{x = 2.0} \int_{y = 0.0}^{y = x^2} y \cdot \cos(x^5) dx dy$$

```
; Define the Fxy function.
FUNCTION Fxy, x, y
   RETURN, y*COS(x^5)
END

; Define the limits of integration for y as a function of x:
FUNCTION PQ_Limits, y
    RETURN, [sqrt(y), 2.0]
END

; Define limits of integration for x:
AB_Limits = [0.0, 4.0]

; Using the function and limits defined above, integrate with 48
; and 96 point formulas using a dy-dx order of integration and
```

```
; double-precision arithmetic:
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 48, /DOUBLE, /ORDER)
PRINT, INT_2D('Fxy', AB_Limits, 'PQ_Limits', 96, /DOUBLE, /ORDER)
```

INT_2D with 48 transformation points yields: 0.055142678

INT_2D with 96 transformation points yields: 0.055142668

The exact solution (7 decimal accuracy) is: 0.055142668

## Version History

Introduced: Pre 4.0

## See Also

INT_3D, INT_TABULATED, QROMB, QROMO, QSIMP

# INT_3D

The INT_3D function computes the integral of a trivariate function using iterated Gaussian quadrature. The algorithm's transformation data is provided in tabulated form with 15 decimal accuracy.

This routine is written in the IDL language. Its source code can be found in the file `int_3d.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = INT_3D( *Fxyz*, *AB_Limits*, *PQ_Limits*, *UV_Limits*, *Pts* [, /DOUBLE] )

## Return Value

Returns the triple integral.

## Arguments

### Fxyz

A scalar string specifying the name of a user-supplied IDL function that defines the trivariate function to be integrated. The function must accept X, Y, and Z, and return a scalar result.

For example, if we wish to integrate the following function:

$$f(x, y, z) = z \cdot (x^2 + y^2 + z^2)^{3/2}$$

We define a function FXY to express this relationship in the IDL language:

```
FUNCTION fxyz, X, Y, Z
   RETURN, z*(x^2+y^2+z^2)^1.5
END
```

### AB_Limits

A two-element vector containing the lower (A) and upper (B) limits of integration with respect to the variable *x*.

### PQ_Limits

A scalar string specifying the name of a user-supplied IDL function that defines the lower (P(*x*)) and upper (Q(*x*)) limits of integration with respect to the variable *y*. The function must accept *x* and return a two-element vector result.

For example, we might write the following IDL function to represent the limits of integration with respect to *y*:

```
FUNCTION PQ_limits, X
   RETURN, [-SQRT(4.0 - X^2), SQRT(4.0 - X^2)]
END
```

### UV_Limits

A scalar string specifying the name of a user-supplied IDL function that defines the lower (U(*x*,*y*)) and upper (V(*x*,*y*)) limits of integration with respect to the variable *z*. The function must accept *x* and *y* and return a two-element vector result.

For example, we might write the following IDL function to represent the limits of integration with respect to *z*:

```
FUNCTION UV_limits, X, Y
   RETURN, [0, SQRT(4.0 - X^2 - Y^2)]
END
```

### Pts

The number of transformation points used in the computation. Possible values are: 6, 10, 20, 48, or 96.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

Compute the triple integral of the trivariate function

Using the functions and limits defined above, integrate with 10, 20, 48, and 96 point formulas (using double-precision arithmetic):

```
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 10,$
   /D)
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 20,$
```

$$I = \int_{x=-2}^{x=2} \int_{y=-\sqrt{4-x^2}}^{y=\sqrt{4-x^2}} \int_{z=0}^{z=\sqrt{4-x^2-y^2}} z \cdot (x^2 + y^2 + z^2)^{3/2} dz dy dx$$

```
   /D)
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 48,$
   /D)
PRINT, INT_3D('Fxyz', [-2.0, 2.0], 'PQ_Limits', 'UV_Limits', 96,$
   /D)
```

INT_3D with 10 transformation points yields: 57.444248

INT_3D with 20 transformation points yields: 57.446201

INT_3D with 48 transformation points yields: 57.446265

INT_3D with 96 transformation points yields: 57.446266

The exact solution (6 decimal accuracy) is: 57.446267

## Version History

Introduced: Pre 4.0

## See Also

INT_2D, INT_TABULATED, QROMB, QROMO, QSIMP

# INT_TABULATED

The INT_TABULATED function integrates a tabulated set of data { *xi* , *fi* } on the closed interval [MIN(*x*) , MAX(*x*)], using a five-point Newton-Cotes integration formula.

**Warning**

Data that is highly oscillatory requires a sufficient number of samples for an accurate integral approximation.

This routine is written in the IDL language. Its source code can be found in the file `int_tabulated.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = INT_TABULATED( *X*, *F* [, /DOUBLE] [, /SORT] )

## Return Value

Returns the area under the curve represented by the function.

## Arguments

### X

The tabulated single- or double-precision floating-point *x*-value data. Data may be irregularly gridded and in random order. (If the data is randomly ordered, set the SORT keyword.)

**Warning**

Each *X* value must be unique; if duplicate *X* values are detected, the routine will exit and display a warning message.

### F

The tabulated single- or double-precision floating-point *f*-value data. Upon input to the function, *xi* and *fi* must have corresponding indices for all values of i. If *x* is reordered, *f* is also reordered.

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## SORT

Set this keyword to sort the tabulated *x*-value data into ascending order. If SORT is set, both *x* and *f* values are sorted.

# Examples

Define 11 *x*-values on the closed interval [0.0 , 0.8]:

```
X = [0.0, .12, .22, .32, .36, .40, .44, .54, .64, .70, .80]
```

Define 11 *f*-values corresponding to *xi*:

```
F = [0.200000, 1.30973, 1.30524, 1.74339, 2.07490, 2.45600, $
     2.84299, 3.50730, 3.18194, 2.36302, 0.231964]
result = INT_TABULATED(X, F)
```

In this example, the f-values are generated from a known function

$$f = 0.2 + 25x - 200x^2 + 675x^3 - 900x^4 + 400x^5$$

which allows the determination of an exact solution. A comparison of methods yields the following results:

- The Multiple Application Trapezoid Method yields: 1.5648
- The Multiple Application Simpson’s Method yields: 1.6036
- INT_TABULATED yields: 1.6271

The exact solution (4 decimal accuracy) is: 1.6405

# Version History

Introduced: Pre 4.0

# See Also

INT_2D, INT_3D, QROMB, QROMO, QSIMP

# INTARR

The INTARR function returns an integer vector or array.

## Syntax

*Result* = INTARR( $D_1$ *[, ..., $D_8$]* [, /NOZERO] )

## Return Value

Returns the integer array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, INTARR sets every element of the result to zero. If NOZERO is nonzero, this zeroing is not performed and INTARR executes faster.

## Examples

Create I, a 3-element by 3-element integer array with each element set to 0 by entering:

```
I = INTARR(3, 3)
```

## Version History

Introduced: Original

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# INTERPOL

The INTERPOL function performs linear, quadratic, or spline, interpolation on vectors with a regular or irregular grid.

This routine is written in the IDL language. Its source code can be found in the file `interpol.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

***For regular grids:*** *Result* = INTERPOL( *V, N* [, /LSQUADRATIC] [, /QUADRATIC] [, /SPLINE] )

***For irregular grids:*** *Result* = INTERPOL( *V, X, U* [, /LSQUADRATIC] [, /QUADRATIC] [, /SPLINE] )

## Return Value

The result is a single- or double-precision floating-point vector, or a complex vector if the input vector is complex.

## Arguments

### V

An input vector of any type except string.

### N

The number of points in the result when both input and output grids are regular. The abscissa values for the output grid will contain the same endpoints as the input.

### X

The abscissa values for *V*, in the irregularly-gridded case. *X* must have the same number of elements as *V*, and the values *must* be monotonically ascending or descending.

### U

The abscissa values for the result. The result will have the same number of elements as *U*. *U* does not need to be monotonic.

# Keywords

## LSQUADRATIC

If set, interpolate using a least squares quadratic fit to the equation $y = a + bx + cx^2$, for each 4 point neighborhood (x[i-1], x[i], x[i+1], x[i+2]) surrounding the interval of the interpolate, $x[i] \leq u < x[i+1]$.

## QUADRATIC

If set, interpolate by fitting a quadratic $y = a + bx + cx^2$, to the three point neighborhood (x[i-1], x[i], x[i+1]) surrounding the interval $x[i] \leq u < x[i+1]$.

## SPLINE

If set, interpolate by fitting a cubic spline to the 4 point neighborhood (x[i-1], x[i], x[i+1], x[i+2]) surrounding the interval, $x[i] \leq u < x[i+1]$.

**Note**

If LSQUADRATIC or QUADRATIC or SPLINE is not set, the default is to use linear interpolation.

# Examples

Create a floating-point vector of 61 elements in the range [-3, 3].

```
X = FINDGEN(61)/10 - 3

; Evaluate V[x] at each point:
V = SIN(X)

; Define X-values where interpolates are desired:
U = [-2.50, -2.25, -1.85, -1.55, -1.20, -0.85, -0.50, -0.10, $
   0.30, 0.40, 0.75, 0.85, 1.05, 1.45, 1.85, 2.00, 2.25, 2.75 ]

; Interpolate:
result = INTERPOL(V, X, U)

; Plot the function:
PLOT, X, V

; Plot the interpolated values:
OPLOT, U, result
```

## Version History

Introduced: Original

## See Also

BILINEAR, INTERPOLATE, KRIG2D

# INTERPOLATE

The INTERPOLATE function returns an array of linear, bilinear or trilinear interpolates, depending on the dimensions of the input array *P*.

Interpolates outside the bounds of *P* can be set to a user-specified value by using the MISSING keyword.

## Syntax

*Result* = INTERPOLATE( *P, X* [, *Y* [, *Z*]] [, CUBIC=*value*{-1 to 0}] [, /GRID] [, MISSING=*value*] )

## Return Value

Linear interpolates are returned in the one-dimensional case, bilinear in the two-dimensional case and trilinear interpolates in the three-dimensional case. The returned array has the same type as *P* and its dimensions depend on those of the location parameters *X*, *Y*, and *Z*, as explained below.

## Arguments

### P

The array of data values. *P* can be an array of any dimensions. Interpolation occurs in the *M* rightmost indices of *P*, where *M* is the number of interpolation arrays.

### X, Y, Z

Arrays of numeric type containing the locations for which interpolates are desired. For linear interpolation (*P* is a vector), the result has the same dimensions as *X*. The *i*-th element of the result is *P* interpolated at location $X_i$. The *Y* and *Z* parameters should be omitted.

For bilinear interpolation *Z* should not be present.

**Note**

INTERPOLATE considers location points with values between zero and *n*, where *n* is the number of values in the input array *P*, to be valid. Location points outside this range are considered missing data. Location points *x* in the range $n\text{-}1 \le x < n$ return the last data value in the array *P*.

If the keyword GRID is not set, all location arrays must have the same number of elements. See the description of the GRID keyword below for more details on how interpolates are computed from *P* and these arrays.

# Keywords

## CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than $\omega_0$, and *f* is sampled with spacing less than or equal to $1/(2\omega_0)$, then *f* can be reconstructed by convolving with a sinc function: $\text{sinc}(x) = \sin(\pi x) / (\pi x)$.

The number of neighboring points used varies according to the dimension:

- 1-dimensional: 4 points
- 2-dimensional: 16 points
- 3-dimensional: not supported

**Note**

Cubic convolution interpolation is significantly slower than bilinear interpolation. Also note that cubic interpolation is not supported for three-dimensional data.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

### GRID

The GRID keyword controls how the location arrays specify where interpolates are desired. This keyword has no effect in the case of linear interpolation.

**If GRID is not set:** The location arrays, *X*, *Y*, and, if present, *Z* must have the same number of elements. The result has the same structure and number of elements as *X*.

In the case of bilinear interpolation, the result is obtained as follows: Let $l = \lfloor X_i \rfloor$ and $k = \lfloor Y_i \rfloor$. Element *i* of the result is computed by interpolating between *P*(*l*, *k*), *P*(*l*+1, *k*), *P*(*l*, *k*+1), and *P*(*l*+1, *k*+1). to obtain the estimated value at (*Xi*, *Yi*). Trilinear interpolation is a direct extension of the above.

**If GRID is set:** Let $N_x$ be the number of elements in *X*, let $N_y$ be the number of elements in *Y*, and $N_z$ be the number of elements in *Z*. The result has dimensions ($N_x$, $N_y$) for bilinear interpolation, and ($N_x$, $N_y$, $N_z$) for trilinear interpolation. For bilinear interpolation, element (*i*,*j*) of the result contains the value of *P* interpolated at position (*Xi*, *Yi*). For trilinear interpolation, element (*i*, *j*, *k*) of the result is *P* interpolated at (*Xi*, *Yi*, *Zi*).

### MISSING

The value to return for elements outside the bounds of *P*. If this keyword is not specified, interpolated positions that fall outside the bounds of the array *P*—that is, elements of the *X*, *Y*, or *Z* arguments that are either less than zero or greater than the largest subscript in the corresponding dimension of *P*—are set equal to the value of the nearest element of *P*.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

The example below computes bilinear interpolates with the keyword GRID set:

```
p = FINDGEN(4,4)
PRINT, INTERPOLATE(p, [.5, 1.5, 2.5], [.5, 1.5, 2.5], /GRID)
```

and prints the 3 by 3 array:

```
2.50000   3.50000   4.50000
6.50000   7.50000   8.50000
10.5000   11.5000   12.5000
```

corresponding to the locations:

(.5,.5), (1.5, .5), (2.5, .5),
(.5,1.5), (1.5, 1.5), (2.5, 1.5),
(.5,2.5), (1.5, 2.5), (2.5, 2.5)

Another example computes interpolates, with GRID not set and a parameter outside the bounds of *P*:

```
PRINT, INTERPOLATE(p, [.5, 1.5, 2.5, 3.1], [.5, 1.5, 2.5, 2])
```

and prints the result:

```
2.50000   7.50000   12.5000   11.0000
```

corresponding to the locations (.5,.5), (1.5, 1.5), (2.5, 2.5) and (3.1, 2.0). Note that the last location is outside the bounds of *P* and is set from the value of the last column. The following command uses the MISSING keyword to set such values to -1:

```
PRINT, INTERPOLATE(p, [.5, 1.5, 2.5, 3.1], [.5, 1.5, 2.5, 2], $
   MISSING = -1)
```

and gives the result:

```
2.50000   7.50000   12.5000   -1.00000
```

## Version History

Introduced: Pre 4.0

## See Also

BILINEAR, INTERPOL, KRIG2D

# INTERVAL_VOLUME

The INTERVAL_VOLUME procedure is used to generate a tetrahedral mesh from volumetric data. The generated mesh spans the portion of the volume where the volume data samples fall between two constant data values. This can also be thought of as a mesh constructed to fill the volume between two isosurfaces which are drawn according to the two supplied constant data values. The algorithm is very similar to the ISOSURFACE algorithm and expands upon the SHADE_VOLUME algorithm. A topologically-consistent tetrahedral mesh is returned by decomposing the volume into oriented tetrahedra. This also allows the algorithm to find the interval volume of any tetrahedral mesh.

If an auxiliary array is provided, its data is interpolated onto the output vertices and is returned. This auxiliary data array may have multiple values at each vertex. Any size-leading dimension is allowed as long as the number of values in the subsequent dimensions matches the number of elements in the input data array.

For more information on the INTERVAL_VOLUME algorithm, see the paper, “Interval Volume Tetrahedrization”, Nielson and Sung, *Proceedings: IEEE Visualization*, 1997.

## Syntax

INTERVAL_VOLUME, *Data*, *Value0*, *Value1*, *Outverts*, *Outconn*
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*]
[, GEOM_XYZ=*array*, TETRAHEDRA=*array*]
[, PROGRESS_CALLBACK=*string*] [, PROGRESS_METHOD=*string*]
[, PROGRESS_OBJECT=*objref*] [, PROGRESS_PERCENT=*percent*{0 to 100}]
[, PROGRESS_USERDATA=*value*]

## Arguments

### Data

Input three-dimensional array of scalars that define the volume data.

### Value0

Input scalar iso-value. This value specifies one of the limits for the interval volume. The generated interval volume encloses all volume samples between and including *Value0* and *Value1*. *Value0* may be greater than or less than *Value1*, but the two values may not be exactly equal. This value also cannot be a NaN, but can be +/- INF.

### Value1

Input scalar iso-value. This value specifies the other limit for the interval volume. The generated interval volume encloses all volume samples between and including *Value0* and *Value1*. *Value1* may be greater than or less than *Value0*, but the two values may not be exactly equal. This value also cannot be a NaN, but can be +/- INF.

### Outverts

A named variable to contain an output [3, n] array of floating point vertices making up the tetrahedral mesh.

### Outconn

A named variable to contain an output array of tetrahedral mesh connectivity values. This array is one-dimensional and consists of a series of four vertex indices, where each group of four indices describes a tetrahedron. The connectivity values are indices into the vertex array returned in *Outverts*. If no tetrahedra are extracted, this argument returns the array [-1].

## Keywords

### AUXDATA_IN

This keyword defines the input array of auxiliary data with trailing dimensions being the number of values in Data.

**Note**

If you specify the AUXDATA_IN then you must specify AUXDATA_OUT.

### AUXDATA_OUT

Set this keyword to a named variable that will contain an output array of auxiliary data sampled at the locations in *Outverts*.

**Note**

If you specify AUXDATA_OUT then you must specify AUXDATA_IN.

### GEOM_XYZ

This keyword defines a [3, n] input array of vertex coordinates (one for each value in the *Data* array). This array is used to define the spatial location of each scalar. If this

keyword is omitted, *Data* must be a three-dimensional array and the scalar locations are assumed to be on a uniform grid.

**Note**

If you specify GEOM_XYZ then you must specify TETRAHEDRA.

## PROGRESS_CALLBACK

Set this keyword to a scalar string containing the name of the IDL function that the INTERVAL_VOLUME procedure calls at PROGRESS_PERCENT intervals as it generates the interval volume.

The PROGRESS_CALLBACK function returns a zero to signal INTERVAL_VOLUME to stop generating the interval volume. This causes INTERVAL_VOLUME to return a single vertex and a connectivity array of [-1], which specifies an empty mesh. If the callback function returns any non-zero value, INTERVAL_VOLUME continues to generate the interval volume.

The PROGRESS_CALLBACK function must specify a single argument, *Percent*, which INTERVAL_VOLUME sets to an integer between 0 and 100, inclusive.

The PROGRESS_CALLBACK function may specify an optional USERDATA keyword parameter, which INTERVAL_VOLUME sets to the variable provided in the PROGRESS_USERDATA keyword.

The following code shows an example of a progress callback function:

```
FUNCTION myProgressCallback, $
   percent, USERDATA = myStruct

oProgressBar = myStruct.oProgressBar

; This method updates the progress bar
; graphic and returns TRUE if the user
; has NOT pressed the cancel button.
keepGoing = oProgressBar -> $
   UpdateProgressValue(percent)

RETURN, keepGoing

END
```

## PROGRESS_METHOD

Set this keyword to a scalar string containing the name of a function method that the INTERVAL_VOLUME procedure calls at PROGRESS_PERCENT intervals as it generates the interval. If this keyword is set, then the PROGRESS_OBJECT keyword

must be set to an object reference that is an instance of a class that defines the specified method.

The PROGRESS_METHOD function method callback has the same specification as the callback described in the PROGRESS_CALLBACK keyword, except that it is defined as an object class method:

```
FUNCTION myClass::myProgressCallback, $
   percent, USERDATA = myStruct
```

## PROGRESS_OBJECT

Set this keyword to an object reference that is an instance of a class that defines the method specified with the PROGRESS_METHOD keyword. If this keyword is set, then the PROGRESS_METHOD keyword must also be set.

## PROGRESS_PERCENT

Set this keyword to a scalar in the range [1, 100] to specify the interval between invocations of the callback function. The default value is 5 and IDL silently clamps other values to the range [1, 100].

For example, a value of 5 (the default) specifies INTERVAL_VOLUME will call the callback function when the interval volume process is 0% complete, 5% complete, 10% complete, ..., 95% complete, and 100% complete.

## PROGRESS_USERDATA

Set this property to any IDL variable that INTERVAL_VOLUME passes to the callback function in the callback function's USERDATA keyword parameter. If this keyword is specified, then the callback function must be able to accept keyword parameters.

## TETRAHEDRA

This keyword defines an input array of tetrahedral connectivity values. If this array is not specified, the connectivity is assumed to be a rectilinear grid over the input three-dimensional array. If this keyword is specified, the input data array need not be a three-dimensional array. Each tetrahedron is represented by four values in the connectivity array. Every four values in the array correspond to the vertices of a single tetrahedron.

**Note**

If you specify TETRAHEDRA then you must specify GEOM_XYZ.

## Examples

The following example generates an interval volume and displays the surface of the volume:

```
RESTORE, FILEPATH('clouds3d.dat', $
   SUBDIRECTORY=['examples','data'])
INTERVAL_VOLUME, rain, 0.1, 0.6, verts, conn
conn = TETRA_SURFACE(verts, conn)
oRain = OBJ_NEW('IDLgrPolygon', verts, POLYGONS=conn, $
   COLOR=[255,255,255], SHADING=1)
XOBJVIEW, oRain, BACKGROUND=[150,200,255]
```

## Version History

Introduced: 5.5

## See Also

ISOSURFACE, SHADE_VOLUME, XVOLUME

# INVERT

The INVERT function uses the Gaussian elimination method to compute the inverse of a square array. Errors from singular or near-singular arrays are accumulated in the optional *Status* argument.

**Note**

If you are working with complex inputs, instead use the LA_INVERT function.

## Syntax

*Result* = INVERT( *Array* [, *Status*] [, /DOUBLE] )

## Return Value

The result is a single- or double-precision array of floating or complex values.

## Arguments

### Array

The array to be inverted. *Array* must have two dimensions of equal size (i.e., a square array) and can be of any type except string. Note that the resulting array will be composed of single- or double-precision floating-point or complex values, depending on whether the DOUBLE keyword is set.

### Status

A named variable to receive the status of the operation. Possible status values are:

- 0 = Successful completion.
- 1 = Singular array (which indicates that the inversion is invalid).
- 2 = Warning that a small pivot element was used and that significant accuracy was probably lost.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

```
; Create an array A:
A = [[ 5.0, -1.0, 3.0], $
     [ 2.0,  0.0, 1.0], $
     [ 3.0,  2.0, 1.0]]
result = INVERT(A)

; We can check the accuracy of the inversion by multiplying the
; inverted array by the original array. The result should be a 3 x
; 3 identity array.
PRINT, result # A
```

IDL prints:

```
      1.00000      0.00000      0.00000
      0.00000      1.00000      0.00000
      0.00000  9.53674e-07      1.00000
```

## Version History

Introduced: Original

## See Also

COND, DETERM, LA_INVERT, REVERSE, ROTATE, TRANSPOSE

# IOCTL

The IOCTL function provides a thin wrapper over the UNIX `ioctl(2)` system call. IOTCL performs special functions on the specified file. The set of functions actually available depends on your version of UNIX and the type of file (tty, tape, disk file, etc.) referred to.

To use IOCTL, read the C programmer's documentation describing the `ioctl(2)` function for the desired device and convert all constants and data to their IDL equivalents.

## Syntax

*Result* = IOCTL( *File_Unit* [, *Request*, *Arg*] [, /BY_VALUE] [, /MT_OFFLINE] [, /MT_REWIND] [, MT_SKIP_FILE=[-]*number_of_files*] [, MT_SKIP_RECORD=[-]*number_of_records*] [, /MT_WEOF] [, /SUPPRESS_ERROR] )

## Return Value

The value returned by the system `ioctl` function is returned as the value of the IDL IOCTL function.

## Arguments

### File_Unit

The IDL logical unit number (LUN) for the open file on which the `ioctl` request is made.

### Request

A longword integer that specifies the ioctl request code. These codes are usually contained in C language header files provided by the operating system, and are not generally portable between UNIX versions. If one of the "MT" keywords is used, this argument can be omitted.

### Arg

A named variable through which data if passed to and from ioctl. IOCTL requests usually request data from the system or supply the system with information. The user must make *Arg* the correct type and size. Errors in typing or sizing *Arg* can corrupt

the IDL address space and/or make IDL crash. If one of the MT keywords is used, this argument can be omitted.

# Keywords

Note that the keywords below that start with “MT” can be used to issue commonly used magnetic tape ioctl() calls. When these keywords are used, the *Request* and *Arg* arguments are ignored and an be omitted. Magnetic tape operations not available via these keywords can still be executed by supplying the appropriate *Request* and *Arg* values. When issuing magnetic tape IOCTL calls, be aware that different devices have different rules for which ioctl calls are allowed, and when. The documentation for your computer system explains those rules.

## BY_VALUE

If this keyword is set, *Arg* is converted to a scalar longword and this longword is passed by value. Normally, *Arg* is passed to ioctl by reference (i.e., by address).

## MT_OFFLINE

Set this keyword to rewind and unload a tape.

## MT_REWIND

Set this keyword to rewind a tape.

## MT_SKIP_FILE

Use this keyword to skip files on a tape. A positive value skips forward that number of files. A negative value skips backward.

## MT_SKIP_RECORD

Use this keyword to skip records on tape. A positive value skips forward that number of files. A negative value skips backward.

## MT_WEOF

Set this keyword to write an end of file (“tape mark”) on the tape at the current location.

### SUPPRESS_ERROR

Set this keyword to log errors quietly and cause a value of -1 to be returned. The default is for IDL to notice any failures associated with the use of `ioctl` and issue the appropriate IDL error and halt execution.

## Examples

The following example prints the size of the terminal being used by the current IDL session. It is known to work under SunOS 4.1.2. Changes may be necessary for other operating systems or even other versions of SunOS.

```
; Variable to receive result. This structure is described in
; Section 4 of the SunOS manual pages under termios(4):
winsize = { row:0, col:0, xpixel:0, ypixel:0 }

; The request code for obtaining the tty size, as determined by
; reading the termios(4) documentation, and reading the system
; include files in the /usr/include/sys directory:
TIOCGWINSZ = 1074295912L

; Make the information request. -1 is the IDL logical file unit for
; the standard output:
ret = IOCTL(-1, TIOCGWINSZ, winsize)

; Output the results:
PRINT,winsize.row, winsize.col, $
   format='("TTY has ", I0," rows and ", I0," columns.")'
```

The following points should be noted in this example:

- Even though we only want the number of rows and columns, we must include all the fields required by the TIOCGWINSIZ `ioctl` in the winsize variable (as documented in the `termio(4)` manual page). Not providing a large enough result buffer would cause IDL's memory to be corrupted.
- The value of TIOCGWINSZ was determined by examining the system header files provided in the `/usr/include/sys` directory. Such values are not always portable between major operating system releases.

## Version History

Introduced: Pre 4.0

## See Also

OPEN

# IPLOT

The IPLOT procedure creates an iTool and the associated user interface (UI) configured to display and manipulate plot data.

**Note**

If no arguments are specified, the IPLOT procedure creates an empty Plot tool.

This routine is written in the IDL language. Its source code can be found in the file `iplot.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

### Cartesian

IPLOT, [*X*,] *Y*

or

IPLOT, *X*, *Y*, *Z*

### Polar

IPLOT[, *R*], *Theta*, /POLAR

**iTool Common Keywords:** [, DIMENSIONS=[*x*, *y*]] [, IDENTIFIER=*variable*] [, LOCATION=[*x*, *y*]] [, NAME=*string*] [, OVERPLOT=*iToolID*] [, TITLE=*string*] [, VIEW_GRID=[*columns*, rows]] [, /VIEW_NEXT] [, VIEW_NUMBER=*integer*] [, {X | Y | Z}RANGE=[*min*, *max*]]

**iTool Plot Keywords:** [, ERRORBAR_COLOR=*RGB vector*] [, ERROR_CAPSIZE=*points*{0.0 to 1.0}] [, /FILL_BACKGROUND] [, FILL_COLOR=*RGB vector*] [, FILL_LEVEL=*value*] [, RGB_TABLE=*byte array of 256 by 3 or 3 by 256 elements*] [, /SCATTER] [, SYM_COLOR=*RGB vector*] [, SYM_INCREMENT=*integer*] [, SYM_INDEX=*integer*] [, SYM_SIZE=*points*{0.0 to 1.0}] [, SYM_THICK=*points*{1.0 to 10.0}] [, TRANSPARENCY=*percent*{0.0 to 100.0}] [, /USE_DEFAULT_COLOR] [, /XY_SHADOW] [, /{X | Y | Z}_ERRORBARS] [, /{X | Y | Z}_LOG] [, {X | Y | Z}ERROR=*vector* or *array*] [, /XZ_SHADOW] [, /YZ_SHADOW]

**Plot Object Keywords:** [, CLIP_PLANES=*array*] [, COLOR = *RGB vector*] [, /HIDE] [, /HISTOGRAM] [, LINESTYLE=*integer*] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, NSUM=*value*] [, /POLAR] [, THICK=*points*{1.0 to 10.0}] [, VERT_COLORS=*byte vector*]

**Axis Object Keywords:** [, {X | Y | Z}GRIDSTYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}]
[, {X | Y | Z}MAJOR=*integer*] [, {X | Y | Z}MINOR=*integer*]
[, {X | Y | Z}SUBTICKLEN=*ratio*] [, {X | Y | Z}TEXT_COLOR=*RGB vector*]
[, {X | Y | Z}TICKFONT_INDEX={0 | 1 | 2 | 3 | 4}]
[, {X | Y | Z}TICKFONT_SIZE=*integer*]
[, {X | Y | Z}TICKFONT_STYLE={0 | 1 | 2 | 3}]
[, {X | Y | Z}TICKFORMAT=*string or string array*]
[, {X | Y | Z}TICKINTERVAL=*value*] [, {X | Y | Z}TICKLAYOUT={0 | 1 | 2}]
[, {X | Y | Z}TICKLEN=*value*] [, {X | Y | Z}TICKNAME=*string array*]
[, {X | Y | Z}TICKUNITS=*string*] [, {X | Y | Z}TICKVALUES=*vector*]
[, {X | Y | Z}TITLE=*string*]

# Arguments

## R

If the POLAR keyword is set, *R* is a vector representing the radius of the polar plot. If *R* is specified, *Theta* is plotted as a function of *R*. If *R* is not specified, *Theta* is plotted as a function of the vector index of *Theta*.

## Theta

If the POLAR keyword is set, *Theta* is a vector representing the angle (in radians) of the polar plot.

## X

A vector representing the *x*-coordinates of the plot.

## Y

A vector or a two-dimensional array. If *Y* is:

- a vector, it represents the *y*-coordinates of the plot. If *X* is not specified, *Y* is plotted as a function of the vector index of *Y*. If *X* is specified, *Y* is plotted as a function of *X*.
- a 2-by-*n* array, *Y*[0, *] represents the *x*-coordinates and *Y*[1, *] represents the *y*-coordinates of the plot.
- a 3-by-*n* array, *Y*[0, *] represents the *x*-coordinates, *Y*[1, *] represents the *y*-coordinates, and *Y*[2, *] represents the *z*-coordinates of the plot.

### Z

A vector representing the *z*-coordinates of the plot.

## Keywords

**Note**

Keywords to the IPLOT routine that correspond to the names of *registered properties* of the iPlot tool must be specified in full, without abbreviation.

### CLIP_PLANES

Set this keyword to an array of dimensions [4, *N*] specifying the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this keyword is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

A window is only able to support a limited number of clipping planes. Some of these clipping planes may already be in use by the tool to support specific data display features. If the total number of clipping planes exceeds the limit, an informational message is displayed.

### COLOR

Set this keyword to an RGB value specifying the color to be used as the foreground color for this plot. The default is [0, 0, 0] (black).

### DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the dimensions of the drawing area of the specific tool in device units. The minimum width of the window correlates to the width of the menubar. The minimum window height is 100 pixels.

### ERRORBAR_COLOR

Set this keyword to an RGB value specifying the color for the error bar. The default value is [0, 0, 0] (black).

## ERRORBAR_CAPSIZE

Set this keyword to a floating-point value specifying the size of the error bar endcaps. This value ranges from 0 to 1.0, where a value of 1.0 results in an endcap that is 10% of the data range.

## FILL_BACKGROUND (for 2D plots only)

Set this keyword to fill the area under the plot. This keyword is only available for two-dimensional plots. This keyword is ignored for three-dimensional plots.

## FILL_COLOR (for 2D plots only)

Set this keyword to an RGB value specifying the color for the filled area. The default value is [255, 255, 255] (white). This keyword is only available for two-dimensional plots. This keyword is ignored for three-dimensional plots.

## FILL_LEVEL (for 2D plots only)

Set this keyword to a floating-point value specifying the *y*-value for the lower boundary of the fill region. This keyword is only available for two-dimensional plots. This keyword is ignored for three-dimensional plots.

## HIDE

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

## HISTOGRAM (for 2D plots only)

Set this keyword to force only horizontal and vertical lines to be used to connect the plotted points. By default, the points are connected using a single straight line. This keyword is only available for two-dimensional plots. This keyword is ignored for three-dimensional plots.

## IDENTIFIER

Set this keyword to a named IDL variable that will contain the iToolID for the created tool. This value can then be used to reference this tool during overplotting operations or command-line-based tool management operations.

## LINESTYLE

Set this keyword to indicate the line style that should be used to draw the plot lines. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE keyword equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

## LOCATION

Set this keyword to a two-element vector of the form [*x*, *y*] to specify the location of the upper left-hand corner of the tool relative to the display screen, in device units.

## MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing data and are not plotted.

**Note**

The IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

## MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing data and are not plotted.

**Note**

The IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

## NAME

Set this keyword to a string to specify the name for this visualization.

## NSUM

Set this keyword to the number of data points to average when plotting. If NSUM is larger than 1, every group of NSUM points is averaged to produce one plotted point. If there are M data points, then M/NSUM points are plotted.

## OVERPLOT

Set this keyword to an iToolID to direct the graphical output of the particular tool to the tool specified by the provided iToolID.

Set this keyword to 1 (one) to place the graphical output for the command in the current tool. If no current tool exists, a new tool is created.

## POLAR

Set this keyword to display the plot as a polar plot. If this keyword is set, the arguments will be interpreted as *R* and *Theta* or simply *Theta* for a single argument. If *R* is not supplied the plot will use a vector of indices for the *R* argument.

## RGB_TABLE

Set this keyword to either a 3 by 256 or 256 by 3 byte array containing color values to use for vertex colors. If the values supplied are not of type byte, they are scaled to the byte range using BYTSCL. Use the VERT_COLORS keyword to specify indices that select colors from the values specified with RGB_TABLE.

## SCATTER

Set this keyword to generate a scatter plot. This action is equivalent to setting LINESTYLE = 6 (no line) and SYM_INDEX = 3 (Period symbol).

## SYM_COLOR

Set this keyword to an RGB value specifying the color for the plot symbol.

**Note**

This color is applied to the symbol only if the USE_DEFAULT_COLOR property is set.

## SYM_INCREMENT

Set this keyword to an integer value specifying the number of vertices to increment between symbol instances. The default value is 1, which places a symbol on every vertex.

## SYM_INDEX

Set this keyword to one of the following scalar-represented internal default symbols:

- 0 = No symbol
- 1 = Plus sign, ‘+’ (default)
- 2 = Asterisk
- 3 = Period (Dot)
- 4 = Diamond
- 5 = Triangle
- 6 = Square
- 7 = X
- 8 = Arrow Head

## SYM_SIZE

Set this keyword to a floating-point value from 0.0 to 1.0 specifying the size of the plot symbol. A value of 1.0 results in an symbol that is 10% of the width/height of the plot.

## SYM_THICK

Set this keyword to floating-point value from 1 to 10 points specifying the thickness of the plot symbol.

## THICK

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to be used to draw the plotted lines, in points. The default is 1.0 points.

## TITLE

Set this keyword to a string to specify a title for the tool. The title is displayed in the title bar of the tool and is used for tool-related display purposes only–as the root of the hierarchy shown in the Tool Browser, for example.

## TRANSPARENCY

Set this keyword to floating-point value specifying the transparency of the filled area. Valid values range from 0.0 to 100.0. The default value is 0.0 (opaque).

## USE_DEFAULT_COLOR

Set this keyword to have the color of the symbols match the plot color. If this keyword is set to 0 (USE_DEFAULT_COLOR = 0), the color specified by the SYM_COLOR keyword is used for symbols instead of matching the color of the plot.

## VERT_COLORS

Set this keyword to a vector of indices into the color table to select colors to use for each vertex (plot data point). Alternately, set this keyword to a 3 by *N* byte array containing color values to use for each vertex. If the values supplied are not of type byte, they are scaled to the byte range using BYTSCL. If indices are supplied but no colors are provided with the RGB_TABLE keyword, then a default grayscale ramp is used. If a 3 by *N* array of colors is provided, the colors are used directly and the color values provided with RGB_TABLE are ignored. If the number of indices or colors specified is less than the number of vertices, the colors are repeated cyclically.

## VIEW_GRID

Set this keyword to a two-element vector of the form [*columns*, *rows*] to specify the view layout within the new tool. This keyword is only used if a new tool is being created (for example, if OVERPLOT, VIEW_NEXT, or VIEW_NUMBER are specified then VIEW_GRID is ignored).

## VIEW_NEXT

Set this keyword to change the view selection to the next view following the currently-selected view before issuing any graphical commands. If the currently-selected view is the last one in the layout, then /VIEW_NEXT will cause the first view in the layout to become selected. This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## VIEW_NUMBER

Set this keyword to change the currently-selected view to the view specified by the VIEW_NUMBER before issuing any graphical commands. The view number starts at 1, and corresponds to the position of the view within the graphics container (not necessarily the position on the screen). This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## XY_SHADOW (for 3D plots only)

Set this keyword to display a shadow of the plot in a three-dimensional plot. The shadow lies in the XY plane at the minimum value of the data space range of the *z*-axis. This keyword has no effect for two-dimensional plots.

## [XYZ]_ERRORBARS

Set this keyword to show error bars. The Z_ERRORBARS keyword is for three-dimensional plots only.

## [XYZ]_LOG

Set this keyword to specify a logarithmic axis. The minimum value of the axis range must be greater than zero. The Z_LOG keyword is for three-dimensional plots only.

## [XYZ]ERROR

Set this keyword to either a vector or a 2 by *N* array of error values to be displayed as error bars for the [XYZ] dimension of the plot. The length of this array must be equal in length to the number of vertices of the plot or it will be ignored. If this keyword is set to a vector, the value will be applied as both a negative and positive error and the error bar will be symmetric about the plot vertex. If this keyword is set to a 2 by *N* array the [0, *] values define the negative error and the [1, *] values define the positive error, allowing asymmetric error bars. The ZERROR keyword is for three-dimensional plots only.

## [XYZ]MAJOR

Set this keyword to an integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely. ZMAJOR is for three-dimensional plots only.

## [XYZ]MINOR

Set this keyword to an integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely. ZMINOR is for three-dimensional plots only.

## [XYZ]RANGE

Set this keyword to the desired data range of the axis, a 2-element vector. The first element is the axis minimum, and the second is the maximum. ZRANGE is for three-dimensional plots only.

## [XYZ]SUBTICKLEN

Set this keyword to a floating-point scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark. ZSUBTICKLEN is for three-dimensional plots only.

## [XYZ]TEXT_COLOR

Set this keyword to an RGB value specifying the color for the axis text. The default value is [0, 0, 0] (black). ZTEXT_COLOR is for three-dimensional plots only.

## [XYZ]TICKFONT_INDEX

Set this keyword equal to one of the following integers, which represent the type of font to be used for the axis text:

- 0 = Helvetica
- 1 = Courier
- 2 = Times
- 3 = Symbol
- 4 = Hershey

ZTICKFONT_INDEX is for three-dimensional plots only.

## [XYZ]TICKFONT_SIZE

Set this keyword to an integer representing the point size of the font used for the axis text. The default is 12.0 points. ZTICKFONT_SIZE is for three-dimensional plots only.

## [XYZ]TICKFONT_STYLE

Set this keyword equal to one of the following integers, which represent the style of font to be used for the axis text:

- 0 = Normal
- 1 = Bold
- 2 = Italic
- 3 = Bold Italic

ZTICKFONT_STYLE is for three-dimensional plots only.

## [XYZ]TICKFORMAT

Set this keyword to a string, or an array of strings, in which each string represents a format string or the name of a function to be used to format the tick mark labels. If an array is provided, each string corresponds to a level of the axis. The TICKUNITS keyword determines the number of levels for an axis.

If the string begins with an open parenthesis, it is treated as a standard format string. See “Format Codes” in Chapter 10 of the *Building IDL Applications* manual.

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels.

**If TICKUNITS are not specified:**

- The callback function is called with three parameters: *Axis*, *Index*, and *Value*, where:
- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis
- *Index* is the tick mark index (indices start at 0)
- *Value* is the data value at the tick mark (a double-precision floating point value)

**If TICKUNITS are specified:**

The callback function is called with four parameters: *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled. (Level indices start at 0.)

Used with the LABEL_DATE function, this property can easily create axes with date/time labels.

ZTICKFORMAT is for three-dimensional plots only.

## [XYZ]TICKINTERVAL

Set this keyword to a floating-point scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis [XYZ]RANGE and the number of major tick marks ([XYZ]MAJOR). The value of this keyword takes precedence over the value set for the [XYZ]MAJOR keyword.

For example, if TICKUNITS = ['S', 'H', 'D'], and TICKINTERVAL = 30, then the interval between major ticks for the first axis level will be 30 seconds.

ZTICKINTERVAL is for three-dimensional plots only.

## [XYZ]TICKLAYOUT

Set this keyword to integer scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

ZTICKLAYOUT is for three-dimensional plots only.

**Note**

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

## [XYZ]TICKLEN

Set this keyword to a floating-point value that specifies the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point. ZTICKLEN is for three-dimensional plots only.

## [XYZ]TICKNAME

Set this keyword to a string array of up to 30 elements that controls the annotation of each tick mark. ZTICKNAME is for three-dimensional plots only.

## [XYZ]TICKUNITS

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling. If more than one unit is provided, the axis will be drawn in multiple levels, one level per unit.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- ""- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the "Numeric" unit. This is the default setting.

If any of the time units are utilized, then the tick values are interpreted as Julian date/time values. Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS = 'Day' is equivalent to TICKUNITS = 'Days').

ZTICKUNITS is for three-dimensional plots only.

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000hidd, respectively.

## [XYZ]TICKVALUES

Set this keyword to a floating-point vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point. ZTICKVALUES is for three-dimensional plots only.

## [XYZ]TITLE

Set this keyword to a string representing the title of the specified axis. ZTITLE is for three-dimensional plots only.

### XZ_SHADOW (for 3D plots only)

Set this keyword to display a shadow of the plot in a three-dimensional plot. The shadow lies in the XZ plane at the minimum value of the data space range of the *y*-axis. This keyword has no effect for two-dimensional plots.

### YZ_SHADOW (for 3D plots only)

Set this keyword to display a shadow of the plot in a three-dimensional plot. The shadow lies in the YZ plane at the minimum value of the data space range of the *x*-axis. This keyword has no effect for two-dimensional plots.

## Examples

In the IDL Intelligent Tools system, data can be imported from the IDL Command Line (as described in Example 1), or data can be imported via the File menu in the iTool window (as described in Examples 2 and 3). For detailed information on importing data via the iTool file menu, refer to "Data Import Methods" in Chapter 2 of the *iTool User's Guide* manual.

### Example 1

This example shows how to use the IDL Command Line to load data and variables into the iPlot tool.

At the IDL Command Line, enter:

```
file = FILEPATH('elnino.dat', SUBDIRECTORY = ['examples','data'])
data = READ_BINARY(file, DATA_TYPE = 4, DATA_DIMS = [500, 1], $
   ENDIAN = 'little')
time = DINDGEN(500)*0.25d + 1871
IPLOT, time, data, TITLE = 'El Nino', COLOR = [255, 128, 0]
```

Place a title on the time axis of your plot by selecting the axis, right-clicking to display the context menu, selecting **Properties** to display the property sheet, and typing `Year` in the **Title** field.

Place a title on the temperature axis of your plot by selecting the axis, displaying the property sheet, and entering the following in the **Title** field:

```
Temperature Anomaly (!Uo!NC)
```

Annotate your plot by selecting the Text Annotation tool, clicking near the top of the plot, and typing `El Nino`.

Add the special character to the annotation by selecting the annotation text, displaying the property sheet, selecting the lower-case `n` in `Nino` in the **Title** field, and replacing it with the following:

```
!Z(U+0F1)
```

**Note**

U+0F1 is unicode for the ñ character.

The following figure displays the output of this example:

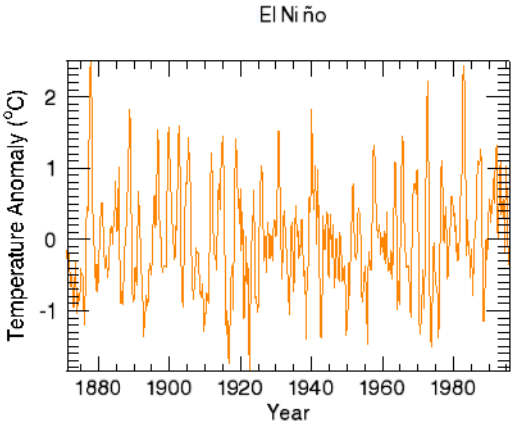



*Figure 3-13: El Niño iPlot Example*

## Example 2

This example shows how to use the **File** → **Open** command to load binary data into the iPlot tool.

At the IDL Command Line, enter:

```
IPLOT
```

Select **File** → **Open** command to display the Open dialog, then browse to find `dirty_sine.dat` in the `examples/data` directory in the IDL distribution, and click **Open**.

In the Binary Template dialog, click **New Field**, and enter the following information in the New Field dialog:

- **Field Name:** `data` (or a name of your choosing)
- **Type:** `Byte (unsigned 8-bits)`
- **Number of Dimensions:** `1`
- **1st Dimension Size:** `256`

Click **OK** to close the New Field dialog and the Binary Template dialog, and the surface is displayed.

**Note**

For more information on using the Binary Template to import data, see "Using the BINARY_TEMPLATE Function" in Chapter 15 of the *Using IDL* manual.

Annotate your plot by selecting the Text Annotation tool, clicking near the curve, and typing `Noisy Sine Wave`.

The following figure displays the output of this example:

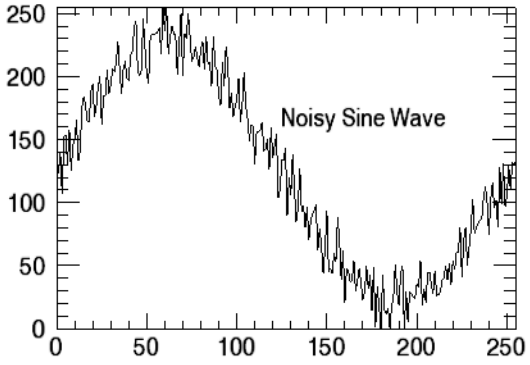



*Figure 3-14: Noisy Sine Data iPlot Example*

## Example 3

This example shows how to use the **File → Import** command to load ASCII data into the iPlot tool.

At the IDL Command Line, enter:

```
IPLOT
```

Select **File** → **Import** to display the IDL Import Data wizard.

1. At Step 1, select **From a File** and click **Next>>**.
2. At Step 2, under **File Name:**, browse to find `sine_waves.txt` in the `examples/data` directory in the IDL distribution, and click **Next**>>.
3. At Step 3, select **Plot** and click **Finish**.

Then, the ASCII Template wizard is displayed.

1. At Step 1, click **Next>>** to accept the displayed data type/range definition.
2. At Step 2, click **Next**>> to accept the displayed delimiter/fields definition.
3. At Step 3, click **Finish** to accept the displayed field specification. The `sine_waves.txt` plot is displayed in the iPlot window.

The plot consists of two overlapping sine waves. To make it easier to distinguish between the two, change the appearance of the noisy sine wave to a dotted line pattern by selecting the noisy sine wave, right-clicking to display the context menu, selecting **Properties**, and changing the **Linestyle** property to a dotted line.

The following figure displays the output of this example:

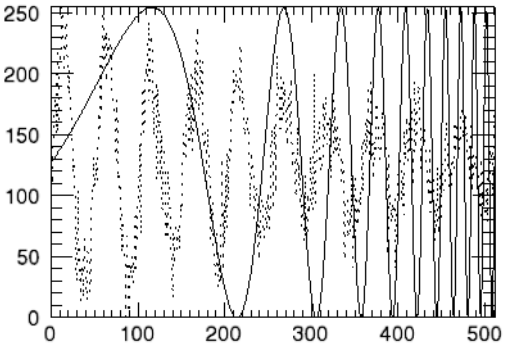



*Figure 3-15: Overlapping Sine Waves iPlot Example*

## Version History

Introduced: 6.0

# ISHFT

The ISHFT function performs the bit shift operation on bytes, integers and longwords.

## Syntax

*Result* = ISHFT($P_1$, $P_2$)

## Return Value

If $P_2$ is positive, $P_1$ is left shifted $P_2$ bit positions with 0 bits filling vacated positions. If $P_2$ is negative, $P_1$ is right shifted with 0 bits filling vacated positions.

## Arguments

### $P_1$

The scalar or array to be shifted.

### $P_2$

The scalar or array containing the number of bit positions and direction of the shift.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Bit shift each element of the integer array [1, 2, 3, 4, 5] three bits to the left and store the result in B by entering:

```
B = ISHFT([1,2,3,4,5], 3)
```

The resulting array B is [8, 16, 24, 32, 40].

## Version History

Introduced: Original

## See Also

SHIFT

# ISOCONTOUR

The ISOCONTOUR procedure interprets the contouring algorithm found in the IDLgrContour object. The algorithm allows for contouring on arbitrary meshes and returns line or orientated tessellated polygonal output. The interface will also allow secondary data values to be interpolated and returned at the output vertices as well.

## Syntax

ISOCONTOUR, *Values*, *Outverts*, *Outconn*
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*]
[, C_LABEL_INTERVAL=*vector of values*] [, C_LABEL_SHOW=*vector of integers*] [, C_VALUE=*scalar or vector*] [, /DOUBLE] [, /FILL] [, GEOMX=*vector*]
[, GEOMY=*vector*] [, GEOMZ=*vector*] [, LEVEL_VALUES=*variable*]
[, N_LEVELS=*levels*] [, OUT_LABEL_OFFSETS=*variable*]
[, OUT_LABEL_POLYLINES=*variable*] [, OUT_LABEL_STRINGS=*variable*]
[, OUTCONN_INDICES=*variable*] [, POLYGONS=*array of polygon descriptions*]

## Arguments

### Values

A vector or two-dimensional array specifying the values to be contoured. If the data is of double-precision floating-point type, or if the DOUBLE keyword is set, computations are done in double precision and the result is a double-precision value. If the data is of any other type, it is converted (if necessary) to single-precision floating-point; all computations are then done in single precision and the result is a single-precision value.

### Outconn

Output variable to contain the connectivity information of the contour geometry in the form: [n0, i(0, 0), i(0, 1)..., i(0, n0–1), n1, i(1, 0), ...].

### Outverts

Output variable to contain the contour vertices. The vertices are returned in double-precision floating point if the DOUBLE keyword is specified with a non-zero value. Otherwise, the vertices are returned in single-precision floating point.

# Keywords

## AUXDATA_IN

The auxiliary values to be interpolated at contour vertices. If *p* is the dimensionality of the auxiliary values, set this argument to a *p*-by-*n* array (if the *Values* argument is a vector of length *n*), or to a *p*-by-*m*-by-*n* array (if the *Values* argument is an *m*-by-*n* two-dimensional array).

## AUXDATA_OUT

If the AUXDATA_IN keyword was specified, set this keyword to a named output variable to contain the interpolated auxiliary values at the contour vertices. If *p* is the dimensionality of the auxiliary values, the output is a *p*-by-*n* array of values, where *n* is the number of vertices in *Outverts*.

## C_LABEL_INTERVAL

Set this keyword to a vector of values indicating the distance (measured parametrically relative to the length of each contour path) between labels for each contour level. If the number of contour levels exceeds the number of provided intervals, the C_LABEL_INTERVAL values will be repeated cyclically. The default is 0.4.

## C_LABEL_SHOW

Set this keyword to a vector of integers. For each contour value, if the corresponding value in the C_LABEL_SHOW vector is non-zero, the contour line for that contour value will be labeled (with the corresponding label information returned via the OUT_LABEL_POLYS, OUT_LABEL_OFFSETS, and OUT_LABEL_STRINGS keywords). If the number of contour levels exceeds the number of elements in this vector, the C_LABEL_SHOW values will be repeated cyclically. The default is 0 indicating that no contour levels will be labeled.

## C_VALUE

Set this keyword to a scalar value or a vector of values for which contour levels are to be generated. If this keyword is set to 0, contour levels will be evenly sampled across the range of the *Values* argument, using the value of the N_LEVELS keyword to determine the number of samples.

## DOUBLE

Set this keyword to use double-precision to compute the contours. IDL converts any data supplied by the *Values* argument or GEOMX, GEOMY, and GEOMZ keywords to double precision and returns the *Outverts* argument in double precision. The default behavior is to convert the input to single precision and return the *Outverts* in single precision.

## FILL

Set this keyword to generate an output connectivity as a set of polygons (Outconn is in the form used by the IDLgrPolygon POLYGONS keyword). The resulting representation is as a set of filled contours. The default is to generate line contours (Outconn is in the form used by the IDLgrPolyline POLYLINES keyword).

## GEOMX

Set this keyword to a vector or two-dimensional array specifying the *X* coordinates of the geometry with which the contour values correspond. If *X* is a vector, it must match the number of elements in the Values argument, or it must match the first of the two dimensions of the Values argument (in which case the *X* coordinates will be repeated for each row of data values).

If necessary, data in the supplied vector or array will be converted to match the data type of the *Values* argument.

## GEOMY

Set this keyword to a vector or two-dimensional array specifying the *Y* coordinates of the geometry with which the contour values correspond. If *Y* is a vector, it must match the number of elements in the *Values* argument, or it must match the second of the two dimensions of the *Values* argument (in which case the *Y* coordinates will be repeated for each column of data values).

If necessary, data in the supplied vector or array will be converted to match the data type of the *Values* argument.

## GEOMZ

Set this keyword to a vector or two-dimensional array specifying the *Z* coordinates of the geometry with which the contour values correspond.

If GEOMZ is a vector or an array, it must match the number of elements in the *Values* argument.

If GEOMZ is not set, the geometry will be derived from the *Values* argument (if it is set to a two-dimensional array). In this case connectivity is implied. The X and Y coordinates match the row and column indices of the array, and the Z coordinates match the data values.

If necessary, data in the supplied vector or array will be converted to match the data type of the *Values* argument.

## LEVEL_VALUES

Set this keyword to a named output variable to receive a vector of values corresponding to the values used to generate the contours. The length of this vector is equal to the number of contour levels generated. This vector is returned in double precision floating point.

## N_LEVELS

Set this keyword to the number of contour levels to generate. This keyword is ignored if the C_VALUE keyword is set to a vector, in which case the number of levels is derived from the number of elements in that vector. Set this keyword to 0 to indicate that IDL should compute a default number of levels based on the range of data values. This is the default.

## OUT_LABEL_OFFSETS

Set this keyword to a named variable that upon return will contain a vector of offsets (parameterized to the corresponding contour line) indicating the positions of the contour labels.

**Note**

The C_LABEL_SHOW keyword should be specified if this keyword is used.

## OUT_LABEL_POLYLINES

Set this keyword to a named variable that upon return will contain a vector of polyline indices, [P0, P1, …], that indicate which contour lines are labeled. Pi corresponds to the ith polyline specified via the Outconn argument. Note that if a given contour line has more than one label along its perimeter, then the corresponding polyline index may appear more than once in the LABEL_POLYS vector.

**Note**

The C_LABEL_SHOW keyword should be specified if this keyword is used.

### OUT_LABEL_STRINGS

Set this keyword to a named variable that upon return will contain a vector of strings, [str0, str1, …], that indicate the label strings.

**Note**

The C_LABEL_SHOW keyword should be specified if this keyword is used.

### OUTCONN_INDICES

Set this keyword to a named output variable to receive an array of beginning and ending indices of connectivity for each contour level.

The output array is of the form: [$start_0$, $end_0$, $start_1$, $end_1$, ..., $start_{nc-1}$, $end_{nc-1}$], where *nc* is the number of contour levels. If a level has no contour lines, the start and stop pair is set to 0 and 0 for that level.

### POLYGONS

Set this keyword to an array of polygonal descriptions that represents the connectivity information for the data to be contoured (as specified in the *Values* argument). A polygonal description is an integer or long array of the form: [n, $i_0$, $i_1$, ..., $i_{n-1}$], where n is the number of vertices that define the polygon, and $i_0$...$i_{n-1}$ are indices into the GEOMX, GEOMY, and GEOMZ keywords that represent the polygonal vertices. To ignore an entry in the POLYGONS array, set the vertex count, n to 0. To end the drawing list, even if additional array space is available, set *n* to –1.

## Version History

Introduced: 5.5

C_LABEL_INTERVAL, C_LABEL_SHOW, OUT_LABEL_OFFSETS, OUT_LABEL_POLYLINES, and OUT_LABEL_STRINGS keywords added: 5.6

# ISOSURFACE

The ISOSURFACE procedure algorithm expands on the SHADE_VOLUME algorithm. It returns topologically consistent triangles by using oriented tetrahedral decomposition internally. This also allows the algorithm to isosurface any arbitrary tetrahedral mesh. If the user provides an optional auxiliary array, the data in this array is interpolated onto the output vertices and is returned as well. This auxiliary data array is allowed to have more than one value at each vertex. Any size leading dimension is allowed as long as the number of values in the subsequent dimensions matches the number of elements in the input Data array.

## Syntax

ISOSURFACE, *Data*, *Value*, *Outverts*, *Outconn*
[, GEOM_XYZ=*array*, TETRAHEDRA=*array*]
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*]
[, PROGRESS_CALLBACK=*string*] [, PROGRESS_METHOD=*string*]
[, PROGRESS_OBJECT=*objref*] [, PROGRESS_PERCENT=*percent*{0 to 100}]
[, PROGRESS_USERDATA=*value*]

## Arguments

### Data

Input three-dimensional array of scalars which are to be contoured.

### Value

Input scalar contour value. This value specifies the constant-density surface (also called an iso-surface) to be extracted.

### Outverts

A named variable to contain an output [3, *n*] array of floating point vertices making up the triangle surfaces.

### Outconn

A named variable to contain an output array of polygonal connectivity values (see IDLgrPolygon, POLYGONS keyword). If no polygons were extracted, this argument returns the array [–1].

# Keywords

## AUXDATA_IN

Input array of auxiliary data with trailing dimensions being the number of values in Data.

**Note**

If AUXDATA_IN is specified then AUXDATA_OUT must also be specified.

## AUXDATA_OUT

Set this keyword to a named variable that will contain an output array of auxiliary data sampled at the locations in Outverts.

**Note**

If AUXDATA_OUT is specified then AUXDATA_IN must also be specified.

## GEOM_XYZ

A [3,n] input array of vertex coordinates (one for each value in the Data array). This array is used to define the spatial location of each scalar. If this keyword is omitted, Data must be a three-dimensional array and the scalar locations are assumed to be on a uniform grid.

**Note**

If GEOM_XYZ is specified then TETRAHEDRA must also be specified if either is to be specified.

## PROGRESS_CALLBACK

Set this keyword to a scalar string containing the name of the IDL function that ISOSURFACE calls at PROGRESS_PERCENT intervals as it generates the isosurface.

The PROGRESS_CALLBACK function returns a zero to signal ISOSURFACE to stop generating the isosurface. This causes ISOSURFACE to return a single vertex and a connectivity array of [-1], which specifies an empty polygon. If the callback function returns any non-zero value, ISOSURFACE continues to generate the isosurface.

The PROGRESS_CALLBACK function must specify a single argument, *Percent*, which ISOSURFACE sets to an integer between 0 and 100, inclusive.

The PROGRESS_CALLBACK function may specify an optional USERDATA keyword parameter, which ISOSURFACE sets to the variable provided in the PROGRESS_USERDATA keyword.

The following code shows an example of a progress callback function:

```
FUNCTION myProgressCallback, percent,$    USERDATA = myStruct

oProgressBar = myStruct.oProgressBar

; This method updates the progress bar
; graphic and returns TRUE if the user has
; NOT pressed the cancel button.
keepGoing = oProgressBar -> $
   UpdateProgressValue(percent)

RETURN, keepGoing

END
```

## PROGRESS_METHOD

Set this keyword to a scalar string containing the name of a function method that ISOSURFACE calls at PROGRESS_PERCENT intervals as it generates the isosurface. If this keyword is set, then the PROGRESS_OBJECT keyword must be set to an object reference that is an instance of a class that defines the specified method.

The PROGRESS_METHOD function method callback has the same specification as the callback described in the PROGRESS_CALLBACK keyword, except that it is defined as an object class method:

```
FUNCTION myClass::myProgressCallback, $
   percent, USERDATA = myStruct
```

## PROGRESS_OBJECT

Set this keyword to an object reference that is an instance of a class that defines the method specified with the PROGRESS_METHOD keyword. If this keyword is set, then the PROGRESS_METHOD keyword must also be set.

### PROGRESS_PERCENT

Set this keyword to a scalar in the range [1, 100] to specify the interval between invocations of the callback function. The default value is 5 and IDL silently clamps other values to the range [1, 100].

For example, a value of 5 (the default) specifies ISOSURFACE will call the callback function when the isosurface process is 0% complete, 5% complete, 10% complete, ..., 95% complete, and 100% complete.

### PROGRESS_USERDATA

Set this property to any IDL variable that ISOSURFACE passes to the callback function in the callback function's USERDATA keyword parameter. If this keyword is specified, then the callback function must be able to accept keyword parameters.

### TETRAHEDRA

An input array of tetrahedral connectivity values. If this array is not specified, the connectivity is assumed to be a rectilinear grid over the input three-dimensional array. If this keyword is specified, the input data array need not be a three-dimensional array. Each tetrahedron is represented by four values in the connectivity array. Every four values in the array correspond to the vertices of a single tetrahedron.

## Version History

Introduced: 5.5

## See Also

INTERVAL_VOLUME, SHADE_VOLUME, XVOLUME

# ISURFACE

The ISURFACE procedure creates an iTool and the associated user interface (UI) configured to display and manipulate surface data.

**Note**

If no arguments are specified, the ISURFACE procedure creates an empty Surface tool.

This routine is written in the IDL language. Its source code can be found in the file `isurface.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

ISURFACE[, *Z* [, *X*, *Y*]]

**iTool Common Keywords:** [, DIMENSIONS=[*x*, *y*]] [, IDENTIFIER=*variable*] [, LOCATION=[*x*, *y*]] [, NAME=*string*] [, OVERPLOT=*iToolID*] [, TITLE=*string*] [, VIEW_GRID=[*columns*, rows]] [, /VIEW_NEXT] [, VIEW_NUMBER=*integer*] [, {X | Y | Z}RANGE=[*min*, *max*]]

**iTool Surface Keywords:** [, RGB_TABLE=*array of 256 by 3 or 3 by 256 elements*] [, TEXTURE_ALPHA=*2-D array*] [, TEXTURE_BLUE=*2-D array*] [, TEXTURE_GREEN=*2-D array*] [, TEXTURE_IMAGE=*array*] [, TEXTURE_RED=*2-D array*]

**Surface Object Keywords**: [, BOTTOM=*index or RGB vector*] [, CLIP_PLANES=*array*] [, COLOR=*RGB vector*] [, DEPTH_OFFSET=*value*] [, /EXTENDED_LEGO] [, /HIDDEN_LINES] [, /HIDE] [, LINESTYLE=*value*] [, SHADING={0 | 1}] [, /SHOW_SKIRT] [, SKIRT=*Z value*] [, STYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}] [, /TEXTURE_HIGHRES] [, /TEXTURE_INTERP] [, THICK=*points*{1.0 to 10.0}] [, /USE_TRIANGLES] [, VERT_COLORS=*vector or 2-D array*] [, ZERO_OPACITY_SKIP={0 | 1}]

**Axis Object Keywords:** [, {X | Y | Z}GRIDSTYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}] [, {X | Y | Z}MAJOR=*integer*] [, {X | Y | Z}MINOR=*integer*] [, {X | Y | Z}SUBTICKLEN=*ratio*] [, {X | Y | Z}TEXT_COLOR=*RGB vector*] [, {X | Y | Z}TICKFONT_INDEX={0 | 1 | 2 | 3 | 4}] [, {X | Y | Z}TICKFONT_SIZE=*integer*] [, {X | Y | Z}TICKFONT_STYLE={0 | 1 | 2 | 3}] [, {X | Y | Z}TICKFORMAT=*string or string array*] [, {X | Y | Z}TICKINTERVAL=*value*] [, {X | Y | Z}TICKLAYOUT={0 | 1 | 2}] [, {X | Y | Z}TICKLEN=*value*] [, {X | Y | Z}TICKNAME=*string array*]

[, {X | Y | Z}TICKUNITS=*string*] [, {X | Y | Z}TICKVALUES=*vector*]
[, {X | Y | Z}TITLE=*string*]

# Arguments

## X

A vector or two-dimensional array specifying the *x*-coordinates of the grid.

If *X* is a vector:

- If *Y* and *Z* are vectors and have the same length as *X*:

  Each element of *X* specifies the *x*-coordinates of a point in space (e.g., *X*[0] specifies the *x*-coordinate for *Y*[0] and *Z*[0]). The gridding wizard will automatically launch in this case.

- If *Z* is a two-dimensional array:

  Each element of *X* specifies the *x*-coordinates for a column of *Z* (e.g., *X*[0] specifies the *x*-coordinate for *Z*[0, *]).

If *X* is a two-dimensional array, each element of *X* specifies the *x*-coordinate of the corresponding point in *Z* ($X_{ij}$ specifies the x-coordinate of $Z_{ij}$).

## Y

A vector or two-dimensional array specifying the *y*-coordinates of the grid.

If *Y* is a vector:

- If *X* and *Z* are vectors and have the same length as *Y*:

  Each element of *Y* specifies the *y*-coordinates of a point in space (e.g., *Y*[0] specifies the *y*-coordinate for *X*[0] and *Z*[0]). The gridding wizard will automatically launch in this case.

- If *Z* is a two-dimensional array:

  Each element of *Y* specifies the *y*-coordinates for a column of *Z* (e.g., *Y*[0] specifies the *y*-coordinate for *Z*[*, 0]).

If *Y* is a two-dimensional array, each element of *Y* specifies the *y*-coordinate of the corresponding point in *Z* ($Y_{ij}$ specifies the y-coordinate of $Z_{ij}$).

### Z

A vector or two-dimensional array specifying the data to be displayed.

If Z is a vector,

- If *X* and *Y* are vectors and have the same length as *Z*:

  Each element of *Z* specifies the *z*-coordinates of a point in space (e.g., *Z*[0] specifies the *z*-coordinate for *X*[0] and *Y*[0]). The gridding wizard will automatically launch in this case.

If Z is a two-dimensional array,

- If *X* and *Y* are provided:

  The surface is defined as a function of the (*x*, *y*) locations specified by their contents.

- If *X* and *Y* are not provided:

  The surface is generated as a function of the array indices of each element of *Z*.

## Keywords

**Note**

Keywords to the ISURFACE routine that correspond to the names of *registered properties* of the iSurface tool must be specified in full, without abbreviation.

### BOTTOM

Set this keyword to an RGB color for drawing the bottom of the surface. Set this keyword to a scalar to draw the bottom with the same color as the top.

### CLIP_PLANES

Set this keyword to an array of dimensions [4, *N*] specifying the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this keyword is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

A window is only able to support a limited number of clipping planes. Some of these clipping planes may already be in use by the tool to support specific data

display features. If the total number of clipping planes exceeds the limit, an informational message is displayed.

## COLOR

Set this keyword to the color to be used as the foreground color for this model. The color is specified as an RGB vector. The default is [225, 184, 0].

## DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the dimensions of the drawing area of the specific tool in device units. The minimum width of the window correlates to the width of the menubar. The minimum window height is 100 pixels.

## DEPTH_OFFSET

Set this keyword to an integer value that specifies an offset in depth to be used when rendering filled primitives. This offset is applied along the viewing axis, with positive values moving the primitive away from the viewer.

The units are “Z-Buffer units,” where a value of 1 is used to specify a distance that corresponds to a single step in the device’s Z-Buffer.

Use DEPTH_OFFSET to always cause a filled primitive to be rendered slightly deeper than other primitives, independent of model transforms. This is useful for avoiding stitching artifacts caused by rendering lines or polygons on top of other polygons at the same depth.

**Note**

RSI suggests using this feature to remove stitching artifacts and not as a means for “layering” complex scenes with multiple DEPTH_OFFSET values. It is safest to use only a DEPTH_OFFSET value of 0, the default, and one other non-zero value, such as 1. Many system-level graphics drivers are not consistent in their handling of DEPTH_OFFSET values, particularly when multiple non-zero values are used. This can lead to portability problems because a set of DEPTH_OFFSET values may produce better results on one machine than on another. Using IDL’s software renderer will help improve the cross-platform consistency of scenes that use DEPTH_OFFSET.

**Note**

DEPTH_OFFSET has no effect unless the value of the STYLE keyword is 2 or 6 (Filled or LegoFilled).

## EXTENDED_LEGO

Set this keyword to force the iSurface tool to display the last row and column of data when lego display styles are selected.

## HIDDEN_LINES

Set this keyword to draw point and wireframe surfaces using hidden line (point) removal. By default, hidden line removal is disabled.

## HIDE

Set this keyword to a boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

## IDENTIFIER

Set this keyword to a named IDL variable that will contain the iToolID for the created tool. This value can then be used to reference this tool during overplotting operations or command-line-based tool management operations.

## LINESTYLE

Set this keyword to indicate the line style that should be used to draw the surface lines. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE keyword equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot

- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

## LOCATION

Set this keyword to a two-element vector of the form [*x*, *y*] to specify the location of the upper left-hand corner of the tool relative to the display screen, in device units.

## NAME

Set this keyword to a string to specify the name for this particular tool. The name is used for tool-related display purposes only–as the root of the hierarchy shown in the Tool Browser, for example.

## OVERPLOT

Set this keyword to an iToolID to direct the graphical output of the particular tool to the tool specified by the provided iToolID.

Set this keyword equal to one to place the graphical output for the command in the current tool. If no current tool exists, a new tool is created.

## RGB_TABLE

Set this keyword to a two-dimensional array containing RGB triplets defining the colors to be used in a color indexed texture image or by vertex colors. The values should be within the range of $0 \leq value \leq 255$. The array must be a 3 by *N* array where *m* must not exceed 256.

## SHADING

Set this keyword to an integer representing the type of shading to use if STYLE is set to 2 (Filled).

- 0 = Flat (default): The color has a constant intensity for each face of the surface, based on the normal vector.
- 1 = Gouraud: The colors are interpolated between vertices, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

## SHOW_SKIRT

Set this keyword to enable skirt drawing. The default is to disable skirt drawing.

## SKIRT

Set this keyword to the *Z* value at which a skirt is to be defined around the array. The *Z* value is expressed in data units; the default is 0.0. If a skirt is defined, each point on the four edges of the surface is connected to a point on the skirt which has the given *Z* value, and the same *X* and *Y* values as the edge point. In addition, each point on the skirt is connected to its neighbor. The skirt value is ignored if skirt drawing is disabled (see SHOW_SKIRT above). IDL converts, maintains, and returns this data as double-precision floating-point.

## STYLE

Set this keyword to and integer value that indicates the style to be used to draw the surface. Valid values are:

- 0 = Points
- 1 = Wire mesh
- 2 = Filled (the default)
- 3 = RuledXZ
- 4 = RuledYZ
- 5 = Lego
- 6 = LegoFilled: for outline or shaded and stacked histogram-style plots.

## TEXTURE_ALPHA

Set the keyword to a two-dimensional array containing the alpha channel of an image to be used as a texture image. Use of this keyword requires that TEXTURE_RED, TEXTURE_GREEN, and TEXTURE_BLUE be set to arrays of identical size and type.

## TEXTURE_BLUE

Set the keyword to a two-dimensional array containing the blue channel of an image to be used as a texture image. Use of this keyword requires that TEXTURE_RED and TEXTURE_GREEN be set to arrays of identical size and type.

## TEXTURE_GREEN

Set the keyword to a two-dimensional array containing the green channel of an image to be used as a texture image. Use of this keyword requires that TEXTURE_RED and TEXTURE_BLUE be set to arrays of identical size and type.

## TEXTURE_HIGHRES

Set this keyword to cause texture tiling to be used as necessary to maintain the full pixel resolution of the original texture image.

Setting this keyword is recommended if IDL is running on modern 3-D hardware and resolution loss due to downscaling becomes problematic. If not set, and the texture map is larger than the maximum resolution supported by the 3-D hardware, the texture is scaled down to the maximum resolution supported by the 3-D hardware on your system. The default value is 0.

## TEXTURE_IMAGE

Set this keyword to an array containing an image to be texture mapped onto the surface. If this keyword is omitted or set to a null object reference, no texture map is applied and the surface is filled with the color specified by the COLOR or VERTEX_COLORS property. The image array can be a two-dimensional array of color indexes or a three-dimensional array specifying RGB values at each pixel (3 x *n* x *m*, *n* x 3 x *m*, or *n* x *m* x 3). Setting TEXTURE_IMAGE to a three-dimensional array contains an alpha channel (4 x *n* x *m*, *n* x 4 x *m*, or *n* x *m* x 4) allows you to create a transparent iSurface object. The TEXTURE_IMAGE keyword will override any values passed to TEXTURE_RED, TEXTURE_GREEN, TEXTURE_BLUE, or TEXTURE_ALPHA.

## TEXTURE_INTERP

Set this keyword to a nonzero value to indicate that bilinear sampling is to be used with texture mapping. The default method is nearest-neighbor sampling.

## TEXTURE_RED

Set the keyword to a two-dimensional array containing the red channel of an image to be used as a texture image. Use of this keyword requires that TEXTURE_GREEN and TEXTURE_BLUE be set to arrays of identical size and type.

## THICK

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to use to draw surface lines, in points. The default is 1.0 points.

## TITLE

Set this keyword to a string to specify a title for the tool. The title is displayed in the title bar of the tool.

## USE_TRIANGLES

Set this keyword to force the iSurface tool to use triangles instead of quads to draw the surface and skirt.

## VERT_COLORS

Set this keyword to a vector, two-dimensional array of equal size to *Z*, or a two-dimensional array containing RGB triplets representing colors to be used at each vertex. If this keyword is set to a vector or a two-dimensional array of equal size to *Z*, these values are indices into a color table that can be specified by the RGB_TABLE keyword. If the RGB_TABLE keyword is not set, a grayscale color is used. If more vertices exist than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. If this keyword is omitted, the surface is drawn in the color specified by the COLOR keyword or the default color.

## VIEW_GRID

Set this keyword to a two-element vector of the form [*columns*, *rows*] to specify the view layout within the new tool. This keyword is only used if a new tool is being created (for example, if OVERPLOT, VIEW_NEXT, or VIEW_NUMBER are specified then VIEW_GRID is ignored).

## VIEW_NEXT

Set this keyword to change the view selection to the next view following the currently-selected view before issuing any graphical commands. If the currently-selected view is the last one in the layout, then /VIEW_NEXT will cause the first view in the layout to become selected. This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## VIEW_NUMBER

Set this keyword to change the currently-selected view to the view specified by the VIEW_NUMBER before issuing any graphical commands. The view number starts at 1, and corresponds to the position of the view within the graphics container (not necessarily the position on the screen). This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## [XYZ]MAJOR

Set this keyword to an integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely.

## [XYZ]MINOR

Set this keyword to an integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely.

## [XYZ]RANGE

Set this keyword to the desired data range of the axis, a 2-element vector. The first element is the axis minimum, and the second is the maximum.

## [XYZ]SUBTICKLEN

Set this keyword to a floating-point scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark.

## [XYZ]TEXT_COLOR

Set this keyword to an RGB value specifying the color for the axis text. The default value is [0, 0, 0] (black).

## [XYZ]TICKFONT_INDEX

Set this keyword equal to one of the following integers, which represent the type of font to be used for the axis text:

- 0 = Helvetica
- 1 = Courier
- 2 = Times
- 3 = Symbol
- 4 = Hershey

## [XYZ]TICKFONT_SIZE

Set this keyword to an integer representing the point size of the font used for the axis text. The default is 12.0 points.

## [XYZ]TICKFONT_STYLE

Set this keyword equal to one of the following integers, which represent the style of font to be used for the axis text:

- 0 = Normal
- 1 = Bold
- 2 = Italic
- 3 = Bold Italic

## [XYZ]TICKFORMAT

Set this keyword to a string, or an array of strings, in which each string represents a format string or the name of a function to be used to format the tick mark labels. If an array is provided, each string corresponds to a level of the axis. The TICKUNITS keyword determines the number of levels for an axis.

If the string begins with an open parenthesis, it is treated as a standard format string. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual.

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels.

### If TICKUNITS are not specified:

- The callback function is called with three parameters: *Axis*, *Index*, and *Value*, where:
- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis
- *Index* is the tick mark index (indices start at 0)
- *Value* is the data value at the tick mark (a double-precision floating point value)

### If TICKUNITS are specified:

The callback function is called with four parameters: *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled. (Level indices start at 0.)

Used with the LABEL_DATE function, this property can easily create axes with date/time labels.

## [XYZ]TICKINTERVAL

Set this keyword to a floating-point scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis [XYZ]RANGE and the number of major tick marks ([XYZ]MAJOR). The value of this keyword takes precedence over the value set for the [XYZ]MAJOR keyword.

For example, if TICKUNITS = ['S', 'H', 'D'], and TICKINTERVAL = 30, then the interval between major ticks for the first axis level will be 30 seconds.

## [XYZ]TICKLAYOUT

Set this keyword to integer scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

**Note**

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

## [XYZ]TICKLEN

Set this keyword to a floating-point value that specifies the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point.

## [XYZ]TICKNAME

Set this keyword to a string array of up to 30 elements that controls the annotation of each tick mark.

## [XYZ]TICKUNITS

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling. If more than one unit is provided, the axis will be drawn in multiple levels, one level per unit.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- ""- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the "Numeric" unit. This is the default setting.

If any of the time units are utilized, then the tick values are interpreted as Julian date/time values. Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS = 'Day' is equivalent to TICKUNITS = 'Days').

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000hidd, respectively.

## [XYZ]TICKVALUES

Set this keyword to a floating-point vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point.

## [XYZ]TITLE

Set this keyword to a string representing the title of the specified axis.

### ZERO_OPACITY_SKIP

Set this keyword to gain finer control over the rendering of textured surface pixels (texels) with an opacity of 0 in the texture map. Texels with zero opacity do not affect the color of a screen pixel since they have no opacity. If this keyword is set to 1, any texels are “skipped” and not rendered at all. If this keyword is set to zero, the Z-buffer is updated for these pixels and the display image is not affected as noted above. By updating the Z-buffer without updating the display image, the surface can be used as a *clipping* surface for other graphics primitives drawn after the current graphics object. The default value for this keyword is 1.

**Note**

This keyword has no effect if no texture map is used or if the texture map in use does not contain an opacity channel.

## Examples

In the IDL Intelligent Tools system, data can be imported from the IDL Command Line (as described in Example 1), or data can be imported via the File menu in the iTool window (as described in Examples 2 and 3). For detailed information on importing data via the iTool file menu, refer to “Data Import Methods” in Chapter 2 of the *iTool User’s Guide* manual.

### Example 1

This example shows how to use the IDL Command Line to load data into the iSurface tool.

At the IDL Command Line, enter:

```
file = FILEPATH('surface.dat', $
   SUBDIRECTORY = ['examples', 'data'])
data = READ_BINARY(file, DATA_DIMS = [350, 450], DATA_TYPE = 2, $
   ENDIAN = 'little')
ISURFACE, data, TITLE = 'Maroon Bells Elevation', $
   COLOR = [255, 128, 0]
```

Place a title on the elevation axis of your plot by selecting the axis, right-clicking to display the context menu, selecting **Properties** to display the property sheet, and typing `Elevation (m)` in the **Title** field.

Use the **Operations** → **Statistics...** option to display the iTools Statistics dialog. Within this dialog, observe the `Z` value's `Maximum`, which is `4241` at `[29, 253]`. Close the iTools Statistics dialog by selecting **File** → **Close**.

Annotate your plot by selecting the Text Annotation tool, clicking near the top of the highest peak in the display, and typing `Highest Point (4241 m)`. Draw a line annotation between the text annotation and the highest peak on the surface.

The following figure displays the output of this example:

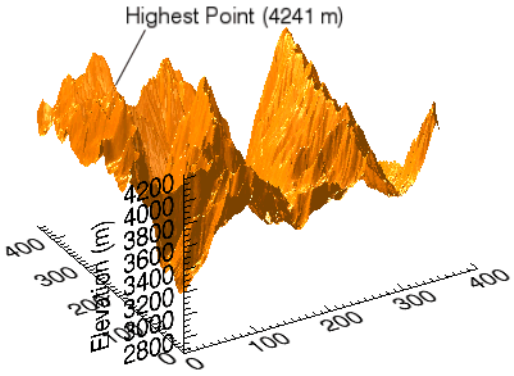



*Figure 3-16: Maroon Bells iSurface Example*

## Example 2

This example shows how to use the **File** → **Open** command to load binary data into the iSurface tool.

At the IDL Command Line, enter:

```
ISURFACE
```

Select **File** → **Open** to display the Open dialog, then browse to find `idemosurf.dat` in the `examples/data` directory in the IDL distribution, and click **Open**.

The Binary Template wizard is displayed. In the Binary Template, change **File's byte ordering** to `Little Endian`. Then, click **New Field**, and enter the following information in the New Field dialog:

- **Field Name:** `data` (or a name of your choosing)
- **Type:** `Float (32 bit)`
- **Number of Dimensions:** `2`
- **1st Dimension Size:** `200`
- **2nd Dimension Size:** `200`

Click **OK** to close the New Field dialog and the Binary Template dialog, and the surface is displayed.

**Note**

For more information on using the Binary Template to import data, see "Using the BINARY_TEMPLATE Function" in Chapter 15 of the *Using IDL* manual.

Insert a contour onto the surface by clicking the **Surface Contour** button on the toolbar, then clicking and dragging on the surface to position the contour at the desired height.

The following figure displays the output of this example:

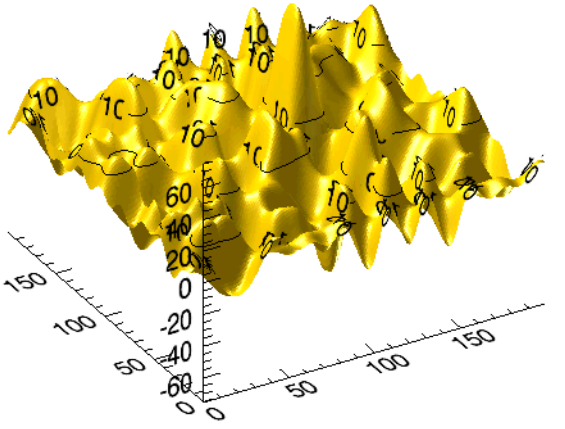



*Figure 3-17: Binary Surface Data iSurface Example*

## Example 3

This example shows how to use the **File** → **Import** command to load ASCII data into the iSurface tool.

At the IDL Command Line, enter:

```
ISURFACE
```

Select **File** → **Import** to display the IDL Import Data wizard.

1. At Step 1, select **From a File** and click **Next>>**.
2. At Step 2, under **File Name:**, browse to find `irreg_grid1.txt` in the `examples/data` directory in the IDL distribution, and click **Next>>**.
3. At Step 3, select **Surface** and click **Finish**.

Then, the ASCII Template wizard is displayed.

1. At Step 1, click **Next>>** to accept the displayed Data Type/Range definitions.
2. At Step 2, click **Next>>** to accept the displayed Delimiter/Fields definitions.
3. At Step 3, click **Finish** to accept the displayed Field Specifications.

**Note**

For more information on using the ASCII Template to import data, see "Using the ASCII_TEMPLATE Function" in Chapter 14 of the *Using IDL* manual.

At the iTool's Create Visualization window, you have the option of launching the Gridding wizard or not creating a visualization. Choose **Launch the gridding wizard** and click **Ok**.

4. At Step 1, click **Next>>** to accept the interpolation of data values and locations.
5. At Step 2, click **Next>>** to accept the dimensions, start and spacing.
6. At Step 3, select **Inverse Distance** as the gridding method, click **Preview** to preview the possible results, and click **Finish** to display the surface.

Double-click the surface to display the Properties sheet, and change the **Fill shading** setting from `Flat` to `Gouraud`.

Use the Rotate tool on the Toolbar to rotate the surface slightly forward to better display the surface convolutions.

The following figure displays the output of this example.

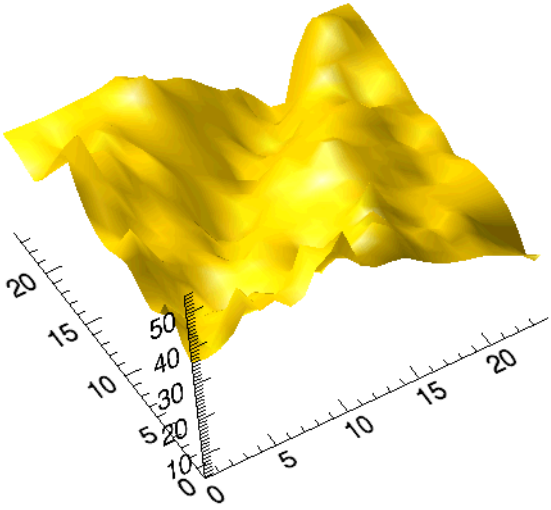



*Figure 3-18: ASCII Surface Data iSurface Example*

## Version History

Introduced: 6.0

# ITCURRENT

The ITCURRENT procedure is used to set the current tool in the IDL Intelligent Tools system. This routine is used with the identifier of the tool to make it current in the system. If the identifier is valid, the specified tool becomes current.

When a tool is set as current, the visible display or the focus state of the tool does not change. Only the internal setting of the current tool changes.

Besides using this procedure to set the current tool, a tool is made current when it is created or when it is placed in focus in the current windowing system.

This routine is written in the IDL language. Its source code can be found in the file `itcurrent.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

ITCURRENT, *iToolID*

## Arguments

### iToolID

The identifier of the existing iTool to be set as current.

## Keywords

None.

## Example

Enter the following at the IDL Command Line:

```
IPLOT, IDENTIFIER = PlotID1
current1 = ITGETCURRENT()
PRINT, 'The current tool is ', current1
```

An iPlot tool is created, and the newly created iPlot tool becomes the current tool. Output similar to the following appears in the IDL Output Log:

```
The current tool is /TOOLS/IPLOT_8
```

Enter the following at the IDL Command Line:

```
IPLOT, IDENTIFIER = PlotID2
current2 = ITGETCURRENT()
PRINT, 'The current tool is ', current2
```

A second iPlot tool is created, and this newly created iPlot tool becomes the current tool. Output similar to the following appears in the IDL Output Log:

```
The current tool is /TOOLS/IPLOT_9
```

Enter the following at the IDL Command Line:

```
ISURFACE, IDENTIFIER = SurfaceID1
current3 = ITGETCURRENT()
PRINT, 'The current tool is ', current3
```

An iSurface tool is created, and the newly created iSurface tool becomes the current tool. Output similar to the following appears in the IDL Output Log:

```
The current tool is /TOOLS/ISURFACE_5
```

Enter the following at the IDL Command Line:

```
ITCURRENT, PlotID1
current = ITGETCURRENT()
PRINT, 'The current tool is ', current
END
```

The iPlot tool created at the beginning of the example (PlotID1) becomes the current tool. Output similar to the following appears in the IDL Output Log:

```
The current tool is /TOOLS/IPLOT_8
```

Note that the system ID of the current tool (IPLOT_8) is the same as that of the current tool at the beginning of the exercise.

## Version History

Introduced: 6.0

## See Also

ITDELETE, ITGETCURRENT, ITRESET

# ITDELETE

The ITDELETE procedure is used to delete a tool in the IDL Intelligent Tools system. If a valid identifier is provided, the tool represented by the identifier is destroyed. If no identifier is provided, the current tool is destroyed.

When a tool is destroyed, all resources specific to that tool are released and the tool ceases to exist.

This routine is written in the IDL language. Its source code can be found in the file `itdelete.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

ITDELETE[, *iToolID*]

## Arguments

### iToolID

This optional argument contains the identifier for the specific iTool to delete. If not provided, the current tool is destroyed.

## Keywords

None.

## Example

Enter the following at the IDL Command Line:

```
IPLOT, IDENTIFIER = PlotID1
ISURFACE, IDENTIFIER = SurfaceID1
```

Two tools are created: an iPlot tool and an iSurface tool.

Next, enter the following at the IDL Command Line:

```
ITDELETE, plotID1
```

The iPlot tool is deleted, leaving only the iSurface tool.

## Version History

Introduced: 6.0

## See Also

ITCURRENT, ITGETCURRENT, ITRESET

# ITGETCURRENT

The ITGETCURRENT function is used to get the identifier of the current tool in the IDL Intelligent Tools system.

This routine is written in the IDL language. Its source code can be found in the file `itgetcurrent.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

*Result* = ITGETCURRENT()

## Return Value

Returns the identifier of the current tool in the iTool system. If no tool exists, an empty string (`''`) is returned.

## Arguments

None.

## Keywords

None.

## Example

The following example line of code creates a plot tool:

```
IPLOT, SIN(FINDGEN(361)*!DTOR), COLOR = [0, 0, 255], THICK = 2
```

The resulting plot tool contains a blue sine function, with a line thickness of 2. To overplot a cosine function on this display, the following lines of code are used:

```
idSin = ITGETCURRENT()
IPLOT, COS(FINDGEN(361)*!DTOR), COLOR = [0, 255, 0], THICK = 2, $
   OVERPLOT = idSin
```

However, it is not necessary to use ITGETCURRENT to retrieve the current tool for overplotting. The following method is also possible because the creation of a new tool causes it to be set as current in the system. In this scenario, the commands to generate the same display are:

```
IPLOT, SIN(FINDGEN(361)*!DTOR), COLOR = [0, 0, 255], THICK = 2
IPLOT, COS(FINDGEN(361)*!DTOR), COLOR = [0, 255, 0], THICK = 2, $
   /OVERPLOT
```

## Version History

Introduced: 6.0

## See Also

ITCURRENT, ITDELETE, ITRESET

# ITREGISTER

The ITREGISTER procedure is used to register tool object classes or other iTool functionality with the IDL Intelligent Tools system.

This routine is written in the IDL language. Its source code can be found in the file `itregister.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

ITREGISTER, *Name*, *ItemName* [, TYPES=*string*] [, /UI_PANEL] [, /UI_SERVICE] [, /VISUALIZATION]

## Arguments

### Name

A string containing the name used to refer to the associated class once registration is completed. Subsequent calls to create items of this type will use this name to identify the associated class.

### ItemName

A string containing the class name of the object class or user interface routine that is to be associated with *Name*. When an item of name *Name* is requested from the system, an object of this class is created or the specified routine is called.

## Keywords

**Note**

Keywords supplied in the call to ITREGISTER but not listed here are passed directly to the underlying objects' registration routines.

### TYPES

This keyword is only used in conjunction with the UI_PANEL keyword.

Set this keyword equal to a string or string array containing iTool types with which the UI panel should be associated. When the registered type of a UI panel matches the registered type of an iTool, the panel will be displayed as part of the iTool's interface.

### UI_PANEL

Set this keyword to indicate that a UI panel is being registered with the system. When this keyword is set, the value of *Name* is the string used to refer to the panel and *ItemName* is the routine that should be called when the panel is created.

To specify that the UI panel is associated with a particular iTool or iTools, set the TYPES keyword to the iTool types that should expose this panel.

### UI_SERVICE

Set this keyword to indicate that a UI service is being registered with the system. When this keyword is set, the value of *Name* is the string used to refer to the UI service and *ItemName* is the routine that should be called to execute the service.

### VISUALIZATION

Set this keyword to indicate that a visualization is being registered with the system. When this keyword is set, the value of *Name* is the string used to refer to the visualization type, and *ItemName* is the name of the visualization type's class definition routine.

## Examples

Suppose you have an iTool class definition file named `myTool__define.pro`, located in a directory included in IDL's !PATH system variable. Register this class with the iTool system with the following command:

```
ITREGISTER, 'My First Tool', 'myTool'
```

Tools defined by the `myTool` class definition file can now be created by the iTool system by specifying the tool name `My First Tool`.

Similarly, suppose you have a user interface service defined in a file named `myUIFileOpen.pro`. Register this UI service with the iTool system with the following command:

```
ITREGISTER, 'My File Open', 'myUIFileOpen', /UI_SERVICE
```

Finally, suppose you have a user interface panel defined in a file named `myPanel.pro`, and that you want this panel to be added to the user interface of iTools registered with the TYPES property set to `MYTOOL`. Register this UI panel with the iTool system with the following command:

```
ITREGISTER, 'My Panel', 'myPanel', /UI_PANEL, TYPES = 'MYTOOL'
```

## Version History

Introduced: 6.0

## See Also

Chapter 5, “Creating an iTool” in the *iTool Developer’s Guide* manual

# ITRESET

The ITRESET procedure resets the IDL iTools session. When called, all active tools and overall system management is destroyed and associated resources released.

This class is written in the IDL language. Its source code can be found in the file `itreset.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

ITRESET[, /NO_PROMPT]

## Arguments

None

## Keywords

### NO_PROMPT

Set this keyword to disable prompting the user before resetting the system. If this keyword is set, the user is not presented with a prompt and the reset is performed immediately.

## Examples

The iTool Data Manager system maintains your data during the entire IDL session, unless ITRESET is used. This example shows how the data is maintained and how ITRESET is used to clear the iTool Data Manager.

Read in plot data and load it into an iPlot tool at the IDL Command Line:

```
file = FILEPATH('dirty_sine.dat', $
   SUBDIRECTORY = ['examples', 'data'])
data = READ_BINARY(file, DATA_DIMS = [256, 1])
IPLOT, data
```

Delete this tool with the ITDELETE procedure at the IDL Command Line:

```
ITDELETE
```

Read in surface data and load it into an iSurface tool at the IDL Command Line:

```
file = FILEPATH('elevbin.dat', $
   SUBDIRECTORY = ['examples', 'data'])
data = READ_BINARY(file, DATA_DIMS = [64, 64])
ISURFACE, data
```

Use **Window → Data Manager...** to access the Data Manager Browser. The browser contains both plot and surface parameters. Although the iPlot tool was deleted, its data remains in the Data Manager. Click **Dismiss**.

Use **File → New → iPlot** to create an empty iPlot tool. If you want to load the plot data in the Data Manager into this tool, use **Insert → Visualization** to access the Insert Visualization dialog, which allows you to specify the plot data to be displayed.

At the IDL Command Line, enter:

```
ITRESET, /NO_PROMPT
```

The two iTools are deleted and the data in the Data Manager is released. To verify the data in released, create an empty iSurface tool at the IDL Command Line:

```
ISURFACE
```

Use **Window → Data Manager...** to access the Data Manager Browser. No data appears in the browser. The iTool Data Manger in empty. Click **Dismiss**.

At the IDL Command Line, enter:

```
ITRESET, /NO_PROMPT
```

## Version History

Introduced: 6.0

## See Also

ITCURRENT, ITDELETE, ITGETCURRENT

# IVOLUME

The IVOLUME procedure creates an iTool and associated user interface (UI) configured to display and manipulate volume data.

**Note**

If no arguments are specified, the IVOLUME procedure creates an empty Volume tool.

This routine is written in the IDL language. Its source code can be found in the file `ivolume.pro` in the `lib/itools` subdirectory of the IDL distribution.

## Syntax

IVOLUME[, *Vol*$_0$[, *Vol*$_1$][, *Vol*$_2$, *Vol*$_3$]]

**iTool Common Keywords:** [, DIMENSIONS=[*x*, *y*]] [, IDENTIFIER=*variable*] [, LOCATION=[*x*, *y*]] [, NAME=*string*] [, OVERPLOT=*iToolID*] [, TITLE=*string*] [, VIEW_GRID=[*columns*, *rows*]] [, /VIEW_NEXT] [. VIEW_NUMBER=*integer*] [, {X | Y | Z}RANGE=[*min*, *max*]]

**iTool Volume Keywords:** [, /AUTO_RENDER] [, RENDER_EXTENTS={0 | 1 | 2}] [, RENDER_QUALITY={1 | 2}] [, SUBVOLUME=[*xmin*, *ymin*, *zmin*, *xmax*, *ymax*, *zmax*]] [, VOLUME_DIMENSIONS=[*width*, *height*, *depth*]] [, VOLUME_LOCATION=[*x*, *y*, *z*]]

**Volume Object Keywords**: [, AMBIENT=*RGB vector*] [, BOUNDS=[*xmin*, *ymin*, *zmin*, *xmax*, *ymax*, *zmax*]] [, CLIP_PLANES=*array*] [, COMPOSITE_FUNCTION={0 | 1 | 2 | 3}] [, CUTTING_PLANES=*array*] [, DEPTH_CUE=[*zbright*, *zdim*]] [, /HIDE] [, HINTS={0 | 1 | 2 | 3}] [, /INTERPOLATE] [, /LIGHTING_MODEL] [, OPACITY_TABLE0=*byte array of 256 elements*] [, OPACITY_TABLE1=*byte array* of *256 elements*] [, RENDER_STEP=[*x*, *y*, *z*]] [, RGB_TABLE0=*byte array of 256 by 3 or 3 by 256 elements*] [, RGB_TABLE1=*byte array of 256 by 3 or 3 by 256 elements*] [, /TWO_SIDED] [, /ZBUFFER] [, ZERO_OPACITY_SKIP={0 | 1}]

**Axis Object Keywords:** [, {X | Y | Z}GRIDSTYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}]
[, {X | Y | Z}MAJOR=*integer*] [, {X | Y | Z}MINOR=*integer*]
[, {X | Y | Z}SUBTICKLEN=*ratio*] [, {X | Y | Z}TEXT_COLOR=*RGB vector*]
[, {X | Y | Z}TICKFONT_INDEX={0 | 1 | 2 | 3 | 4}]
[, {X | Y | Z}TICKFONT_SIZE=*integer*]
[, {X | Y | Z}TICKFONT_STYLE={0 | 1 | 2 | 3}]
[, {X | Y | Z}TICKFORMAT=*string or string array*]
[, {X | Y | Z}TICKINTERVAL=*value*] [, {X | Y | Z}TICKLAYOUT={0 | 1 | 2}]
[, {X | Y | Z}TICKLEN=*value*] [, {X | Y | Z}TICKNAME=*string array*]
[, {X | Y | Z}TICKUNITS=*string*] [, {X | Y | Z}TICKVALUES=*vector*]
[, {X | Y | Z}TITLE=*string*]

# Arguments

**Note**

The volume data provided in the $Vol_0$, $Vol_1$, $Vol_2$, and $Vol_3$ arguments are scaled into byte values (ranging from 0 to 255) with the BYTSCL function to facilitate using the volume data as indices into the RGB and OPACITY tables. This scaling is done for display purposes only; the iVolume tool maintains the original data as supplied with the arguments for use in other operations. The minimum and maximum values used by the BYTSCL function may be adjusted in the volume's property sheet. By default, the tool uses the minimum and maximum values of all volume parameters to uniformly byte-scale the data.

## $Vol_0$, $Vol_1$, $Vol_2$, $Vol_3$

A three-dimensional array of any numeric type containing volume data. Arrays of strings, structures, object references, and pointers are not allowed. If more than one volume is specified, they must all have the same dimensions.

The number of volumes present and the value of the COMPOSITE_FUNCTION keyword determine how the volume data is rendered by the iVolume tool. The number of volume arguments determine how the `src` and `srcalpha` values for the COMPOSITE_FUNCTION are computed:

- If $Vol_0$ is the only argument present, the values of `src` and `srcalpha` are taken directly from the RGB and OPACITY tables, as indexed by each volume data sample:

```
src = RGB_TABLE0[VOL0]
srcalpha = OPACITY_TABLE0[VOL0]
```

- If $Vol_0$ and $Vol_1$ are the only arguments present, the two volumes are blended together using independent tables:

```
src = (RGB_TABLE0[VOL0]*RGB_TABLE1[VOL1])/256
srcalpha = (OPACITY_TABLE0[VOL0]*OPACITY_TABLE1[VOL1])/256
```

- If all the arguments are present, $Vol_0$ indexes the red channel of RGB_TABLE0, $Vol_1$ indexes the green channel of RGB_TABLE0, and $Vol_2$ indexes the blue channel of RGB_TABLE0. The $Vol_3$ argument indexes OPACITY_TABLE0:

```
src = (RGB_TABLE[VOL0, 0], RGB_TABLE[VOL1, 1], $
   RGB_TABLE[VOL2, 2])/256
srcalpha = (OPACITY_TABLE0[VOL3])/256.
```

**Note**

If all the arguments are present, the composite function cannot be set to the average-intensity projection (COMPOSITE_FUNCTION = 3).

# Keywords

**Note**

Keywords to the IVOLUME routine that correspond to the names of *registered properties* of the iVolume tool must be specified in full, without abbreviation.

## AMBIENT

Use this keyword to set the color and intensity of the volume's base ambient lighting. Color is specified as an RGB vector. The default is [255, 255, 255]. AMBIENT is applicable only when LIGHTING_MODEL is set.

## AUTO_RENDER

Set this keyword to 1 to always render the volume. The default is to not render the volume each time the tool window is drawn.

## BOUNDS

Set this keyword to a six-element vector of the form [$x_{min}$, $y_{min}$, $z_{min}$, $x_{max}$, $y_{max}$, $z_{max}$], which represents the sub-volume to be rendered. This keyword is the same as the SUBVOLUME keyword.

## CLIP_PLANES

Set this keyword to an array of dimensions [4, *N*] specifying the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this keyword is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

Clipping planes are equivalent to cutting planes (refer to the CUTTING_PLANES keyword). The CUTTING_PLANES will be applied first, then the CLIP_PLANES (until a maximum number of planes is reached).

**Note**

A window is only able to support a limited number of clipping planes. Some of these clipping planes may already be in use by the tool to support specific data display features. If the total number of clipping planes exceeds the limit, an informational message is displayed.

## COMPOSITE_FUNCTION

The composite function determines the value of a pixel on the viewing plane by analyzing the voxels falling along the corresponding ray, according to one of the following compositing functions:

- 0 = Alpha (default): Alpha-blending. The recursive equation

  ```
  dest' = src * srcalpha + dest * (1 - srcalpha)
  ```

  is used to compute the final pixel color.

- 1 = MIP: Maximum intensity projection. The value of each pixel on the viewing plane is set to the brightest voxel, as determined by its opacity. The most opaque voxel's color appropriation is then reflected by the pixel on the viewing plane.

- 2 = Alpha sum: Alpha-blending. The recursive equation

  ```
  dest' = src + dest * (1 - srcalpha)
  ```

  is used to compute the final pixel color. This equation assumes that the color tables have been pre-multiplied by the opacity tables. The accumulated values can be no greater than 255.

- 3 = Average: Average-intensity projection. The resulting image is the average of all voxels along the corresponding ray.

  **Note**

  This option (COMPOSITE_FUNCTION = 3) is not supported for 4-channel volumes.

## CUTTING_PLANES

Set this keyword to a floating-point array with dimensions (4, *n*) specifying the coefficients of *n* cutting planes. The cutting plane coefficients are in the form {{$n_x$, $n_y$, $n_z$, $D$}, ...} where $(n_x)X+(n_y)Y+(n_z)Z+ D > 0$, and ($X$, $Y$, $Z$) are the voxel coordinates. To clear the cutting planes, set this property to any scalar value (e.g. CUTTING_PLANES = 0). By default, no cutting planes are defined.

## DEPTH_CUE

Set this keyword to a two-element floating-point array [*zbright*, *zdim*] specifying the near and far Z planes between which depth cueing is in effect.

Depth cueing causes an object to appear to fade into the background color of the view object with changes in depth. If the depth of an object is further than *zdim* (that is, if the object's location in the Z direction is farther from the origin than the value specified by *zdim*), the object will be painted in the background color.

Similarly, if the object is closer than the value of *zbright*, the object will appear in its "normal" color. Anywhere in-between, the object will be a blend of the background color and the object color. For example, if the DEPTH_CUE property is set to [-1, 1], an object at the depth of 0.0 will appear as a 50% blend of the object color and the view color.

The relationship between $Z_{bright}$ and $Z_{dim}$ determines the result of the rendering:

- $Z_{bright} < Z_{dim}$: Rendering darkens with depth.
- $Z_{bright} > Z_{dim}$: Rendering brightens with depth.
- $Z_{bright} = Z_{dim}$: Disables depth cueing.

You can disable depth cueing by setting $z_{bright} = z_{dim}$. The default is [0.0, 0.0].

## DIMENSIONS

Set this keyword to a two-element vector of the form [width, height] to specify the dimensions of the drawing area of the specific tool in device units. The minimum width of the window correlates to the width of the menubar. The minimum window height is 100 pixels.

## HIDE

Set this keyword to a boolean value indicating whether the volume should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

## HINTS

Set this keyword to specify one of the following acceleration hints:

- 0 = Disables all acceleration hints (default).
- 1 = Enables Euclidean distance map (EDM) acceleration. This option generates a volume map containing the distance from any voxel to the nearest non-zero opacity voxel. The map is used to speed ray casting by allowing the ray to jump over open spaces. It is most useful with sparse volumes. After setting the EDM hint, the draw operation generates the volume map; this process can take some time. Subsequent draw operations will reuse the generated map and may be much faster, depending on the volume's sparseness. A new map is not automatically generated to match changes in opacity tables or volume data (for performance reasons). The user may force recomputation of the EDM map by setting the HINTS property to 1 again.
- 2 = Enables the use of multiple CPUs for volume rendering if the platforms used support such use. If HINTS is set to 2, IDL will use all the available (up to 8) CPUs to render portions of the volume in parallel.
- 3 = Selects the two acceleration options described above.

## IDENTIFIER

Set this keyword to a named IDL variable that will contain the iToolID for the created tool. This value can then be used to reference this tool during overplotting operations or command-line-based tool management operations.

## INTERPOLATE

Set this keyword to indicate that trilinear interpolation is to be used to determine the data value for each step on a ray. Setting this keyword improves the quality of images produced, at the cost of more computing time. especially when the volume has low resolution with respect to the size of the viewing plane. Nearest neighbor sampling is used by default.

## LIGHTING_MODEL

Set this keyword to use the current lighting model during rendering in conjunction with a local gradient evaluation.

**Note**

Only DIRECTIONAL light sources are honored by the volume object. Because normals must be computed for all voxels in a lighted view, enabling light sources increases the rendering time.

## LOCATION

Set this keyword to a two-element vector of the form [*x*, *y*] to specify the location of the upper left-hand corner of the tool relative to the display screen, in device units.

## NAME

Set this keyword to a string to specify the name for this particular tool. The name is used for tool-related display purposes only–as the root of the hierarchy shown in the Tool Browser, for example.

## OPACITY_TABLE0

Set this keyword to a 256-element byte array to specify an opacity table for $Vol_0$ if $Vol_0$ or $Vol_0$ and $Vol_1$ are present. If all the volume arguments are present, this keyword represents the opacity of the resulting RGBA volume. A value of 0 indicates complete transparency and a value of 255 indicates complete opacity. The default table is a linear ramp.

## OPACITY_TABLE1

Set this keyword to a 256-element byte array to specify an opacity table for $Vol_1$ when $Vol_0$ and $Vol_1$ are present. A value of 0 indicates complete transparency and a value of 255 indicates complete opacity. The default table is a linear ramp.

## OVERPLOT

Set this keyword to an iToolID to direct the graphical output of the particular tool to the tool specified by the provided iToolID.

Set this keyword to 1 (one) to place the graphical output for the command in the current tool. If no current tool exists, a new tool is created.

## RENDER_EXTENTS

Set this keyword to draw a boundary around the rendered volume. The default (RENDER_EXTENTS = 2) is to draw a translucent boundary box. Possible values for this keyword are:

- 0 = Do not draw anything around the volume.
- 1 = Draw a wireframe around the volume.
- 2 = Draw a translucent box around the volume

## RENDER_STEP

Set this keyword to a three element vector of the form [*x*, *y*, *z*] to specify the stepping factor through the voxel matrix. This keyword is only valid if render quality is set to high (RENDER_QUALITY = 2). The default render step is [1, 1, 1].

## RENDER_QUALITY

Set this keyword to determine the quality of the rendered volume. The default (RENDER_QUALITY = 1) is low quality. Possible values for this keyword are:

- 1 = Low - Renders volume with a stack of two-dimensional texture maps.
- 2 = High - Use ray-casting rendering, see the COMPOSITE_FUNCTION for more details.

## RGB_TABLE0

Set this keyword to a 3 by 256 or 256 by 3 byte array of RGB color values to specify a color table for $Vol_0$ if $Vol_0$ or $Vol_0$ and $Vol_1$ are present. If all the arguments are present, this keyword represents the RGB color values of all of these volumes. The default is a linear ramp

## RGB_TABLE1

Set this keyword to a 3 by 256 or 256 by 3 byte array of RGB color values to specify a color table for $Vol_1$ when $Vol_0$ and $Vol_1$ are present. The default is a linear ramp.

## SUBVOLUME

Set this keyword to a six-element vector of the form [$x_{min}$, $y_{min}$, $z_{min}$, $x_{max}$, $y_{max}$, $z_{max}$], which represents the sub-volume to be rendered. This keyword is the same as the BOUNDS keyword.

## TITLE

Set this keyword to a string to specify the title for this particular tool. The title is displayed in the title bar of the tool.

## TWO_SIDED

Set this keyword to force the lighting model to use a two-sided voxel gradient. The two-sided gradient is different from the one-sided gradient (default) in that the absolute value of the inner product of the light direction and the surface gradient is used instead of clamping to 0.0 for negative values.

## VIEW_GRID

Set this keyword to a two-element vector of the form [*columns*, *rows*] to specify the view layout within the new tool. This keyword is only used if a new tool is being created (for example, if OVERPLOT, VIEW_NEXT, or VIEW_NUMBER are specified then VIEW_GRID is ignored).

## VIEW_NEXT

Set this keyword to change the view selection to the next view following the currently-selected view before issuing any graphical commands. If the currently-selected view is the last one in the layout, then /VIEW_NEXT will cause the first view in the layout to become selected. This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## VIEW_NUMBER

Set this keyword to change the currently-selected view to the view specified by the VIEW_NUMBER before issuing any graphical commands. The view number starts at 1, and corresponds to the position of the view within the graphics container (not necessarily the position on the screen). This keyword is ignored if no current tool exists.

**Note**

The contents of the newly-selected view will be emptied unless /OVERPLOT is set.

## VOLUME_DIMENSIONS

A 3-element vector specifying the volume dimensions in terms of user data units. For example, specifying [0.1, 0.1, 0.1] would cause the volume to be rendered into a region that is 0.1 data units long on each side of the volume cube. If this parameter is not specified, the volume is rendered into a region the same size as the number of samples, with an origin of [0, 0, 0]. In this case, a volume with sample size of [20, 25, 20] would render into the region [0:19, 0:24, 0:19] in user data units. Use the VOLUME_LOCATION keyword to specify a different origin.

## VOLUME_LOCATION

A 3-element vector specifying the volume location in user data units. Use this keyword to render the volume so that the first sample voxel appears at the specified location, instead of at [0, 0, 0], the default. Specify the location in terms of coordinates after the application of the VOLUME_DIMENSIONS values. For example, if the value of the VOLUME_DIMENSIONS keyword is [0.1, 0.1, 0.1] and you want the volume to be centered at the origin, set the VOLUME_LOCATION keyword to [-0.05, -0.05, -0.05].

## [XYZ]MAJOR

Set this keyword to an integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely.

## [XYZ]MINOR

Set this keyword to an integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely.

## [XYZ]RANGE

Set this keyword to the desired data range of the axis, a 2-element vector. The first element is the axis minimum, and the second is the maximum.

## [XYZ]SUBTICKLEN

Set this keyword to a floating-point scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark.

## [XYZ]TEXT_COLOR

Set this keyword to an RGB value specifying the color for the axis text. The default value is [0, 0, 0] (black).

## [XYZ]TICKFONT_INDEX

Set this keyword equal to one of the following integers, which represent the type of font to be used for the axis text:

- 0 = Helvetica
- 1 = Courier
- 2 = Times
- 3 = Symbol
- 4 = Hershey

## [XYZ]TICKFONT_SIZE

Set this keyword to an integer representing the point size of the font used for the axis text. The default is 12.0 points.

## [XYZ]TICKFONT_STYLE

Set this keyword equal to one of the following integers, which represent the style of font to be used for the axis text:

- 0 = Normal
- 1 = Bold
- 2 = Italic
- 3 = Bold Italic

## [XYZ]TICKFORMAT

Set this keyword to a string, or an array of strings, in which each string represents a format string or the name of a function to be used to format the tick mark labels. If an array is provided, each string corresponds to a level of the axis. The TICKUNITS keyword determines the number of levels for an axis.

If the string begins with an open parenthesis, it is treated as a standard format string. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual.

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels.

### If TICKUNITS are not specified:

- The callback function is called with three parameters: *Axis*, *Index*, and *Value*, where:
- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis
- *Index* is the tick mark index (indices start at 0)
- *Value* is the data value at the tick mark (a double-precision floating point value)

### If TICKUNITS are specified:

The callback function is called with four parameters: *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled. (Level indices start at 0.)

Used with the LABEL_DATE function, this property can easily create axes with date/time labels.

## [XYZ]TICKINTERVAL

Set this keyword to a floating-point scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis [XYZ]RANGE and the number of major tick marks ([XYZ]MAJOR). The value of this keyword takes precedence over the value set for the [XYZ]MAJOR keyword.

For example, if TICKUNITS = ['S', 'H', 'D'], and TICKINTERVAL = 30, then the interval between major ticks for the first axis level will be 30 seconds.

## [XYZ]TICKLAYOUT

Set this keyword to integer scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

**Note**

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

## [XYZ]TICKLEN

Set this keyword to a floating-point value that specifies the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point.

## [XYZ]TICKNAME

Set this keyword to a string array of up to 30 elements that controls the annotation of each tick mark.

## [XYZ]TICKUNITS

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling. If more than one unit is provided, the axis will be drawn in multiple levels, one level per unit.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- ""- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the "Numeric" unit. This is the default setting.

If any of the time units are utilized, then the tick values are interpreted as Julian date/time values. Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS = 'Day' is equivalent to TICKUNITS = 'Days').

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000hidd, respectively.

## [XYZ]TICKVALUES

Set this keyword to a floating-point vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point.

## [XYZ]TITLE

Set this keyword to a string representing the title of the specified axis.

### ZBUFFER

Set this keyword to clip the rendering to the current Z-buffer and then update the buffer.

### ZERO_OPACITY_SKIP

Set this keyword to skip voxels with an opacity of 0. This keyword can increase the output contrast of MIP (MAXIMUM_INTENSITY) projections by allowing the background to show through. If this keyword is set, voxels with an opacity of zero will not modify the Z-buffer. The default (not setting the keyword) continues to render voxels with an opacity of zero.

## Examples

In the IDL Intelligent Tools system, data can be imported from the IDL Command Line (as described in Example 1), or data can be imported via the **File** menu in the iTool window (as described in Examples 2 and 3). For detailed information on importing data via the iTool file menu, refer to "Data Import Methods" in Chapter 2 of the *iTool User's Guide* manual.

### Example 1

This example shows how to use the IDL Command Line to bring data into the iVolume tool.

At the IDL Command Line, enter:

```
file = FILEPATH('clouds3d.dat', $
   SUBDIRECTORY = ['examples', 'data'])
RESTORE, file
IVOLUME, clouds
```

Derive an interval volume by selecting **Operations** → **Volume** → **Interval Volume**. In the Interval Volume Value Selector dialog, change the minimum value to `0.2` and the **Decimate: % of original surface** slider to `20`, then click **OK**.

The following figure displays the output of this example:

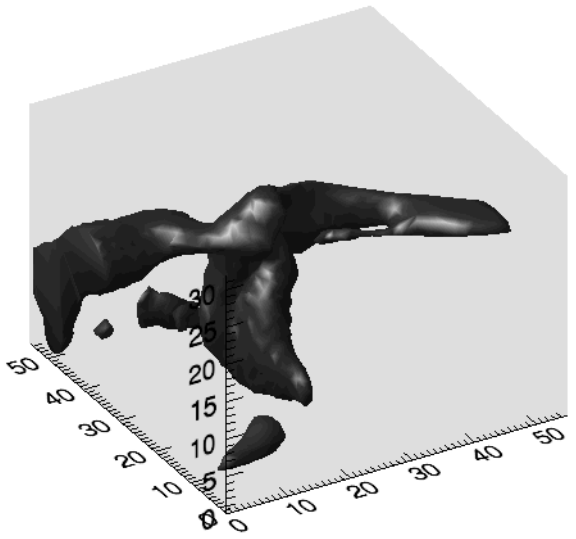



*Figure 3-19: Cloud Interval Volume iVolume Example*

## Example 2

This example shows how to use the iTool **File** → **Open** command to load binary data into the iVolume tool.

At the IDL Command Line, enter:

```
IVOLUME
```

Select **File** → **Open** to display the Open dialog, then browse to find `head.dat` in the `examples/data` directory in the IDL distribution, and click **Open**.

In the Binary Template dialog, click **New Field**, and enter the following information in the New Field dialog:

- **Field Name:** `data` (or a name of your choosing)
- **Type:** `Byte (unsigned 8-bits)`
- **Number of Dimensions:** `3`
- **1st Dimension Size:** `80`

- **2nd Dimension Size:** `100`
- **3rd Dimension Size:** `57`

Click **OK** to close the New Field dialog and the Binary Template dialog, and the image is displayed.

**Note**

For more information on using the Binary Template to import data, see “Using the BINARY_TEMPLATE Function” in Chapter 15 of the *Using IDL* manual.

Select **Operations** → **Volume** → **Isosurface**, and insert an isosurface with a value of 60, decimated to 20% of the original surface.

The following figure displays the output of this example:

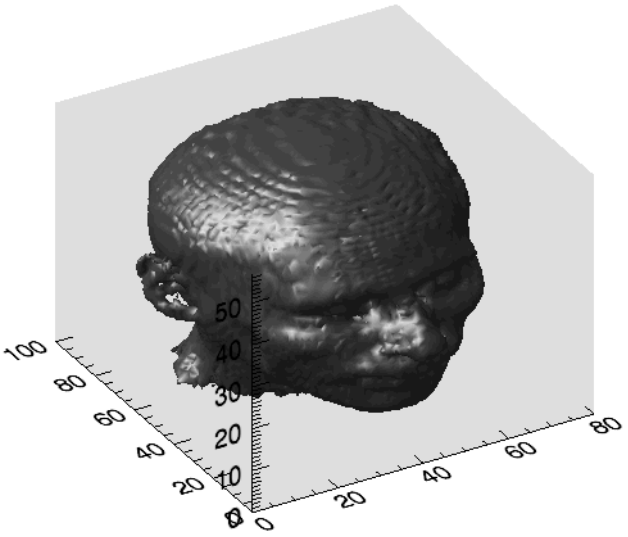



*Figure 3-20: Human Head MRI Isosurface iVolume Example*

## Example 3

This example shows how to use the **File → Import** command to load binary data into the iVolume tool.

At the IDL Command Line, enter:

```
IVOLUME
```

Select **File → Import** to display the IDL Import Data wizard.

1. At Step 1, select **From a File** and click **Next>>**.
2. At Step 2, under **File Name:**, browse to find `jet.dat` in the `examples/data` directory in the IDL distribution, and click **Next>>**.
3. At Step 3, select **Volume** and click **Finish**.

The Binary Template wizard is displayed. In the Binary Template, change **File's byte ordering** to `Little Endian`. Then, click **New Field**, and enter the following information in the New Field dialog:

- **Field Name:** `data` (or a name of your choosing)
- **Type:** `Byte (unsigned 8-bits)`
- **Number of Dimensions:** `3`
- **1st Dimension Size:** `81`
- **2nd Dimension Size:** `40`
- **3rd Dimension Size:** `101`

Click **OK** to close the New Field dialog and the Binary Template dialog, and the volume is displayed.

Select **Operations → Volume → Image Plane** to display a plane in the *x*-direction. Double-click on the plane to access its properties through the property sheet. Change the **Orientation** setting to `Z`. You can drag the image to see it at different z values by clicking on the edge of the image plane.

The following figure displays the output of this example:

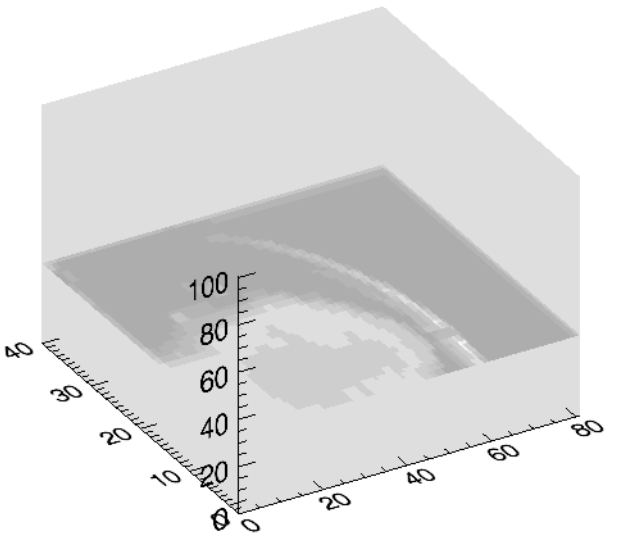



*Figure 3-21: Plasma Jet Image Plane iVolume Example*

## Example 4

This example shows how to use a second volume argument to cut away a section of the first volume argument.

First, load the MRI head data into IDL. At the IDL Command Line, enter:

```
file = FILEPATH('head.dat', SUBDIRECTORY = ['examples', 'data'])
data0 = READ_BINARY(file, DATA_DIMS = [80, 100, 57])
```

Then, create the second volume that will cut away the upper left corner of the head. At the IDL Command Line, enter:

```
data1 = BYTARR(80, 100, 57) + 1B
data1[0:39, *, 28:56] = 0B
```

Derive the color and opacity tables for the second volume. At the IDL Command Line, enter:

```
rgbTable1 = [[BYTARR(256)], [BYTARR(256)], [BYTARR(256)]]
rgbTable1[1, *] = [255, 255, 255]
opacityTable1 = BYTARR(256)
opacityTable1[1] = 255
```

Now, display the two volumes. At the IDL Command Line, enter:

```
IVOLUME, data0, data1, RGB_TABLE1 = rgbTable1, $
   OPACITY_TABLE1 = opacityTable1, /AUTO_RENDER
```

The following figure displays the output of this example:

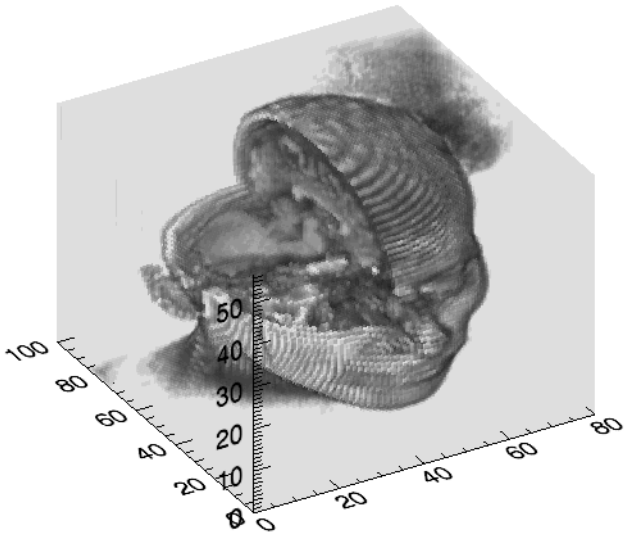



*Figure 3-22: Cut Away iVolume Example*

## Example 5

This example shows how to use all the volume arguments to display an RGB (Red, Green, Blue) volume.

First, create the volumes to contain primary colors (black, red, green, blue, yellow, cyan, magenta, and white) in each corner. At the IDL Command Line, enter:

```
vol0 = BYTARR(32, 32, 32)
vol1 = BYTARR(32, 32, 32)
vol2 = BYTARR(32, 32, 32)
vol3 = BYTARR(32, 32, 32)
vol0[0:15, *, *] = 255
vol1[*, 0:15, *] = 255
vol2[*, *, 0:15] = 255
vol3[*, *, *] = 128
```

Then, derive the color and opacity tables. At the IDL Command Line, enter:

```
rgbTable = [[BYTARR(256)], [BYTARR(256)], [BYTARR(256)]]
opacityTable = BINDGEN(256)
```

Now, display the two volumes. At the IDL Command Line, enter:

```
IVOLUME, vol0, vol1, vol2, vol3, RGB_TABLE0 = rgbTable, $
   OPACITY_TABLE0 = opacityTable, /AUTO_RENDER
```

The following figure displays the output of this example:

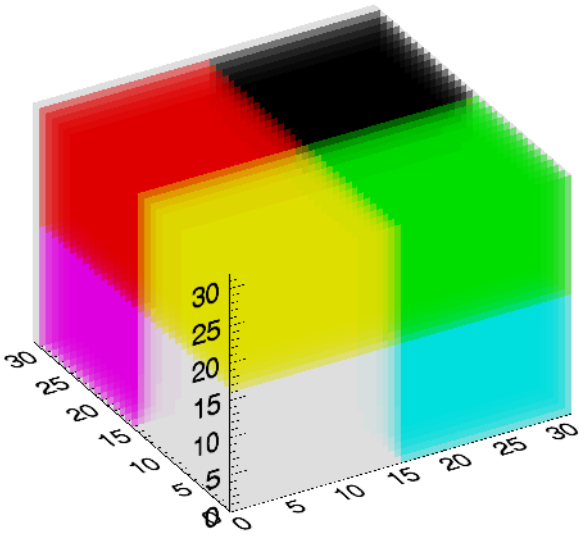



*Figure 3-23: RGB iVolume Example*

**Note**

The white corner of this example volume is actually gray to distinguish it from the white background.

## Version History

Introduced: 6.0

# JOURNAL

The JOURNAL procedure provides a record of an interactive session by saving, in a file, all text entered from the terminal in response to the IDL prompt. The first call to JOURNAL starts the logging process. The read-only system variable !JOURNAL is set to the file unit used. To stop saving commands and close the file, call JOURNAL with no parameters. If logging is in effect and JOURNAL is called with a parameter, the parameter is simply written to the journal file.

## Syntax

JOURNAL [, *Arg*]

## Arguments

### Arg

A string containing the name of the journal file to be opened or text to be written to an open journal file. If *Arg* is not supplied, and a journal file is not already open, the file `idlsave.pro` is used. Once journaling is enabled, a call to JOURNAL with *Arg* supplied causes *Arg* to be written into the journal file. Calling JOURNAL without *Arg* while journaling is in progress closes the journal file and ends the logging process.

## Keywords

None.

## Examples

To begin journaling to the file `myjournal.pro`, enter:

```
JOURNAL, 'myjournal.pro'
```

Any commands entered at the IDL prompt are recorded in the file until IDL is exited or the JOURNAL command is entered without an argument.

## Version History

Introduced: Original

## See Also

RESTORE, SAVE

# JULDAY

The JULDAY function calculates the Julian Day Number (which begins at noon) for the specified date. This is the inverse of the CALDAT procedure.

**Note**

The Julian calendar, established by Julius Caesar in the year 45 BCE, was corrected by Pope Gregory XIII in 1582, excising ten days from the calendar. The CALDAT procedure reflects the adjustment for dates after October 4, 1582. See the example below for an illustration.

**Note**

A small offset is added to the returned Julian date to eliminate roundoff errors when calculating the day fraction from hours, minutes, seconds. This offset is given by the larger of EPS and EPS*Julian, where Julian is the integer portion of the Julian date, and EPS is the EPS field from MACHAR. For typical Julian dates, this offset is approximately $6x10^{-1}$ (which corresponds to $5x10^{-5}$ seconds). This offset ensures that if the Julian date is converted back to hour, minute, and second, then the hour, minute, and second will have the same integer values as were originally input.

**Note**

Calendar dates must be in the range 1 Jan 4716 B.C.E. to 31 Dec 5000000, which corresponds to Julian values -1095 and 1827933925, respectively.

This routine is written in the IDL language. Its source code can be found in the file `julday.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = JULDAY(*Month, Day, Year, Hour, Minute, Second*)

## Return Value

*Result* is of type double-precision if Hour, Minute, or Second is specified, otherwise *Result* is of type long integer. If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of the arrays, returning an array with the same dimensions as the smallest array. If the inputs contain both scalars and arrays, the function uses the scalar value with each element of the arrays, and returns an array with the same dimensions as the smallest input array.

# Arguments

## Month

Number of the desired month (1 = January, ..., 12 = December). *Month* can be either a scalar or an array.

## Day

Number of the day of the month (1-31). *Day* can be either a scalar or an array.

## Year

Number of the desired year (e.g., 1994). *Year* can be either a scalar or an array.

## Hour

Number of the hour of the day (0-23). *Hour* can be either a scalar or an array.

## Minute

Number of the minute of the hour (0-59). *Minute* can be either a scalar or an array.

## Second

Number of the second of the minute (0-59). *Second* can be either a scalar or an array.

# Examples

In 1582, Pope Gregory XIII adjusted the Julian calendar to correct for its inaccuracy of slightly more than 11 minutes per year. As a result, the day following October 4, 1582 was October 15, 1582. JULDAY follows this convention, as illustrated by the following commands:

```
PRINT, JULDAY(10,4,1582), JULDAY(10,5,1582), JULDAY(10,15,1582)
```

IDL prints:

```
2299160    2299161    2299161
```

Using arrays, this can also be calculated as follows:

```
PRINT, JULDAY(10, [4, 5, 15], 1582)
```

If you are using JULDAY to calculate an absolute number of days elapsed, be sure to account for the Gregorian adjustment.

## Version History

Introduced: Original

## See Also

BIN_DATE, CALDAT, SYSTIME

# KEYWORD_SET

The KEYWORD_SET function returns a Boolean value based on the value of the specified expression. It returns a True (1) if its argument is defined and nonzero, and False (0) otherwise. The exact rules used to determine this are given in  below.

## Syntax

*Result* = KEYWORD_SET(*Expression*)

## Return Value

This function returns True (1) if:

- *Expression* is a scalar or 1-element array with a non-zero value.
- *Expression* is a structure.
- *Expression* is an ASSOC file variable.

KEYWORD_SET returns False (0) if:

- *Expression* is undefined.
- *Expression* is a scalar or 1-element array with a zero value.

## Arguments

### Expression

The expression to be tested. *Expression* is usually a named variable.

## Keywords

None.

## Examples

Suppose that you are writing an IDL procedure that has the following procedure definition line:

```
PRO myproc, KEYW1 = keyw1, KEYW2 = keyw2
```

The following command could be used to execute a set of commands only if the keyword KEYW1 is set (i.e., it is present and nonzero):

```
IF KEYWORD_SET(keyw1) THEN BEGIN
```

The commands to be executed only if KEYW1 is set would follow.

## Version History

Introduced: Original

## See Also

ARG_PRESENT, LOGICAL_TRUE, N_ELEMENTS, N_PARAMS

# KRIG2D

The KRIG2D function interpolates a regularly- or irregularly-gridded set of points z = *f* (*x*, *y*) using kriging.

The parameters of the data model – the range, nugget, and sill – are highly dependent upon the degree and type of spatial variation of your data, and should be determined statistically. Experimentation, or preferably rigorous analysis, is required.

For *n* data points, a system of *n*+1 simultaneous equations are solved for the coefficients of the surface. For any interpolation point, the interpolated value is:

$$f(x, y) = \sum w_i \cdot C(x_i, y_i, x, y)$$

The following formulas are used to model the variogram functions:

d(*i*,*j*) = the distance from point i to point j.

V = the variance of the samples.

C(*i*,*j*) = the covariance of sample i with sample j.

C($x_0$,$y_0$,$x_1$,$y_1$) = the covariance of point ($x_0$,$y_0$) with point ($x_1$,$y_1$).

Exponential covariance:

$$C(d) = \begin{cases} C_1 \cdot e^{(-3 \cdot d / A)} & \text{if } d \neq 0 \\ C_1 + C_0 & \text{if } d = 0 \end{cases}$$

Spherical covariance:

**Note**

The accuracy of this function is limited by the single-precision floating-point accuracy of the machine.

This routine is written in the IDL language. Its source code can be found in the file `krig2d.pro` in the `lib` subdirectory of the IDL distribution.

$$C(d) = \begin{cases} 1.0 - (1.5 \cdot d/A) + (0.5 \cdot (d/A)^3) & \text{if } d < a \\ C_1 + C_0 & \text{if } d = 0 \\ 0 & \text{if } d > a \end{cases}$$

# Syntax

*Result* = KRIG2D( *Z* [, *X*, *Y*] [, EXPONENTIAL=*vector*] [, SPHERICAL=*vector*] [, /REGULAR] [, XGRID=*[xstart, xspacing]*] [, XVALUES=*array*] [, YGRID=*[ystart, yspacing]*] [, YVALUES=*array*] [, GS=*[xspacing, yspacing]*] [, BOUNDS=*[xmin, ymin, xmax, ymax]*] [, NX=*value*] [, NY=*value*] )

# Return Value

Returns a two dimensional floating-point array containing the interpolated surface, sampled at the grid points.

# Arguments

## Z, X, Y

Arrays containing the *Z*, *X*, and *Y* coordinates of the data points on the surface. Points need not be regularly gridded. For regularly gridded input data, *X* and *Y* are not used: the grid spacing is specified via the XGRID and YGRID (or XVALUES and YVALUES) keywords, and *Z* must be a two dimensional array. For irregular grids, all three parameters must be present and have the same number of elements.

# Keywords

## Model Parameter Keywords:

## EXPONENTIAL

Set this keyword to a two- or three-element vector of model parameters [A,C0, C1] to use an exponential semivariogram model. The model parameters are as follows:

- A — The *range*. At distances beyond *A*, the semivariogram or covariance remains essentially constant.
- C0 — The *nugget*, which provides a discontinuity at the origin.
- C1 — If specified, C1 is the covariance value for a zero distance, and the variance of the random sample *z* variable. If only a two element vector is supplied, C1 is set to the sample variance. (C0 + C1) = the *sill*, which is the variogram value for very large distances.

## SPHERICAL

Set this keyword to a two- or three-element vector of model parameters [A, C0, C1] to use a spherical semivariogram model. The model parameters are as follows:

- A — The *range*. At distances beyond *A*, the semivariogram or covariance remains essentially constant.
- C0 — The *nugget*, which provides a discontinuity at the origin.
- C1 — If specified, C1 is the covariance value for a zero distance, and the variance of the random sample *z* variable. If only a two element vector is supplied, C1 is set to the sample variance. (C0 + C1) = the *sill*, which is the variogram value for very large distances.

## Input Grid Keywords:

## REGULAR

If set, the *Z* parameter is a two dimensional array of dimensions (*n*,*m*), containing measurements over a regular grid. If any of XGRID, YGRID, XVALUES, or YVALUES are specified, REGULAR is implied. REGULAR is also implied if there is only one parameter, *Z*. If REGULAR is set, and no grid specifications are present, the grid is set to (0, 1, 2, ...).

## XGRID

A two-element array, [*xstart*, *xspacing*], defining the input grid in the *x* direction. Do not specify both XGRID and XVALUES.

## XVALUES

An *n*-element array defining the *x* locations of Z[*i*,*j*]. Do not specify both XGRID and XVALUES.

### YGRID

A two-element array, [*ystart, yspacing*], defining the input grid in the *y* direction. Do not specify both YGRID and YVALUES.

### YVALUES

An *n*-element array defining the *y* locations of Z[*i*,*j*]. Do not specify both YGRID and YVALUES.

### Output Grid Keywords:

### BOUNDS

If present, BOUNDS must be a four-element array containing the grid limits in *x* and *y* of the output grid: [*xmin, ymin, xmax, ymax*]. If not specified, the grid limits are set to the extent of *x* and *y*.

### GS

The output grid spacing. If present, GS must be a two-element vector [*xs, ys*], where *xs* is the horizontal spacing between grid points and *ys* is the vertical spacing. The default is based on the extents of *x* and *y*. If the grid starts at *x* value *xmin* and ends at *xmax*, then the default horizontal spacing is (*xmax* - *xmin*)/(NX-1). *ys* is computed in the same way. The default grid size, if neither NX or NY are specified, is 26 by 26.

### NX

The output grid size in the *x* direction. NX need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

### NY

The output grid size in the *y* direction. NY need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

## Examples

```
; Make a random set of points that lie on a Gaussian:
N = 15
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; The Gaussian:
Z = EXP(-2 * ((X-.5)^2 + (Y-.5)^2))
```

```
; Get a 26 by 26 grid over the rectangle bounding x and y:
; Range is 0.25 and nugget is 0. These numbers are dependent on
; your data model:
E = [ 0.25, 0.0]

; Get the surface:
R = KRIG2D(Z, X, Y, EXPON = E)
```

Alternatively, get a surface over the unit square, with spacing of 0.05:

```
R = KRIG2D(Z, X, Y, EXPON=E, GS=[0.05, 0.05], BOUNDS=[0,0,1,1])
```

## Version History

Introduced: Pre 4.0

## See Also

BILINEAR, INTERPOLATE

# KURTOSIS

The KURTOSIS function computes the statistical kurtosis of an *n*-element vector. Kurtosis is defined as the degree to which a statistical frequency curve is peaked. KURTOSIS calls the IDL function MOMENT.

**Note**

KURTOSIS subtracts 3 from the raw kurtosis value since 3 is the kurtosis for a Gaussian (normal) distribution. For resulting values, positive values of the kurtosis (leptokurtic) indicate pointed or peaked distributions. Negative values (platykurtic) indicate flattened or non-peaked distributions.

## Syntax

*Result* = KURTOSIS(*X* [, /DOUBLE] [, /NAN] )

## Return Value

Returns the floating point or double precision statistical kurtosis. If the variance of the vector is zero, the kurtosis is not defined, and KURTOSIS returns !VALUES.F_NAN as the result.

## Arguments

### X

An *n*-element, floating-point or double-precision vector.

## Keywords

### DOUBLE

If this keyword is set, computations are performed in double precision arithmetic.

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See “Special Floating-Point Values” in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## Examples

```
; Define the n-element vector of sample data:
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]
; Compute the kurtosis:
result = KURTOSIS(x)
; Print the result:
PRINT, result
```

IDL prints

```
-1.18258
```

## Version History

Introduced: 5.1

## See Also

MEAN, MEANABSDEV, MOMENT, STDDEV, SKEWNESS, VARIANCE

# KW_TEST

The KW_TEST function tests the hypothesis that three or more sample populations have the same mean of distribution against the hypothesis that they differ. The populations may be of equal or unequal lengths. The output is a vector containing the test statistic, H, and value indicating the probability of obtaining a value equal to or greater than H from a Chi-square distribution.

This test is an extension of the Rank Sum Test implemented in the RS_TEST function. When each sample population contains at least five observations, the H test statistic is approximated very well by a Chi-square distribution with DF degrees of freedom. The hypothesis that three of more sample populations have the same mean of distribution is rejected if two or more populations differ with statistical significance. This type of test is often referred to as the Kruskal-Wallis H-Test.

The test statistic H is defined as follows:

$$H = \frac{12}{N_T(N_T + 1)} \sum_{i=0}^{M-1} \frac{R_i^2}{N_i} - 3(N_T + 1)$$

where $N_i$ is the number of observations in the $i^{th}$ sample population, $N_T$ is the total number of observations in all sample populations, and $R_i$ is the overall rank sum of the $i^{th}$ sample population.

This routine is written in the IDL language. Its source code can be found in the file `kw_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = KW_TEST( *X* [, DF=*variable*] [, MISSING=*nonzero_value*] )

## Return Value

The result is a two-element vector containing the test statistic H and the one-tailed probability of obtaining a value of H or greater from a Chi-square distribution.

# Arguments

## X

An integer, single-, or double-precision floating-point array of *m*-columns (with $m \geq 3$) and *n*-rows. The columns of this two-dimensional array correspond to the sample populations.

If the sample populations are of unequal length, any columns of *X* that are shorter than the longest column must be “filled in” by appending a user-specified missing data value. This method requires the use of the MISSING keyword. See the *Example* section below for an example of this case.

# Keywords

## DF

Use this keyword to specify a named variable that will contain the number of degrees of freedom used to compute the probability of obtaining a value of H or greater from the corresponding Chi-square distribution

## MISSING

Set this keyword equal to a non-zero numeric value that has been appended to some columns of *X* to make them all a common length of *n*.

# Examples

Test the hypothesis that three sample populations have the same mean of distribution against the hypothesis that they differ at the 0.05 significance level. Assume we have the following sample populations:

sp0 = [24.0, 16.7, 22.8, 19.8, 18.9]

sp1 = [23.2, 19.8, 18.1, 17.6, 20.2, 17.8]

sp2 = [18.2, 19.1, 17.3, 17.3, 19.7, 18.9, 18.8, 19.3]

Since the sample populations are of unequal lengths, a missing value must be appended to sp0 and sp1. In this example the missing value is -1.0 and the 3-column, 8-row input array `X` is defined as:

```
X = [[24.0, 23.2, 18.2], $
     [16.7, 19.8, 19.1], $
     [22.8, 18.1, 17.3], $
     [19.8, 17.6, 17.3], $
```

```
        [18.9, 20.2, 19.7], $
        [-1.0, 17.8, 18.9], $
        [-1.0, -1.0, 18.8], $
        [-1.0, -1.0, 19.3]]
PRINT, KW_TEST(X, MISSING = -1)
```

IDL prints:

```
[1.65862, 0.436351]
```

The computed probability (0.436351) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that the three sample populations sp0, sp1, and sp2 have the same mean of distribution.

## Version History

Introduced: 4.0

## See Also

FV_TEST, RS_TEST, S_TEST, TM_TEST

# L64INDGEN

The L64INDGEN function creates a 64-bit integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = L64INDGEN($D_1$ [, ..., $D_8$])

## Return Value

The return value is the specified 64-bit integer array.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create L, a 10-element by 10-element 64-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
L = L64INDGEN(10, 10)
```

## Version History

Introduced: 5.2

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# LA_CHOLDC

The LA_CHOLDC procedure computes the Cholesky factorization of an *n*-by-*n* symmetric (or Hermitian) positive-definite array as:

If A is real: $A = U^T U$ *or* $A = L L^T$

If A is complex: $A = U^H U$ *or* $A = L L^H$

where *U* and *L* are upper and lower triangular arrays. The *T* represents the transpose while *H* represents the Hermitian, or transpose complex conjugate.

LA_CHOLDC is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | spotrf |
| Double | dpotrf |
| Complex | cpotrf |
| Double complex | zpotrf |

*Table 31: LAPACK Routine Basis for LA_CHOLDC*

For more details, see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

LA_CHOLDC, *Array* [, /DOUBLE] [, STATUS=*variable*] [, /UPPER]

## Arguments

### Array

A named variable containing the real or complex array to be factorized. Only the lower triangular portion of *Array* is used (or upper if the UPPER keyword is set). This procedure returns *Array* as a lower triangular array from the Cholesky decomposition (upper triangular if the UPPER keyword is set).

# Keywords

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE = 0.

## STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: The array is not positive definite and the factorization could not be completed. The STATUS value specifies the order of the leading minor which is not positive definite.

**Note**

If STATUS is not specified, any error messages will output to the screen.

## UPPER

If this keyword is set, then only the upper triangular portion of *Array* is used, and the upper triangular array is returned. The default is to use the lower triangular portion and to return the lower triangular array.

# Examples

The following example program computes the Cholesky decomposition of a given symmetric positive-definite array:

```
PRO ExLA_CHOLDC
; Create a symmetric positive-definite array.
n = 10
seed = 12321
array = RANDOMU(seed, n, n)
array = array ## TRANSPOSE(Array)

; Compute the Cholesky decomposition.
lower = array    ; make a copy
LA_CHOLDC, lower
```

```
; Zero out the upper triangular portion.
for i = 0,n - 2 Do lower[i+1:*,i] = 0

; Reconstruct the array and check the difference
arecon = lower ## TRANSPOSE(lower)
PRINT, 'LA_CHOLDC Error:', MAX(ABS(arecon - array))
END
```

When this program is compiled and run, IDL prints:

```
LA_CHOLDC Error:
4.76837e-007
```

## Version History

Introduced 5.6

## See Also

CHOLDC, LA_CHOLMPROVE, LA_CHOLSOL

# LA_CHOLMPROVE

The LA_CHOLMPROVE function uses Cholesky factorization to improve the solution to a system of linear equations, *AX* = *B* (where *A* is symmetric or Hermitian), and provides optional error bounds and backward error estimates.

The LA_CHOLMPROVE function may also be used to improve the solutions for multiple systems of linear equations, with each column of *B* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the improved solution vector for that set of equations.

LA_CHOLMPROVE is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sporfs |
| Double | dporfs |
| Complex | cporfs |
| Double complex | zporfs |

*Table 32: LAPACK Routine Basis for LA_CHOLMPROVE*

For more details, see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_CHOLMPROVE( *Array*, *Achol*, *B*, *X*
[, BACKWARD_ERROR=*variable*] [, /DOUBLE]
[, FORWARD_ERROR=*variable*] [, /UPPER] )

## Return Value

The result is an *n*-element vector or *k*-by-*n* array.

## Arguments

### Array

The original *n*-by-*n* array of the linear system *AX* = *B*.

### Achol

The *n*-by-*n* Cholesky factorization of *Array*, created by the LA_CHOLDC procedure.

### B

An *n*-element input vector containing the right-hand side of the linear system, or a *k*-by-*n* array, where each of the *k* columns represents a different linear system.

### X

An *n*-element input vector, or a *k*-by-*n* array, containing the approximate solutions to the linear system, created by the LA_CHOLSOL function.

## Keywords

### BACKWARD_ERROR

Set this keyword to a named variable that will contain the relative backward error estimate for each linear system. If *B* is a vector containing a single linear system, then BACKWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems, then BACKWARD_ERROR will be a *k*-element vector. The backward error is the smallest relative change in any element of *A* or *B* that makes *X* an exact solution.

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE = 0.

### FORWARD_ERROR

Set this keyword to a named variable that will contain the estimated forward error bound for each linear system. If *B* is a vector containing a single linear system, then FORWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems, then FORWARD_ERROR will be a *k*-element vector. For each linear system, if *Xtrue* is the true solution corresponding to *X*, then the forward error is an estimated upper bound for the magnitude of the largest element in (*X* - *Xtrue*) divided by the magnitude of the largest element in *X*.

### UPPER

Set this keyword if *A* contains the upper triangular array, rather than the lower triangular array.

**Note**

If the UPPER keyword is set in LA_CHOLDC and LA_CHOLSOL then the UPPER keyword must also be set in LA_CHOLMPROVE.

## Examples

The following example program computes an improved solution to a set of 10 equations:

```
PRO ExLA_CHOLMPROVE
; Create a symmetric positive-definite array.
n = 10
seed = 12321
a = RANDOMU(seed, n, n, /DOUBLE)
a = a ## TRANSPOSE(a)

; Create the right-hand side vector b:
b = RANDOMU(seed, n, /DOUBLE)

; Compute the Cholesky decomposition.
achol = a    ; make a copy
LA_CHOLDC, achol

; Compute the first approximation to the solution:
x = LA_CHOLSOL(achol, b)

; Improve the solution and print the error estimate:
xmprove = LA_CHOLMPROVE(a, achol, b, x, $
     FORWARD_ERROR = fError)
PRINT, 'LA_CHOLMPROVE error:', $
     MAX(ABS(a ## xmprove - b))
PRINT, 'LA_CHOLMPROVE Error Estimate:', fError
END
```

When this program is compiled and run, IDL prints:

```
LA_CHOLMPROVE error:   3.9412917e-15
LA_CHOLMPROVE error estimate:   5.1265892e-12
```

## Version History

Introduced 5.6

## See Also

LA_CHOLDC, LA_CHOLSOL

# LA_CHOLSOL

The LA_CHOLSOL function is used in conjunction with the LA_CHOLDC to solve a set of *n* linear equations in *n* unknowns, *AX* = *B*, where *A* must be a symmetric (or Hermitian) positive-definite array. The parameter *A* is input not as the original array, but as its Cholesky decomposition, created by the routine LA_CHOLDC.

The LA_CHOLSOL function may also be used to solve for multiple systems of linear equations, with each column of *B* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the solution vector for that set of equations.

LA_CHOLSOL is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | spotrs |
| Double | dpotrs |
| Complex | cpotrs |
| Double complex | zpotrs |

*Table 33: LAPACK Routine Basis for LA_CHOLSOL*

For more details, see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_CHOLSOL( *A*, *B* [, /DOUBLE] [, /UPPER] )

## Return Value

The result is an *n*-element vector or *k*-by-*n* array.

## Arguments

### A

The *n*-by-*n* Cholesky factorization of an array, created by the LA_CHOLDC procedure.

### B

An *n*-element input vector containing the right-hand side of the linear system, or a *k*-by-*n* array, where each of the *k* columns represents a different linear system.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

### UPPER

Set this keyword if *A* contains the upper triangular array, rather than the lower triangular array.

**Note**

If the UPPER keyword is set in the LA_CHOLDC then the UPPER keyword must also be set in LA_CHOLSOL.

## Examples

Given the following system of equations:

$$6u + 15v + 55w = 9.5$$

$$15u + 55v + 225w = 50$$

$$55u + 225v + 979w = 237$$

The solution can be derived by using the following program:

```
PRO ExLA_CHOLSOL
; Define the coefficient array:
a =  [[6.0, 15.0, 55.0], $
     [15.0, 55.0, 225.0], $
     [55.0, 225.0, 979.0]]

; Define the right-hand side vector b:
b = [9.5, 50.0, 237.0]

; Compute the Cholesky decomposition of a:
achol = a    ; make a copy
```

```
LA_CHOLDC, achol

; Compute and print the solution:
x = LA_CHOLSOL(achol, b)
PRINT, 'LA_CHOLSOL solution:', x
END
```

When this program is compiled and run, IDL prints:

```
LA_CHOLSOL Solution:
-0.499999     -1.00000     0.500000
```

The exact solution vector is [-0.5, -1.0, 0.5].

## Version History

Introduced 5.6

## See Also

CHOLSOL, LA_CHOLDC, LA_CHOLMPROVE

# LA_DETERM

The LA_DETERM function uses LU decomposition to compute the determinant of a square array.

This routine is written in the IDL language. Its source code can be found in the file `la_determ.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LA_DETERM( *A* [, /CHECK] [, /DOUBLE] [, ZERO=*value*] )

## Return Value

The result is a scalar of the same type as the input array.

## Arguments

### A

An *n*-by-*n* real or complex array.

## Keywords

### CHECK

Set this keyword to check *A* for any singularities. The determinant of a singular array is returned as zero if this keyword is set. Run-time errors may result if *A* is singular and this keyword is not set.

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

### ZERO

Use this keyword to set the absolute value of the floating-point zero. A floating-point zero on the main diagonal of a triangular array results in a zero determinant. For single-precision inputs, the default value is $1.0 \times 10^{-6}$. For double-precision inputs,

the default value is 1.0 x $10^{-12}$. Setting this keyword to a value less than the default may improve the precision of the result.

## Examples

The following program computes the determinant of a square array:

```
PRO ExLA_DETERM
; Create a square array.
array =[[1d, 2, 1], $
     [4, 10, 15], $
     [3, 7, 1]]
; Compute the determinant.
adeterm = LA_DETERM(array)
PRINT, 'LA_DETERM:', adeterm
END
```

When this program is compiled and run, IDL prints:

```
A_DETERM:
-15.000000
```

## Version History

Introduced 5.6

## See Also

DETERM, LA_LUDC

# LA_EIGENPROBLEM

The LA_EIGENPROBLEM function uses the QR algorithm to compute all eigenvalues λ and eigenvectors $v \neq 0$ of an *n*-by-*n* real nonsymmetric or complex non-Hermitian array *A*, for the eigenproblem $Av = \lambda v$. The routine can also compute the left eigenvectors $u \neq 0$, which satisfy $u^H A = \lambda u^H$.

LA_EIGENPROBLEM may also be used for the generalized eigenproblem:

$$Av = \lambda Bv \text{ and } u^H A = \lambda u^H B$$

where *A* and *B* are square arrays, *v* are the right eigenvectors, and *u* are the left eigenvectors.

LA_EIGENPROBLEM is based on the following LAPACK routines:

| Output Type | Standard LAPACK Routine | Generalized LAPACK Routine |
|---|---|---|
| Float | sgeevx | sggevx |
| Double | dgeevx | dggevx |
| Complex | cgeevx | cggevx |
| Double complex | zgeevx | zggevx |

*Table 34: LAPACK Routine Basis for LA_EIGENPROBLEM*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_EIGENPROBLEM( *A* [, *B*] [, ALPHA=*variable*] [, BALANCE=*value*] [, BETA=*variable*] [, /DOUBLE] [, EIGENVECTORS=*variable*] [, LEFT_EIGENVECTORS=*variable*] [, NORM_BALANCE = *variable*] [, PERMUTE_RESULT=*variable*] [, SCALE_RESULT=*variable*] [, RCOND_VALUE=*variable*] [, RCOND_VECTOR=*variable*] [, STATUS=*variable*] )

## Return Value

The result is a complex *n*-element vector containing the eigenvalues.

# Arguments

## A

The real or complex array for which to compute eigenvalues and eigenvectors.

## B

An optional real or complex *n*-by-*n* array used for the generalized eigenproblem. The elements of *B* are converted to the same type as *A* before computation.

# Keywords

## ALPHA

For the generalized eigenproblem with the *B* argument, set this keyword to a named variable in which the numerator of the eigenvalues will be returned as a complex *n* -element vector. For the standard eigenproblem this keyword is ignored.

**Tip**

The ALPHA and BETA values are useful for eigenvalues which underflow or overflow. In this case the eigenvalue problem may be rewritten as $\alpha Av = \beta Bv$.

## BALANCE

Set this keyword to one of the following values:

- BALANCE = 0: No balancing is applied to *A*.
- BALANCE = 1: Both permutation and scale balancing are performed.
- BALANCE = 2: Permutations are performed to make the array more nearly upper triangular.
- BALANCE = 3: Diagonally scale the array to make the columns and rows more equal in norm.

The default is BALANCE = 1, which performs both permutation and scaling balances. Balancing a nonsymmetric (or non-Hermitian) array is recommended to reduce the sensitivity of eigenvalues to rounding errors.

## BETA

For the generalized eigenproblem with the *B* argument, set this keyword to a named variable in which the denominator of the eigenvalues will be returned as a real or complex *n*-element vector. For the standard eigenproblem this keyword is ignored.

**Tip**

The ALPHA and BETA values are useful for eigenvalues which underflow or overflow. In this case, the eigenvalue problem may be rewritten as $\alpha Av = \beta Bv$.

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

## EIGENVECTORS

Set this keyword to a named variable in which the eigenvectors will be returned as a set of row vectors. If this variable is omitted then eigenvectors will not be computed unless the RCOND_VALUE or RCOND_VECTOR keywords are present.

**Note**

For the standard eigenproblem the eigenvectors are normalized and rotated to have norm 1 and largest component real. For the generalized eigenproblem the eigenvectors are normalized so that the largest component has abs(real) + abs(imaginary) = 1.

## LEFT_EIGENVECTORS

Set this keyword to a named variable in which the left eigenvectors will be returned as a set of row vectors. If this variable is omitted then left eigenvectors will not be computed unless the RCOND_VALUE or RCOND_VECTOR keywords are present.

**Note**

Note - For the standard eigenproblem the eigenvectors are normalized and rotated to have norm 1 and largest component real. For the generalized eigenproblem the eigenvectors are normalized so that the largest component has abs(real) + abs(imaginary) = 1.

## NORM_BALANCE

Set this keyword to a named variable in which the one-norm of the balanced matrix will be returned. The one-norm is defined as the maximum value of the sum of absolute values of the columns. For the standard eigenproblem, this will be returned as a scalar value; for the generalized eigenproblem this will be returned as a two-element vector containing the *A* and *B* norms.

## PERMUTE_RESULT

Set this keyword to a named variable in which the result for permutation balancing will be returned as a two-element vector [*ilo*, *ihi*]. If permute balancing is not done then the values will be *ilo = 1* and *ihi = n*.

## RCOND_VALUE

Set this keyword to a named variable in which the reciprocal condition numbers for the eigenvalues will be returned as an *n*-element vector. If RCOND_VALUE is present then left and right eigenvectors must be computed.

## RCOND_VECTOR

Set this keyword to a named variable in which the reciprocal condition numbers for the eigenvectors will be returned as an *n*-element vector. If RCOND_VECTOR is present then left and right eigenvectors must be computed.

## SCALE_RESULT

Set this keyword to a named variable in which the results for permute and scale balancing will be returned. For the standard eigenproblem, this will be returned as an *n*-element vector. For the generalized eigenproblem, this will be returned as a *n*-by-2 array with the first row containing the permute and scale factors for the left side of *A* and *B* and the second row containing the factors for the right side of *A* and *B*.

## STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: The QR algorithm failed to compute all eigenvalues; no eigenvectors or condition numbers were computed. The STATUS value indicates that eigenvalues *ilo:STATUS* (starting at index 1) did not converge; all other eigenvalues converged.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

## Examples

Find the eigenvalues and eigenvectors for an array using the following program:

```
PRO ExLA_EIGENPROBLEM
; Create a random array:
n = 4
seed = 12321
array = RANDOMN(seed, n, n)

; Compute all eigenvalues and eigenvectors:
eigenvalues = LA_EIGENPROBLEM(array, $
     EIGENVECTORS = eigenvectors)
PRINT, 'LA_EIGENPROBLEM Eigenvalues:'
PRINT, eigenvalues

; Check the results using the eigenvalue equation:
maxErr = 0d
FOR i = 0, n - 1 DO BEGIN
     ; A*z = lambda*z
     alhs = array ## eigenvectors[*,i]
     arhs = eigenvalues[i]*eigenvectors[*,i]
     maxErr = maxErr > MAX(ABS(alhs - arhs))
ENDFOR
PRINT, 'LA_EIGENPROBLEM Error:', maxErr

; Now try the generalized eigenproblem:
b = IDENTITY(n) + 0.01*RANDOMN(seed, n, n)
eigenvalues = LA_EIGENPROBLEM(Array, B)
PRINT, 'LA_EIGENPROBLEM Generalized Eigenvalues:'
PRINT, EIGENVALUES
END
```

When this program is compiled and run, IDL prints:

```
LA_EIGENPROBLEM eigenvalues:
(    -0.593459,     0.566318)(    -0.593459,    -0.566318)
(      1.06216,      0.00000)(      1.61286,      0.00000)
LA_EIGENPROBLEM error:   4.0978193e-07
LA_EIGENPROBLEM generalized eigenvalues:
(    -0.574766,     0.567452)(    -0.574766,    -0.567452)
(      1.57980,      0.00000)(      1.08711,      0.00000)
```

## Version History

Introduced 5.6

## See Also

LA_EIGENVEC, LA_ELMHES, LA_HQR

# LA_EIGENQL

The LA_EIGENQL function computes selected eigenvalues λ and eigenvectors $z \neq 0$ of an *n*-by-*n* real symmetric or complex Hermitian array *A*, for the eigenproblem $Az = \lambda z$.

LA_EIGENQL may also be used for the generalized symmetric eigenproblems:

$$Az = \lambda Bz \quad \text{or} \quad ABz = \lambda z \quad \text{or} \quad BAz = \lambda z$$

where *A* and *B* are symmetric (or Hermitian) and *B* is positive definite.

LA_EIGENQL is based on the following LAPACK routines:

| Output Type | Standard Eigenproblem | Generalized |
|---|---|---|
| Float | ssyevx, ssyevr, ssyevd | ssygvx, ssygvd |
| Double | dsyevx, dsyevr, dsyevd | dsygvx, dsygvd |
| Complex | cheevx, cheevr, cheevd | chegvx, chegvd |
| Double complex | zheevx, zheevr, zheevd | zhegvx, zhegvd |

*Table 35: LAPACK Routine Basis for LA_EIGENQL*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_EIGENQL( *A* [, B] [, /DOUBLE] [, EIGENVECTORS=*variable*] [, FAILED=*variable*] [, GENERALIZED=*value*] [, METHOD=*value*] [, RANGE=*vector*] [, SEARCH_RANGE=*vector*] [, STATUS=*variable*] [, TOLERANCE=*value*] )

## Return Value

The result is a real vector containing the eigenvalues in ascending order.

# Arguments

## A

The real or complex *n*-by-*n* array for which to compute eigenvalues and eigenvectors. A must be symmetric (or Hermitian).

## B

An optional real or complex *n*-by-*n* array used for the generalized eigenproblem. *B* must be symmetric (or Hermitian) and positive definite. The elements of *B* are converted to the same type as *A* before computation.

# Keywords

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

## EIGENVECTORS

Set this keyword to a named variable in which the eigenvectors will be returned as a set of row vectors. If this variable is omitted then eigenvectors will not be computed. All eigenvectors will be returned unless the RANGE or SEARCH_RANGE keywords are used to restrict the eigenvalue range.

## FAILED

Set this keyword to a named variable in which to return the indices of eigenvectors that did not converge. This keyword is only available for METHOD = 0, and will be ignored for other methods.

**Note**

Index numbers within FAILED start at 1.

## GENERALIZED

For the generalized eigenproblem with the optional B argument, set this keyword to indicate which problem to solve. Possible values are:

- GENERALIZED = 0 (the default): Solve $Az = \lambda Bz$.

- GENERALIZED = 1: Solve $ABz = \lambda z$.
- GENERALIZED = 2: Solve $BAz = \lambda z$.

This keyword is ignored if argument *B* is not present.

## METHOD

Set this keyword to indicate which computation method to use. Possible values are:

- METHOD = 0 (the default): Use tridiagonal decomposition to compute some or all of the eigenvalues and (optionally) eigenvectors.
- METHOD = 1: Use the Relatively Robust Representation (RRR) algorithm to compute some or all of the eigenvalues and (optionally) eigenvectors. This method is unavailable for the generalized eigenproblem with the optional *B* argument, and will default to METHOD = 0.

**Note**

The RRR method may produce *NaN* and *Infinity* floating-point exception messages during normal execution.

- METHOD = 2: Use a divide-and-conquer algorithm to compute all of the eigenvalues and (optionally) all eigenvectors. This method is available for either the standard or generalized eigenproblems. For METHOD = 2 the RANGE, SEARCH_RANGE, and TOLERANCE keywords are ignored, and all eigenvalues are returned.

## RANGE

Set this keyword to a two-element vector containing the indices of the smallest and largest eigenvalues to be returned. The default is [0, *n*-1], which returns all eigenvalues and eigenvectors. This keyword is ignored for METHOD = 2.

## SEARCH_RANGE

Set this keyword to a two-element floating-point vector containing the lower and upper bounds of the interval to be searched for eigenvalues. The default is to return all eigenvalues and eigenvectors. This keyword is ignored for METHOD = 2. If both RANGE and SEARCH_RANGE are specified, only the SEARCH_RANGE values are used.

**Note**

If the search range does not contain any eigenvalues, then Result, EIGENVECTORS, and FAILED will each be set to a scalar zero.

## STATUS

Set this keyword to a named variable that will contain the status of the computation. In all cases STATUS = 0 indicates successful computation. For the standard eigenproblem, possible nonzero values are:

- METHOD = 0, STATUS > 0: STATUS eigenvectors failed to converge. The FAILED keyword contains the indices of the eigenvectors that did not converge.
- METHOD = 1, STATUS < 0 or STATUS > 0: An internal error occurred during the computation.
- METHOD = 2, STATUS > 0: STATUS off-diagonal elements of an intermediate tridiagonal matrix did not converge to zero.

For the generalized eigenproblem, possible nonzero values are:

- METHOD = 0, 0 < STATUS ≤ *n*: STATUS eigenvectors failed to converge. The FAILED keyword contains the indices of the eigenvectors that did not converge.
- METHOD = 0, STATUS > *n*: The factorization of *B* could not be completed and the computation failed. The value of (STATUS - *n*) specifies the order of the leading minor of *B* which is not positive definite.
- METHOD = 2, 0 < STATUS ≤ *n*: STATUS off-diagonal elements of an intermediate tridiagonal matrix did not converge to zero.
- METHOD = 2, STATUS > *n*: The factorization of *B* could not be completed and the computation failed. The value of (STATUS - *n*) specifies the order of the leading minor of *B* which is not positive definite.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

## TOLERANCE

Set this keyword to a scalar giving the absolute error tolerance for the eigenvalues and eigenvectors. For the most accurate eigenvalues, TOLERANCE should be set to 2**XMIN*, where *XMIN* is the magnitude of the smallest usable floating-point value. For METHOD = 0, if TOLERANCE is less than or equal to zero, or is unspecified, then a tolerance value of $EPS*||T||_1$ will be used, where T is the tridiagonal matrix obtained from A. For METHOD = 1, if TOLERANCE is less than or equal to $N*EPS*||T||_1$, or is unspecified, then a tolerance value of $N*EPS*||T||_1$ will be used.

For values of *EPS* and *XMIN*, see the MACHAR. This keyword is ignored for METHOD = 2.

**Tip**

If the LA_EIGENQL routine fails to converge, try setting the TOLERANCE to a larger value.

## Examples

Find the eigenvalues and eigenvectors for a symmetric array using the following program:

```
PRO ExLA_EIGENQL
; Create a random symmetric array:
n = 10
seed = 12321
array = RANDOMN(seed, n, n)
array = array + TRANSPOSE(array)

; Compute all eigenvalues and eigenvectors:
eigenvalues = LA_EIGENQL(array, $
     EIGENVECTORS=eigenvectors)

; Check the results using the eigenvalue equation:
maxErr = 0d
FOR i=0,n-1 DO BEGIN
      ; a*z = lambda*z
      alhs = array ## eigenvectors[*,i]
      arhs = eigenvalues[i]*eigenvectors[*,i]
      maxErr = maxErr > MAX(ABS(alhs - arhs))
ENDFOR
PRINT, 'LA_EIGENQL error:', maxErr

; Compute the three largest eigenvalues:
eigenvalues = LA_EIGENQL(array, $
     EIGENVECTORS = eigenvectors, $
     RANGE = [n-3,n-1])
PRINT, 'LA_EIGENQL eigenvalues:', eigenvalues

; Now try the generalized eigenproblem:
b = IDENTITY(n) + 0.01*RANDOMN(seed,n,n)
; Make B symmetric and positive definite:
b = b ## TRANSPOSE(b)

; Compute the three largest generalized eigenvalues:
eigenvalues = LA_EIGENQL(array, b, RANGE=[n-3,n-1])
PRINT, 'LA_EIGENQL Generalized Eigenvalues:'
```

```
PRINT, Eigenvalues
END
```

When this program is compiled and run, IDL prints:

```
LA_EIGENQL error:   1.3560057e-06
LA_EIGENQL eigenvalues:      3.82993      4.69785      5.61567
LA_EIGENQL generalized eigenvalues:
3.83750      4.74803      5.57692
```

## Version History

Introduced 5.6

## See Also

EIGENQL, LA_TRIQL, LA_TRIRED

# LA_EIGENVEC

The LA_EIGENVEC function uses the QR algorithm to compute all or some of the eigenvectors $v \neq 0$ of an $n$-by-$n$ real nonsymmetric or complex non-Hermitian array $A$, for the eigenproblem $Av = \lambda v$. The routine can also compute the left eigenvectors $u \neq 0$, which satisfy $u^H A = \lambda u^H$.

**Note**

The left and right eigenvectors returned by LA_EIGENVEC are normalized to norm 1. Unlike the LA_EIGENPROBLEM, they are not rotated to have largest component real. Therefore, you may notice slight differences in results between LA_EIGENVEC and LA_EIGENPROBLEM.

LA_EIGENVEC is based on the following LAPACK routines:

| Output Type | Eigenvectors | Condition Numbers | Undo Balancing |
|---|---|---|---|
| Float | strevc | strsna | sgebak |
| Double | dtrevc | dtrsna | dgebak |
| Complex | ctrevc | ctrsna | cgebak |
| Double complex | ztrevc | ztrsna | zgebak |

*Table 36: LAPACK Routine Basis for LA_EIGENVEC*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_EIGENVEC( *T*, *QZ* [, BALANCE=*value*] [, /DOUBLE]
[, EIGENINDEX=*variable*] [, LEFT_EIGENVECTORS=*variable*]
[, PERMUTE_RESULT=[*ilo*, *ihi*]] [, SCALE_RESULT=*vector*]
[, RCOND_VALUE=*variable*] [, RCOND_VECTOR=*variable*] [, SELECT=*vector*])

## Return Value

The result is a complex array containing the eigenvectors as a set of row vectors.

# Arguments

## T

The upper quasi-triangular array containing the Schur form, created by LA_HQR.

## QZ

The array of Schur vectors, created by LA_HQR.

# Keywords

## BALANCE

If balancing was applied in the call to LA_ELMHES, then set this keyword to the same value that was used, in order to apply the backward balancing transform to the eigenvectors. If BALANCE is not specified, then the default is BALANCE = 1.

**Note**

If BALANCE is not zero, then both PERMUTE_RESULT and SCALE_RESULT must be supplied.

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *T* is double precision, otherwise the default is DOUBLE = 0.

## EIGENINDEX

If keyword SELECT is used, then set this keyword to a named variable in which the indices of the eigenvalues that correspond to the selected eigenvectors will be returned. If the SELECT keyword is not used then EIGENINDEX will be set to LINDGEN(*n*).

**Tip**

This keyword is most useful for real input arrays when the SELECT keyword is present. In this case, a value of SELECT[*j*] equal to 1 may produce two eigenvectors if the eigenvalue is part of a complex-conjugate pair.

## LEFT_EIGENVECTORS

Set this keyword to a named variable in which the left eigenvectors will be returned as a set of row vectors. If this variable is omitted then left eigenvectors will not be computed unless the RCOND_VALUE keyword is present.

## PERMUTE_RESULT

Set this keyword to a two-element vector containing the [*ilo*, *ihi*] permutation results from the LA_ELMHES procedure. This keyword must be present if BALANCE = 1 or BALANCE = 2.

## RCOND_VALUE

Set this keyword to a named variable in which the reciprocal condition numbers for the eigenvalues will be returned as an *n*-element vector. If RCOND_VALUE is present then left and right eigenvectors must be computed.

## RCOND_VECTOR

Set this keyword to a named variable in which the reciprocal condition numbers for the eigenvectors will be returned as an *n*-element vector.

## SCALE_RESULT

Set this keyword to an n-element vector containing the permute and scale balancing results from the LA_ELMHES procedure. This keyword must be present if BALANCE is not zero.

## SELECT

Set this keyword to an *n*-element vector of zeroes or ones that indicates which eigenvectors to compute. There are two cases:

- The original array was real: If the *j*-th eigenvalue (as created by LA_HQR) is real, then if SELECT[*j*] is set to 1, then the *j*-th eigenvector will be computed. If the *j*-th and (*j*+1) eigenvalues form a complex-conjugate pair, then if either SELECT[*j*] or SELECT[*j*+1] is set to 1, then the complex-conjugate pair of *j*-th and (*j*+1) eigenvectors will be computed.
- The original array was complex: If SELECT[*j*] is set to 1, then the *j*-th eigenvector will be computed.

If SELECT is omitted then all eigenvectors are returned.

# Examples

Compute the eigenvalues and selected eigenvectors of a random array using the following program:

```
PRO ExLA_EIGENVEC
; Create a random array:
n = 10
seed = 12321
array = RANDOMN(seed, n, n)

     ; Reduce to upper Hessenberg and compute Q:
     H = LA_ELMHES(array, q, $
     PERMUTE_RESULT = permute, SCALE_RESULT = scale)

; Compute eigenvalues, T, and QZ arrays:
eigenvalues = LA_HQR(h, q, PERMUTE_RESULT = permute)

; Compute eigenvectors corresponding to
; the first 3 eigenvalues.
select = [1, 1, 1, REPLICATE(0, n - 3)]
eigenvectors = LA_EIGENVEC(H, Q, $
     EIGENINDEX = eigenindex, $
     PERMUTE_RESULT = permute, SCALE_RESULT = scale, $
     SELECT = select)

PRINT, 'LA_EIGENVEC eigenvalues:'
PRINT, eigenvalues[eigenindex]
END
```

When this program is compiled and run, IDL prints:

```
LA_EIGENVEC eigenvalues:
(-0.278633, 2.55055) ( -0.278633, -2.55055)
(2.31208,     0.000000)
```

# Version History

Introduced 5.6

# See Also

EIGENVEC, LA_ELMHES, LA_HQR

# LA_ELMHES

The LA_ELMHES function reduces a real nonsymmetric or complex non-Hermitian array to upper Hessenberg form *H*. If the array is real then the decomposition is $A = Q\ H\ Q^T$, where *Q* is orthogonal. If the array is complex Hermitian then the decomposition is $A = Q\ H\ Q^H$, where *Q* is unitary. The superscript T represents the transpose while superscript *H* represents the Hermitian, or transpose complex conjugate.

LA_ELMHES is based on the following LAPACK routines:

| Output Type | Balance & Reduce | Norm | Optional Q |
|---|---|---|---|
| Float | sgebal, sgehrd | slange | sorghr |
| Double | dgebal, dgehrd | dlange | dorghr |
| Complex | cgebal, cgehrd | clange | cunghr |
| Double complex | zgebal, zgehrd | zlange | zunghr |

*Table 37: LAPACK Routine Basis for LA_ELMHES*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_ELMHES( *Array* [, Q] [, BALANCE=*value*] [, /DOUBLE]
[, NORM_BALANCE=*variable*] [, PERMUTE_RESULT=*variable*]
[, SCALE_RESULT=*variable*] )

## Return Value

The result is an array of the same type as *A* containing the upper Hessenberg form. The Hessenberg array is stored in the upper triangle and the first subdiagonal. Elements below the subdiagonal should be ignored but are not automatically set to zero.

# Arguments

## Array

The *n*-by-*n* real or complex array to reduce to upper Hessenberg form.

## Q

Set this optional argument to a named variable in which the array *Q* will be returned. The *Q* argument may then be input into LA_HQR to compute the Schur vectors.

# Keywords

## BALANCE

Set this keyword to one of the following values:

- BALANCE = 0: No balancing is applied to *Array.*
- BALANCE = 1: Both permutation and scale balancing are performed.
- BALANCE = 2: Permutations are performed to make the array more nearly upper triangular.
- BALANCE = 3: Diagonally scale the array to make the columns and rows more equal in norm.

The default is BALANCE = 1, which performs both permutation and scaling balances. Balancing a nonsymmetric array is recommended to reduce the sensitivity of eigenvalues to rounding errors.

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE = 0.

## NORM_BALANCE

Set this keyword to a named variable in which the one-norm of the balanced matrix will be returned. The one-norm is defined as the maximum value of the sum of absolute values of the columns.

### PERMUTE_RESULT

Set this keyword to a named variable in which the result for permutation balancing will be returned as a two-element vector [*ilo, ihi*]. If permute balancing is not done then the values will be *ilo = 1* and *ihi = n*.

### SCALE_RESULT

Set this keyword to a named variable in which the result for permute and scale balancing will be returned as an *n*-element vector.

## Examples

See LA_EIGENVEC for an example of using this procedure.

## Version History

Introduced 5.6

## See Also

ELMHES, LA_HQR

# LA_GM_LINEAR_MODEL

The LA_GM_LINEAR_MODEL function is used to solve a general Gauss-Markov linear model problem:

$$\text{minimize}_x \, ||y||_2 \text{ with constraint } d = Ax + By$$

where $A$ is an $m$-column by $n$-row array, $B$ is a $p$-column by $n$-row array, and $d$ is an $n$-element input vector with $m \le n \le m+p$.

The following items should be noted:

- If $A$ has full column rank $m$ and the array ($A$ $B$) has full row rank $n$, then there is a unique solution $x$ and a minimal 2-norm solution $y$.
- If $B$ is square and nonsingular then the problem is equivalent to a weighted linear least-squares problem, $\text{minimize}_x \, ||B^{-1}(Ax - d)||_2$.
- If $B$ is the identity matrix then the problem reduces to the ordinary linear least-squares problem, $\text{minimize}_x \, ||Ax - d||_2$.

LA_ GM_LINEAR_MODEL is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sggglm |
| Double | dggglm |
| Complex | cggglm |
| Double complex | zggglm |

*Table 38: LAPACK Routine Basis for LA_GM_LINEAR_MODEL*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_GM_LINEAR_MODEL( *A*, *B*, *D*, *Y* [, /DOUBLE] )

## Return Value

The result ($x$) is an $m$-element vector whose type is identical to $A$.

# Arguments

## A

The *m*-by-*n* array used in the constraint equation.

## B

The *p*-by-*n* array used in the constraint equation.

## D

An *n*-element input vector used in the constraint equation.

## Y

Set this argument to a named variable, which will contain the *p*-element output vector.

# Keywords

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

# Examples

Given the constraint equation $d = Ax + By$, (where *A*, *B*, and *d* are defined in the program below) the following example program solves the general Gauss-Markov problem:

```
PRO ExLA_GM_LINEAR_MODEL
; Define some example coefficient arrays:
a = [[2, 7, 4], $
     [5, 1, 3], $
     [3, 3, 6], $
     [4, 5, 2]]
b = [[-3, 2], $
     [1, 5], $
     [2, 9], $
     [4, 1]]
```

```
; Define a sample left-hand side vector D:
d = [-1, 2, -3, 4]

; Find and print the solution x:
x = LA_GM_LINEAR_MODEL(a, b, d, y)
PRINT, 'LA_GM_LINEAR_MODEL solution:'
PRINT, X
PRINT, 'LA_GM_LINEAR_MODEL 2-norm solution:'
PRINT, Y
END
```

When this program is compiled and run, IDL prints:

```
LA_GM_LINEAR_MODEL solution:
      1.04668     0.350346     -1.28445
LA_GM_LINEAR_MODEL 2-norm solution:
     0.151716    0.0235733
```

## Version History

Introduced 5.6

## See Also

LA_LEAST_SQUARE_EQUALITY, LA_LEAST_SQUARES

# LA_HQR

The LA_HQR function uses the multishift QR algorithm to compute all eigenvalues of an *n*-by-*n* upper Hessenberg array. The LA_ELMHES routine can be used to reduce a real or complex array to upper Hessenberg form suitable for input to this procedure. LA_HQR may also be used to compute the matrices *T* and *QZ* from the Schur decomposition $A = (QZ)\ T\ (QZ)^H$.

LA_HQR is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | shseqr |
| Double | dhseqr |
| Complex | chseqr |
| Double complex | zhseqr |

*Table 39: LAPACK Routine Basis for LA_HQR*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_HQR(*H* [, Q] [, /DOUBLE] [, PERMUTE_RESULT=[*ilo*, *ihi*]] [, STATUS=*variable*] )

## Return Value

The result is an *n*-element complex vector.

## Arguments

### H

An *n*-by-*n* upper Hessenberg array, created by the LA_ELMHES procedure. If argument *Q* is present, then on return *H* is replaced by the Schur form *T*. If argument *Q* is not present then *H* is unchanged.

### Q

Set this optional argument to the array *Q* created by the LA_ELMHES procedure. If argument *Q* is present, then on return *Q* is replaced by the Schur vectors *QZ*.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *H* is double precision, otherwise the default is DOUBLE = 0.

### PERMUTE_RESULT

Set this keyword to a two-element vector containing the [*ilo*, *ihi*] permutation results from the LA_ELMHES procedure. The default is [1, *n*], indicating that permute balancing was not done on *H*.

### STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: The algorithm failed to find all eigenvalues in *30**(*ihi* - *ilo* + *1*) iterations. The STATUS value indicates that eigenvalues ilo:STATUS (starting at index *1*) did not converge; all other eigenvalues converged.

**Note**

If STATUS is not specified, any error messages will output to the screen.

## Examples

See LA_EIGENVEC for an example of using this procedure.

## Version History

Introduced 5.6

## See Also

HQR, LA_EIGENVEC, LA_ELMHES

# LA_INVERT

The LA_INVERT function uses LU decomposition to compute the inverse of a square array.

LA_INVERT is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgetrf, sgetri |
| Double | dgetrf, dgetri |
| Complex | cgetrf, cgetri |
| Double complex | zgetrf, zgetri |

*Table 40: LAPACK Routine Basis for LA_INVERT*

For more details, see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_INVERT( *A* [, /DOUBLE] [, STATUS=*variable*] )

## Return Value

The result is an array of the same dimensions as the input array.

## Arguments

### A

The *n*-by-*n* array to be inverted.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

### STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: The array is singular and the inverse could not be computed. The STATUS value specifies which value along the diagonal (starting at one) is zero.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

## Examples

The following program computes the inverse of a square array:

```
PRO ExLA_INVERT
; Create a square array.
array =[[1d, 2, 1], $
     [4, 10, 15], $
     [3, 7, 1]]
; Compute the inverse and check the error.
ainv = LA_INVERT(array)
PRINT, 'LA_INVERT Identity Matrix:'
PRINT, ainv ## array
END
```

When this program is compiled and run, IDL prints:

```
A_INVERT Identity Matrix:
1.0000000   1.7763568e-015  6.6613381e-016
0.00000000  1.0000000       1.2212453e-015
0.00000000  0.00000000      1.0000000
```

## Version History

Introduced 5.6

## See Also

INVERT, LA_LUDC

# LA_LEAST_SQUARE_EQUALITY

The LA_LEAST_SQUARE_EQUALITY function is used to solve the linear least-squares problem:

$$\text{Minimize}_x \, ||Ax - c||_2 \text{ with constraint } Bx = d$$

where $A$ is an $n$-column by $m$-row array, $B$ is an $n$-column by $p$-row array, $c$ is an $m$-element input vector, and $d$ is an $p$-element input vector with $p \le n \le m+p$. If $B$ has full row rank $p$ and the array $\begin{pmatrix} A \\ B \end{pmatrix}$ has full column rank $n$, then a unique solution exists.

LA_ LEAST_SQUARE_EQUALITY is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgglse |
| Double | dgglse |
| Complex | cgglse |
| Double complex | zgglse |

*Table 41: LAPACK Routine Basis for LA_LEAST_SQUARE_EQUALITY*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_LEAST_SQUARE_EQUALITY( *A*, *B*, *C*, *D* [, /DOUBLE] [, RESIDUAL=*variable*] )

## Return Value

The result (*x*) is an *n*-element vector.

## Arguments

### A

The *n*-by-*m* array used in the least-squares minimization.

### B

The *n*-by-*p* array used in the equality constraint.

### C

An *m*-element input vector containing the right-hand side of the least-squares system.

### D

A *p*-element input vector containing the right-hand side of the equality constraint.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

### RESIDUAL

Set this keyword to a named variable in which to return a scalar giving the residual sum-of-squares for Result. If *n* = *m* + *p* then RESIDUAL will be zero.

## Examples

Given the following system of equations:

```
2t + 5u + 3v + 4w = 9
7t +  u + 3v + 5w = 1
4t + 3u + 6v + 2w = 2
```

with constraints,

```
-3t +  u + 2v + 4w = -4
 2t + 5u + 9v + 1w =  4
```

find the solution using the following program:

```
PRO ExLA_LEAST_SQUARE_EQUALITY
; Define the coefficient array:
a = [[2, 5, 3, 4], $
     [7, 1, 3, 5], $
     [4, 3, 6, 2]]
```

```
; Define the constraint array:
b = [[-3, 1, 2, 4], $
     [2, 5, 9, 1]]

; Define the right-hand side vector c:
c = [9, 1, 2]

; Define the constraint right-hand side d:
d = [-4, 4]

; Find and print the minimum norm solution of a:
x = LA_LEAST_SQUARE_EQUALITY(a, b, c, d)
PRINT, 'LA_LEAST_SQUARE_EQUALITY solution:'
PRINT, x
END
```

When this program is compiled and run, IDL prints:

```
LA_LEAST_SQUARE_EQUALITY solution:
     0.651349      2.72695     -1.14638    -0.620036
```

## Version History

Introduced 5.6

## See Also

LA_GM_LINEAR_MODEL, LA_LEAST_SQUARES

# LA_LEAST_SQUARES

The LA_LEAST_SQUARES function is used to solve the linear least-squares problem:

$$\text{Minimize}_x \, ||Ax - b||_2$$

where *A* is a (possibly rank-deficient) *n*-column by *m*-row array, *b* is an *m*-element input vector, and *x* is the *n*-element solution vector. There are three possible cases:

- If $m \geq n$ and the rank of *A* is *n*, then the system is overdetermined and a unique solution may be found, known as the least-squares solution.
- If $m < n$ and the rank of *A* is *m*, then the system is under determined and an infinite number of solutions satisfy $Ax - b = 0$. In this case, the solution is found which minimizes $||x||_2$, known as the minimum norm solution.
- If *A* is rank deficient, such that the rank of *A* is less than MIN(*m*, *n*), then the solution is found which minimizes both $||Ax - b||_2$ and $||x||_2$, known as the minimum-norm least-squares solution.

The LA_LEAST_SQUARES function may also be used to solve for multiple systems of least squares, with each column of *b* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the solution vector for that set of equations.

LA_ LEAST_SQUARES is based on the following LAPACK routines:

| Output Type | LAPACK Routines |
|---|---|
| Float | sgels, sgelsy, sgelss, sgelsd |
| Double | dgels, dgelsy, dgelss, dgelsd |
| Complex | cgels, cgelsy, cgelss, cgelsd |
| Double complex | zgels, zgelsy, zgelss, zgelsd |

*Table 42: LAPACK Routine Basis for LA_LEAST_SQUARES*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

# Syntax

*Result* = LA_LEAST_SQUARES( *A*, *B* [, /DOUBLE] [, METHOD=*value*] [, RANK=*variable*] [, RCONDITION=*value*] [, RESIDUAL=*variable*] [, STATUS=*variable*] )

# Return Value

The result is an *n*-element vector or *k*-by-*n* array.

# Arguments

## A

The *n*-by-*m* array used in the least-squares system.

## B

An *m*-element input vector containing the right-hand side of the linear least-squares system, or a *k*-by-*m* array, where each of the *k* columns represents a different least-squares system.

# Keywords

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

## METHOD

Set this keyword to indicate which computation method to use. Possible values are:

- METHOD = 0 (the default): Assume that array *A* has full rank equal to min(*m*, *n*). If $m \geq n$, find the least-squares solution to the overdetermined system. If $m < n$, find the minimum norm solution to the under determined system. Both cases use QR or LQ factorization of *A*.
- METHOD = 1: Assume that array *A* may be rank deficient; use a complete orthogonal factorization of *A* to find the minimum norm least-squares solution.

- METHOD = 2: Assume that array *A* may be rank deficient; use singular value decomposition (SVD) to find the minimum norm least-squares solution.
- METHOD = 3: Assume that array *A* may be rank deficient; use SVD with a divide-and-conquer algorithm to find the minimum norm least-squares solution. The divide-and-conquer method is faster than regular SVD, but may require more memory.

## RANK

Set this keyword to a named variable in which to return the effective rank of *A*. If METHOD = 0 or the array is full rank, then RANK will have the value MIN(*m*, *n*).

## RCONDITION

Set this keyword to the reciprocal condition number used as a cutoff value in determining the effective rank of *A*. Arrays with condition numbers larger than 1/RCONDITION are assumed to be rank deficient. If RCONDITION is set to zero or omitted, then array *A* is assumed to be of full rank. This keyword is ignored for METHOD = 0.

## RESIDUAL

If $m > n$ and the rank of *A* is *n* (the system is overdetermined), then set this keyword to a named variable in which to return the residual sum-of-squares for *Result*. If *B* is an *m*-element vector then RESIDUAL will be a scalar; if *B* is a *k*-by-*m* array then RESIDUAL will be a *k*-element vector containing the residual sum-of-squares for each system of equations. If $m \leq n$ or *A* is rank deficient (rank < *n*) then the values in RESIDUAL will be zero.

## STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: For METHOD=2 or METHOD=3, this indicates that the SVD algorithm failed to converge, and STATUS off-diagonal elements of an intermediate bidiagonal form did not converge to zero. For METHOD=0 or METHOD=1 the STATUS will always be zero.

# Examples

Given the following under determined system of equations:

```
2t + 5u + 3v + 4w = 3
7t +  u + 3v + 5w = 1
4t + 3u + 6v + 2w = 6
```

The following program can be used to find the solution:

```
PRO ExLA_LEAST_SQUARES
; Define the coefficient array:
a = [[2, 5, 3, 4], $
     [7, 1, 3, 5], $
     [4, 3, 6, 2]]

; Define the right-hand side vector b:
b = [3, 1, 6]

; Find and print the minimum norm solution of a:
x = LA_LEAST_SQUARES(a, b)
PRINT, 'LA_LEAST_SQUARES solution:', x
END
```

When this program is compiled and run, IDL prints:

```
LA_LEAST_SQUARES solution:
-0.0376844     0.350628     0.986164    -0.409066
```

# Version History

Introduced 5.6

# See Also

LA_GM_LINEAR_MODEL, LA_LEAST_SQUARE_EQUALITY

# LA_LINEAR_EQUATION

The LA_LINEAR_EQUATION function uses LU decomposition to solve a system of linear equations, *AX* = *B*, and provides optional error bounds and backward error estimates.

The LA_LINEAR_EQUATION function may also be used to solve for multiple systems of linear equations, with each column of *B* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the solution vector for that set of equations.

This routine is written in the IDL language. Its source code can be found in the file `la_linear_equation.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LA_LINEAR_EQUATION( *Array, B* [, BACKWARD_ERROR=*variable*] [, /DOUBLE] [, FORWARD_ERROR=*variable*] [, STATUS=*variable*])

## Return Value

The result is an *n*-element vector or *k*-by-*n* array.

## Arguments

### Array

The *n*-by-*n* array of the linear system *AX* = *B*.

### B

An *n*-element input vector containing the right-hand side of the linear system, or a *k*-by-*n* array, where each of the *k* columns represents a different linear system.

## Keywords

### BACKWARD_ERROR

Set this keyword to a named variable that will contain the relative backward error estimate for each linear system. If *B* is a vector containing a single linear system, then BACKWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems,

then BACKWARD_ERROR will be a *k*-element vector. The backward error is the smallest relative change in any element of *A* or *B* that makes *X* an exact solution.

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if Array is double precision, otherwise the default is DOUBLE = 0.

### FORWARD_ERROR

Set this keyword to a named variable that will contain the estimated forward error bound for each linear system. If *B* is a vector containing a single linear system, then FORWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems, then FORWARD_ERROR will be a *k*-element vector. For each linear system, if *Xtrue* is the true solution corresponding to *X*, then the forward error is an estimated upper bound for the magnitude of the largest element in (*X* - *Xtrue*) divided by the magnitude of the largest element in *X*.

### STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: The computation failed because one of the diagonal elements of the LU decomposition is zero. The STATUS value specifies which value along the diagonal (starting at one) is zero.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

## Examples

Given the system of equations:

```
4u + 16000v + 17000w = 100.1
2u +     5v +     8w = 0.1
3u +     6v +    10w = 0.01
```

The following program can be used to find the solution:

```
PRO ExLA_LINEAR_EQUATION
; Define the coefficient array:
a = [[4, 16000, 17000], $
     [2, 5, 8], $
     [3, 6, 10]]

; Define the right-hand side vector b:
b = [100.1, 0.1, 0.01]

; Compute and print the solution to ax=b:
x = LA_LINEAR_EQUATION(a, b)
PRINT, 'LA_LINEAR_EQUATION solution:', X
end
```

When this program is compiled and run, IDL prints:

```
LA_LINEAR_EQUATION solution:
-0.397432    -0.334865     0.321148
```

The exact solution to 6 decimal places is [-0.397432, -0.334865, 0.321149].

## Version History

Introduced 5.6

## See Also

LA_LUDC, LA_LUMPROVE, LA_LUSOL

# LA_LUDC

The LA_LUDC procedure computes the LU decomposition of an *n*-column by *m*-row array as:

$$A = P\ L\ U$$

where $P$ is a permutation matrix, $L$ is lower trapezoidal with unit diagonal elements (lower triangular if $n = m$), and $U$ is upper trapezoidal (upper triangular if $n = m$).

LA_LUDC is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgetrf |
| Double | dgetrf |
| Complex | cgetrf |
| Double complex | zgetrf |

*Table 43: LAPACK Routine Basis for LA_LUDC*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

LA_LUDC, *Array*, *Index* [, /DOUBLE] [, STATUS=*variable*]

## Arguments

### Array

A named variable containing the real or complex array to decompose. This procedure returns *Array* as its LU decomposition.

### Index

An output vector with MIN(*m*, *n*) elements that records the row permutations which occurred as a result of partial pivoting. For $1 < j <$ MIN(*m*,*n*), row *j* of the matrix was interchanged with row *Index*[*j*].

**Note**

Row numbers within *Index* start at one rather than zero.

# Keywords

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE = 0.

## STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: One of the diagonal elements of *U* is zero. The STATUS value specifies which value along the diagonal (starting at one) is zero.

**Note**

If STATUS is not specified, any error messages will output to the screen.

# Examples

The following example uses the LU decomposition on a given array, then determines the residual error of using the resulting lower and upper arrays to recompute the original array:

```
PRO ExLA_LUDC
; Create a random array:
n = 20
seed = 12321
array = RANDOMN(seed, n, n)

; Compute LU decomposition.
aludc = array           ; make a copy
LA_LUDC, aludc, index

; Extract the lower and upper triangular arrays.
l = IDENTITY(n)
u = FLTARR(n, n)
```

```
FOR j = 1,n - 1 DO l[0:j-1,j] = aludc[0:j-1,j]
FOR j=0,n - 1 DO u[j:*,j] = aludc[j:*,j]

; Reconstruct array, but with rows permuted.
arecon = l ## u
; Adjust from LAPACK back to IDL indexing.
Index = Index - 1
; Permute the array rows back into correct order.
; Note that we need to loop in reverse order.
FOR i = n - 1,0,-1 DO BEGIN & $
     temp = arecon[*,i]
     arecon[*, i] = arecon[*,index[i]]
     arecon[*, index[i]] = temp
ENDFOR
PRINT, 'LA_LUDC Error:', MAX(ABS(arecon - array))
END
```

When this program is compiled and run, IDL prints:

```
LA_LUDC error: 4.76837e-007
```

## Version History

Introduced 5.6

## See Also

LA_LUMPROVE, LA_LUSOL, LUDC

# LA_LUMPROVE

The LA_LUMPROVE function uses LU decomposition to improve the solution to a system of linear equations, *AX* = *B*, and provides optional error bounds and backward error estimates.

The LA_LUMPROVE function may also be used to improve the solutions for multiple systems of linear equations, with each column of *B* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the improved solution vector for that set of equations.

LA_LUMPROVE is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgerfs |
| Double | dgetrfs |
| Complex | cgetrfs |
| Double complex | zgetrfs |

*Table 44: LAPACK Routine Basis for LA_LUMPROVE*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_LUMPROVE( *Array, Aludc, Index, B, X*
[, BACKWARD_ERROR=*variable*] [, /DOUBLE]
[, FORWARD_ERROR=*variable*])

## Return Value

The result is an *n*-element vector or *k*-by-*n* array.

## Arguments

### Array

The original *n*-by-*n* array of the linear system.

### Aludc

The *n*-by-*n* LU decomposition of *Array*, created by the LA_LUDC procedure.

### Index

An *n*-element input vector, created by the LA_LUDC procedure, containing the row permutations which occurred as a result of partial pivoting.

### B

An *n*-element input vector containing the right-hand side of the linear system, or a *k*-by-*n* array, where each of the *k* columns represents a different linear system.

### X

An *n*-element input vector, or a *k*-by-*n* array, containing the approximate solutions to the linear system, created by the LA_LUSOL function.

## Keywords

### BACKWARD_ERROR

Set this keyword to a named variable that will contain the relative backward error estimate for each linear system. If *B* is a vector containing a single linear system, then BACKWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems, then BACKWARD_ERROR will be a *k*-element vector. The backward error is the smallest relative change in any element of *A* or *B* that makes *X* an exact solution.

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE = 0.

### FORWARD_ERROR

Set this keyword to a named variable that will contain the estimated forward error bound for each linear system. If *B* is a vector containing a single linear system, then FORWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems, then FORWARD_ERROR will be a *k*-element vector. For each linear system, if *Xtrue* is the true solution corresponding to *X*, then the forward error is an estimated upper

bound for the magnitude of the largest element in (*X* - *Xtrue*) divided by the magnitude of the largest element in *X*.

## Examples

The solution to a given system of equations can be derived and improved by using the following program:

```
PRO ExLA_LUMPROVE
; Define the coefficient array:
     a= [[4, 16000, 17000], $
     [2, 5, 8], $
     [3, 6, 10]]
; Compute the LU decomposition:
aludc = a
; make a copy
LA_LUDC, aludc, index

; Define the right-hand side vector B:
b = [100.1, 0.1, 0.01]
; Find the solution to Ax=b:
x = LA_LUSOL(aludc, index, b)
PRINT, 'LA_LUSOL Solution:', x

; Improve the solution:
xnew = LA_LUMPROVE(a, aludc, index, b, x)
PRINT, 'LA_LUMPROVE Solution:', xnew
END
```

When this program is compiled and run, IDL prints:

```
LA_LUSOL Solution:
-0.397355    -0.334742     0.321033
LA_LUMPROVE Solution:
-0.397432    -0.334865     0.321148
```

The exact solution to 6 decimal places is [-0.397432, -0.334865, 0.321149].

## Version History

Introduced 5.6

## See Also

LA_LUDC, LA_LUSOL, LUMPROVE

# LA_LUSOL

The LA_LUSOL function is used in conjunction with the LA_LUDC procedure to solve a set of *n* linear equations in *n* unknowns, *AX* = *B*. The parameter *A* is not the original array, but its LU decomposition, created by the routine LA_LUDC.

The LA_LUSOL function may also be used to solve for multiple systems of linear equations, with each column of *B* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the solution vector for that set of equations.

LA_LUSOL is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgetrs |
| Double | dgetrs |
| Complex | cgetrs |
| Double complex | zgetrs |

*Table 45: LAPACK Routine Basis for LA_LUSOL*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_LUSOL( *A*, *Index*, *B* [, /DOUBLE] )

## Return Value

The result is an *n*-element vector or *k*-by-*n* array.

## Arguments

### A

The *n*-by-*n* LU decomposition of an array, created by the LA_LUDC procedure.

**Note**

LA_LUSOL cannot accept any non-square output generated by LA_LUDC.

### Index

An *n*-element input vector, created by the LA_LUDC procedure, containing the row permutations which occurred as a result of partial pivoting.

### B

An *n*-element input vector containing the right-hand side of the linear system, or a *k*-by-*n* array, where each of the *k* columns represents a different linear system.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *A* is double precision, otherwise the default is DOUBLE = 0.

## Examples

Given the system of equations:

```
4u + 16000v + 17000w = 100.1
2u +     5v +     8w = 0.1
3u +     6v +    10w = 0.01
```

find the solution can be derived by using the following program:

```
PRO ExLA_LUSOL
; Define the coefficient array:
a = [[4, 16000, 17000], $
     [2, 5, 8], $
     [3, 6, 10]]
; Compute the LU decomposition:
aludc = a
; make a copy
LA_LUDC, aludc, index

; Define the right-hand side vector B:
b = [100.1, 0.1, 0.01]

; Compute and print the solution to Ax=b:
x = LA_LUSOL(aludc, index, b)
PRINT, 'LA_LUSOL Solution:', x
END
```

When this program is compiled and run, IDL prints:

```
LA_LUSOL solution:     -0.397355     -0.334742      0.321033
```

The exact solution to 6 decimal places is [-0.397432, -0.334865, 0.321149].

**Note**

UNIX users may see slightly different output results.

## Version History

Introduced 5.6

## See Also

LA_LINEAR_EQUATION, LA_LUDC, LA_LUMPROVE, LUSOL

# LA_SVD

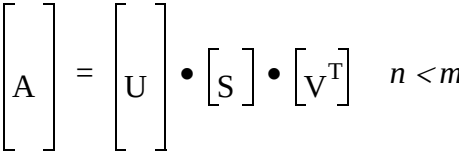
The LA_SVD procedure computes the singular value decomposition (SVD) of an *n*-columns by *m*-row array as the product of orthogonal and diagonal arrays:

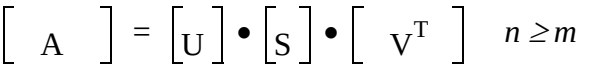
*A* is real: $A = U S V^T$

*A* is complex: $A = U S V^H$

where *U* is an orthogonal array containing the left singular vectors, *S* is a diagonal array containing the singular values, and *V* is an orthogonal array containing the right singular vectors. The superscript *T* represents the transpose while the superscript *H* represents the Hermitian, or transpose complex conjugate.

If $n < m$ then *U* has dimensions (*n* x *n*), *S* has dimensions (*n* x *n*), and $V^H$ has dimensions (*n* x *n*). If $n \geq m$ then *U* has dimensions (*m* x *m*), *S* has dimensions (*m* x *m*), and $V^H$ has dimensions (*n* x *m*). The following diagram shows the array dimensions:




LA_SVD is based on the following LAPACK routines:

| Output Type | LAPACK Routine | |
|---|---|---|
| | QR Iteration | Divide-and-conquer |
| Float | sgesvd | sgesdd |
| Double | dgesvd | dgesdd |
| Complex | cgesvd | cgesdd |
| Double complex | zgesvd | zgesdd |

*Table 46: LAPACK Routine Basis for LA_SVD*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

# Syntax

LA_SVD, *Array*, *W*, *U*, *V* [, /DOUBLE] [, /DIVIDE_CONQUER]
[, STATUS=*variable*]

# Arguments

## Array

The real or complex array to decompose.

## W

On output, *W* is a vector with MIN(*m*, *n*) elements containing the singular values.

## U

On output, *U* is an orthogonal array with MIN(*m*, *n*) columns and *m* rows used in the decomposition of *Array*. If *Array* is complex then *U* will be complex, otherwise *U* will be real.

## V

On output, *V* is an orthogonal array with MIN(*m*, *n*) columns and *n* rows used in the decomposition of *Array*. If *Array* is complex then *V* will be complex, otherwise *V* will be real.

**Note**

To reconstruct *Array*, you will need to take the transpose or Hermitian of *V*.

# Keywords

## DIVIDE_CONQUER

If this keyword is set, then the divide-and-conquer method is used to compute the singular vectors, otherwise, QR iteration is used. The divide-and-conquer method is faster at computing singular vectors of large matrices, but uses more memory and may produce less accurate singular values.

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE = 0.

### STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: The computation did not converge. The STATUS value specifies how many superdiagonals did not converge to zero.

**Note**

If STATUS is not specified, any error messages will output to the screen.

## Examples

Construct a sample input array *A*, consisting of smoothed random values:

```
PRO ExLA_SVD
; Create a smoothed random array:
n = 100
m = 200
seed = 12321
a = SMOOTH(RANDOMN(seed, n, m, /DOUBLE), 5)

; Compute the SVD and check reconstruction error:
LA_SVD, a, w, u, v
arecon = u ## DIAG_MATRIX(w) ## TRANSPOSE(v)
PRINT, 'LA_SVD error:', MAX(ABS(arecon - a))

; Keep only the 15 largest singular values
wfiltered = w
wfiltered[15:*] = 0.0
; Reconstruct the array:
afiltered = u ## DIAG_MATRIX(wfiltered) ## TRANSPOSE(v)
percentVar = 100*(w^2)/TOTAL(w^2)
PRINT, 'LA_SVD Variance:', TOTAL(percentVar[0:14])
END
```

When this program is compiled and run, IDL prints:

```
LA_SVD error:  1.0103030e-014
LA_SVD variance:       82.802816
```

**Note**

More than 80% of the variance is contained in the 15 largest singular values.

## Version History

Introduced 5.6

## See Also

LA_CHOLDC, LA_LUDC, SVDC

# LA_TRIDC

The LA_TRIDC procedure computes the LU decomposition of a tridiagonal (*n* x *n*) array as *Array* = *L U*, where *L* is a product of permutation and unit lower bidiagonal arrays, and *U* is upper triangular with nonzero elements only in the main diagonal and the first two superdiagonals.

LA_TRIDC is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgttrf |
| Double | dgttrf |
| Complex | cgttrf |
| Double complex | zgttrf |

*Table 47: LAPACK Routine Basis for LA_TRIDC*

For more details, see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

LA_TRIDC, *AL*, *A*, *AU*, *U2*, *Index* [, /DOUBLE] [, STATUS=*variable*]

## Arguments

### AL

A named vector of length (*n* - 1) containing the subdiagonal elements of an array. This procedure returns *AL* as the (*n* - 1) elements of the lower bidiagonal array from the LU decomposition.

### A

A named vector of length *n* containing the main diagonal elements of an array. This procedure returns *A* as the *n* diagonal elements of the upper array from the LU decomposition.

### AU

A named vector of length (*n* - 1) containing the superdiagonal elements of an array. This procedure returns *AU* as the (*n* - 1) superdiagonal elements of the upper array.

### U2

An output vector that contains the (*n* - 2) elements of the second superdiagonal of the upper array.

### Index

An output vector that records the row permutations which occurred as a result of partial pivoting. For $1 < j < n$, row *j* of the matrix was interchanged with row *Index*[*j*].

**Note**

Row numbers within *Index* start at one rather than zero.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *AL* is double precision, otherwise the default is DOUBLE = 0.

### STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: One of the diagonal elements of *U* is zero. The STATUS value specifies which value along the diagonal (starting at one) is zero.

**Note**

If STATUS is not specified, any error messages will output to the screen.

## Examples

Create a test program to compute the LU decomposition of a tridiagonal array:

```
pro EX_LA_TRIDC
    ; Create a random tridiagonal array.
    n = 9
    seed = 12321
    AL = RANDOMN(seed, n-1)
    A  = RANDOMN(seed, n)
    AU = RANDOMN(seed, n-1)

    ; Construct tridiagonal array.
    Array = DIAG_MATRIX(AL, -1) + DIAG_MATRIX(A) + $
        DIAG_MATRIX(AU, 1)

    ; Compute the LU decomposition.
    LA_TRIDC, AL, A, AU, U2, Index

    ; Adjust from LAPACK back to IDL indexing.
    Index = Index - 1

    ; Create upper and lower arrays.
    Upper = DIAG_MATRIX(A) + $
        DIAG_MATRIX(AU, 1) + DIAG_MATRIX(U2, 2)
    Lower = DIAG_MATRIX(AL, -1) + IDENTITY(n)

    ; To conserve storage, LA_TRIDC keeps all lower diagonal
    ; elements in AL, regardless of row. The Index array
    ; tells which subdiagonals need to be shifted down.
    ; Loop starts at 1 since there aren't any subdiagonals
    ; to the left of the first diagonal element.
    for i = 1,n-2 do begin
        if (Index[i] ne i) then $
            Lower[0:i-1,[i,i+1]] = Lower[0:i-1,[i+1,i]]
    endfor

    ; Permute the row order.
    for i = n-2, 0, -1 do begin
        if (Index[i] ne i) then $
            Lower[*,[i,i+1]] = Lower[*,[i+1,i]]
    endfor

    ; Reconstruct the array and check the difference:
    Arecon = Lower ## Upper
    print, 'LA_TRIDC error:', MAX(ABS(Arecon - Array))
end
```

When this program is compiled and run, IDL prints:

```
LA_TRIDC error: 1.50427e-008
```

## Version History

Introduced 5.6

## See Also

LA_TRIMPROVE, LA_TRISOL

# LA_TRIMPROVE

The LA_TRIMPROVE function improves the solution to a system of linear equations with a tridiagonal array, *AX* = *B*, and provides optional error bounds and backward error estimates.

The LA_TRIMPROVE function may also be used to improve the solutions for multiple systems of linear equations, with each column of *B* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the improved solution vector for that set of equations.

LA_TRIMPROVE is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgtrfs |
| Double | dgtrfs |
| Complex | cgtrfs |
| Double complex | zgtrfs |

*Table 48: LAPACK Routine Basis for LA_TRIMPROVE*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_TRIMPROVE( *AL*, *A*, *AU*, *DAL*, *DA*, *DAU*, *DU2*, *Index*, *B*, *X*
[, BACKWARD_ERROR=*variable*] [, /DOUBLE]
[, FORWARD_ERROR=*variable*] )

## Return Value

The result is an *n*-element vector or *k*-by-*n* array.

## Arguments

### AL

A vector of length (*n* - 1) containing the subdiagonal elements of the original array.

## A

A vector of length *n* containing the main diagonal elements of the original array.

## AU

A vector of length (*n* - 1) containing the superdiagonal elements of the original array.

## DAL

The (*n* - 1) elements of the lower bidiagonal array, created by the LA_TRIDC procedure.

## DA

The *n* diagonal elements of the upper triangular array, created by the LA_TRIDC procedure.

## DAU

The (*n* - 1) superdiagonal elements of the upper triangular array, created by the LA_TRIDC procedure.

## DU2

The (*n* - 2) elements of the second superdiagonal of the upper triangular array, created by the LA_TRIDC procedure.

## Index

An input vector, created by the LA_TRIDC procedure, containing the row permutations which occurred as a result of partial pivoting.

## B

An *n*-element input vector containing the right-hand side of the linear system, or a *k*-by-*n* array, where each of the *k* columns represents a different linear system.

## X

An *n*-element input vector, or a *k*-by-*n* array, containing the approximate solutions to the linear system, created by the LA_TRISOL function.

# Keywords

## BACKWARD_ERROR

Set this keyword to a named variable that will contain the relative backward error estimate for each linear system. If *B* is a vector containing a single linear system, then BACKWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems, then BACKWARD_ERROR will be a *k*-element vector. The backward error is the smallest relative change in any element of *A* or *B* that makes *X* an exact solution.

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *AL* is double precision, otherwise the default is DOUBLE = 0.

## FORWARD_ERROR

Set this keyword to a named variable that will contain the estimated forward error bound for each linear system. If *B* is a vector containing a single linear system, then FORWARD_ERROR will be a scalar. If *B* is an array containing *k* linear systems, then FORWARD_ERROR will be a *k*-element vector. For each linear system, if *Xtrue* is the true solution corresponding to *X*, then the forward error is an estimated upper bound for the magnitude of the largest element in (*X* - *Xtrue*) divided by the magnitude of the largest element in *X*.

# Examples

Given the tridiagonal system of equations:

```
-4t + u             =  6
 2t - 4u +  v       = -8
      2u - 4v + w   = -5
           2v -4w   =  8
```

the solution can be found and improved by using the following program:

```
PRO ExLA_TRIMPROVE
; Define array a:
aupper = [1, 1, 1]
adiag = [-4, -4, -4, -4]
alower = [2, 2, 2]
; Define right-hand side vector b:
b = [6, -8, -5, 8]
```

```
; Decompose a:
dlower = alower
darray = adiag
dupper = aupper
LA_TRIDC, dlower, darray, dupper, u2, index

; Compute and improve the solution:
x = LA_TRISOL(dlower, darray, dupper, u2, index, b)
xnew = LA_TRIMPROVE(Alower, Adiag, Aupper, $
     dlower, darray, dupper, u2, index, b, x)
PRINT, 'LA_TRISOL improved solution:'
PRINT, xnew
END
```

When this program is compiled and run, IDL prints:

```
LA_TRISOL improved solution:
-1.00000      2.00000      2.00000     -1.00000
```

## Version History

Introduced 5.6

## See Also

LA_TRIDC, LA_TRISOL

# LA_TRIQL

The LA_TRIQL procedure uses the QL and QR variants of the implicitly-shifted QR algorithm to compute the eigenvalues and eigenvectors of a symmetric tridiagonal array. The LA_TRIRED routine can be used to reduce a real symmetric (or complex Hermitian) array to tridiagonal form suitable for input to this procedure.

LA_TRIQL is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | ssteqr |
| Double | dsteqr |
| Complex | csteqr |
| Double complex | zsteqr |

*Table 49: LAPACK Routine Basis for LA_TRIQL*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

LA_TRIQL, D, E [, A] [, /DOUBLE] [, STATUS=*variable*]

## Arguments

### D

A named vector of length *n* containing the real diagonal elements, optionally created by the LA_TRIRED procedure. Upon output, *D* is replaced by a real vector of length *n* containing the eigenvalues.

### E

The (*n* - 1) real subdiagonal elements, optionally created by the LA_TRIRED procedure. On output, the values within *E* are destroyed.

### A

An optional named variable that returns the eigenvectors as a set of *n* row vectors. If the eigenvectors of a tridiagonal array are desired, *A* should be input as an identity

array. If the eigenvectors of an array that has been reduced by LA_TRIRED are desired, *A* should be input as the Array output from LA_TRIRED. If *A* is not input, then eigenvectors are not computed. *A* may be either real or complex.

# Keywords

## DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is DOUBLE = 0 if none of the inputs are double precision. If *A* is not input, then the default is /DOUBLE if *D* is double precision. If *A* is input, then the default is /DOUBLE if *A* is double precision (real or complex).

## STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: The algorithm failed to find all eigenvalues in 30*n* iterations. The STATUS value specifies how many elements of *E* have not converged to zero.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

# Examples

The following example program computes the eigenvalues and eigenvectors of a given symmetric array:

```
PRO ExLA_TRIQL
; Create a symmetric random array:
n = 4
seed = 12321
Array = RANDOMN(seed, n, n)
array = array + TRANSPOSE(array)

; Reduce to tridiagonal form
q = array    ; make a copy
LA_TRIRED, q, d, e

; Compute eigenvalues and eigenvectors
```

```
eigenvalues = d
eigenvectors = q
LA_TRIQL, eigenvalues, e, eigenvectors
PRINT, 'LA_TRIQL eigenvalues:'
PRINT, eigenvalues
END
```

When this program is compiled and run, IDL prints:

```
LA_TRIQL eigenvalues:
-2.87710    -0.663354      2.92018      3.59648
```

## Version History

Introduced 5.6

## See Also

LA_TRIRED, TRIQL

# LA_TRIRED

The LA_TRIRED procedure reduces a real symmetric or complex Hermitian array to real tridiagonal form *T*. If the array is real symmetric then the decomposition is $A = Q\ T\ Q^T$, where *Q* is orthogonal. If the array is complex Hermitian then the decomposition is $A = Q\ T\ Q^H$, where *Q* is unitary. The superscript *T* represents the transpose while superscript *H* represents the Hermitian, or transpose complex conjugate.

LA_TRIRED is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | ssytrd, sorgtr |
| Double | dsytrd, dorgtr |
| Complex | chetrd, cungtr |
| Double complex | zhetrd, zungtr |

*Table 50: LAPACK Routine Basis for LA_TRIRED*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

LA_TRIRED, *Array*, *D*, *E* [, /DOUBLE] [, /UPPER]

## Arguments

### Array

A named variable containing the real or complex array to decompose. Only the lower triangular portion of *Array* is used (or upper if the /UPPER keyword is set). This procedure returns *Array* as the real orthogonal (or complex unitary) *Q* array used to reduce the original array to tridiagonal form.

### D

An *n*-element output vector containing the real diagonal elements of the tridiagonal array. Note that *D* is always real.

### E

An (*n* - 1) element output vector containing the real subdiagonal elements of the tridiagonal array. Note that *E* is always real.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real) result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE = 0.

### UPPER

If this keyword is set, then only the upper triangular portion of *Array* is used, and the upper triangular array is returned. The default is to use the lower triangular portion and return the lower triangular array.

## Examples

See LA_TRIQL for an example of using this procedure.

## Version History

Introduced 5.6

## See Also

LA_TRIQL, TRIRED

# LA_TRISOL

The LA_TRISOL function is used in conjunction with the LA_TRIDC procedure to solve a set of *n* linear equations in *n* unknowns, *AX* = *B*, where *A* is a tridiagonal array. The parameter *A* is input not as the original array, but as its LU decomposition, created by the routine LA_TRIDC.

The LA_TRISOL function may also be used to solve for multiple systems of linear equations, with each column of *B* representing a different set of equations. In this case, the result is a *k*-by-*n* array where each of the *k* columns represents the solution vector for that set of equations.

LA_TRISOL is based on the following LAPACK routines:

| Output Type | LAPACK Routine |
|---|---|
| Float | sgttrs |
| Double | dgttrs |
| Complex | cgttrs |
| Double complex | zgttrs |

*Table 51: LAPACK Routine Basis for LA_TRISOL*

For details see Anderson et al., *LAPACK Users' Guide*, 3rd ed., SIAM, 1999.

## Syntax

*Result* = LA_TRISOL( *AL*, *A*, *AU*, *U2*, *Index*, *B* [, /DOUBLE] )

## Return Value

The result is an *n*-element vector or *k*-by-*n* array.

## Arguments

### AL

The (*n* - 1) elements of the lower bidiagonal array, created by the LA_TRIDC procedure.

### A

The *n* diagonal elements of the upper triangular array, created by the LA_TRIDC procedure.

### AU

The (*n* - 1) superdiagonal elements of the upper triangular array, created by the LA_TRIDC procedure.

### U2

The (*n* - 2) elements of the second superdiagonal of the upper triangular array, created by the LA_TRIDC procedure.

### Index

An input vector, created by the LA_TRIDC procedure, containing the row permutations which occurred as a result of partial pivoting.

### B

An *n*-element input vector containing the right-hand side of the linear system, or a *k*-by-*n* array, where each of the *k* columns represents a different linear system.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision (real or complex) result. Set DOUBLE = 0 to use single-precision for computations and to return a single-precision (real or complex) result. The default is /DOUBLE if *AL* is double precision, otherwise the default is DOUBLE = 0.

## Examples

For an example of using this routine see LA_TRIMPROVE.

## Version History

Introduced 5.6

## See Also

LA_TRIDC, LA_TRIMPROVE, TRISOL

# LABEL_DATE

The LABEL_DATE function can be used, in conjunction with the [XYZ]TICKFORMAT keyword to IDL plotting routines, to easily label axes with dates and times.

This routine is written in the IDL language. Its source code can be found in the file `label_date.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LABEL_DATE( [DATE_FORMAT=*string/string array*]
[, AM_PM=2-element vector of strings]
[, DAYS_OF_WEEK=7-element vector of strings]
[, MONTHS=12-element vector of strings] [, OFFSET=*value*] [, /ROUND_UP] )

and then,

PLOT, *x*, *y*, XTICKFORMAT = 'LABEL_DATE'

## Return Value

Returns a date formatting definition.

## Arguments

If LABEL_DATE is being called to initialize string formats, it should be called with no arguments and the DATE_FORMAT keyword should be set.

## Keywords

**Note**

The settings for LABEL_DATE remain in effect for all subsequent calls to LABEL_DATE. To restore any default settings, call LABEL_DATE again with the appropriate keyword set to either a null string (") or to 0, depending upon the data type of that keyword.

### AM_PM

Set this keyword to a two-element string array that contains the names to be used with '%A'. The default is ['am','pm'].

## DATE_FORMAT

Set this keyword to a format string or array of format strings. Each string corresponds to an axis level as provided by the [XYZ]TICKUNITS keyword to the plotting routine. If there are fewer strings than axis levels, then the strings are cyclically repeated. A string can contain any of the following codes:

| Code | Description |
|---|---|
| %M | Month name. |
| %N | Month number (2 digits). |
| %D | Day of month (2 digits). |
| %Y | Year (4 digits, or 5 digits for negative years). |
| %Z | Last 2 digits of the year. |
| %W | Day of the week. |
| %A | AM or PM (%H is then 12-hour instead of 24-hour). |
| %H | Hours (2 digits). |
| %I | Minutes (2 digits). |
| %S | Seconds (2 digits), followed optionally by %n where n is an integer 0-9 representing the number of digits after the decimal point for seconds; the default is no decimal places. |
| %% | Represents the % character. |

*Table 52: DATE_FORMAT Codes*

Other items you can include can consist of:

- Any other text characters in the format string.
- Any vector font positioning and font change commands. For more information, see “Embedded Formatting Commands” in Appendix H.

If DATE_FORMAT is not specified then the default is the standard 24-character system format, `'%W %M %D %H:%I:%S %Y'`.

The following table contains some examples of DATE_FORMAT strings and the resulting output:

| DATE_FORMAT String | Example Result |
|---|---|
| '%D/%N/%Y' | 11/12/1993 |
| '%M!C%Y'<br>**Note -** !C is the code for a newline character. | Dec<br>1993 |
| '%H:%I:%S' | 21:33:58 |
| '%H:%I:%S%3' | 21:33:58.125 |
| '%W, %M %D, %H %A' | Sat, Jan 01, 9 pm |
| '%S seconds' | 60 seconds |

*Table 53: DATE_FORMAT Examples*

## DAYS_OF_WEEK

Set this keyword to a seven-element string array that contains the names to be used with '%W'. The default is the three-letter English abbreviations, ['Sun, 'Mon', 'Tue', 'Wed', 'Thu', 'Fri', 'Sat'].

## MONTHS

Set this keyword to a twelve-element string array that contains the names to be used with '%M'.  The default is the three-letter English abbreviations, ['Jan', 'Feb',…, 'Dec'].

## OFFSET

Set this keyword to a value representing the offset to be added to each tick value before conversion to a label. This keyword is usually used when your axis values are measured relative to a certain starting time. In this case, OFFSET should be set to the Julian date of the starting time.

## ROUND_UP

Set this keyword to force times to be rounded up to the smallest time unit that is present in the DATE_FORMAT string. The default is for times to be truncated to the smallest time unit.

## Examples

This example creates a sample plot that has a date axis from Jan 1 to June 30, 2000:

```
; Create format strings for a two-level axis:
dummy = LABEL_DATE(DATE_FORMAT=['%D-%M','%Y'])

;Generate the Date/Time data
time = TIMEGEN(START=JULDAY(1,1,2000), FINAL=JULDAY(6,30,2000))

;Generate the Y-axis data
data = RANDOMN(seed, N_ELEMENTS(time))

;Plot the data
PLOT, time, data, XTICKUNITS = ['Time', 'Time'], $
   XTICKFORMAT='LABEL_DATE', XSTYLE=1, XTICKS=6, YMARGIN=[6,2]
```

For more examples, see "[XYZ]TICKFORMAT" on page 3883.

## Version History

Introduced: Pre 4.0

## See Also

"[XYZ]TICKFORMAT" on page 3883, CALDAT, JULDAY, SYSTIME, TIMEGEN, "Format Codes" in Chapter 10 of the *Building IDL Applications* manual.

# LABEL_REGION

The LABEL_REGION function consecutively labels all of the regions, or blobs, of a bi-level image with a unique region index. This process is sometimes called “blob coloring”. A region is a set of non-zero pixels within a neighborhood around the pixel under examination.

The argument for LABEL_REGION is an *n*-dimensional bi-level integer type array—only zero and non-zero values are considered.

Statistics on each of the regions may be easily calculated using the HISTOGRAM function as shown in the examples below.

## Syntax

*Result* = LABEL_REGION( *Data* [, /ALL_NEIGHBORS] [, /ULONG] )

## Return Value

The result of the function is an integer array of the same dimensions with each pixel containing its region index. A region index of zero indicates that the original pixel was zero and belongs to no region. Output values range from 0 to the number of regions.

## Arguments

### Data

A *n*-dimensional image to be labeled. *Data* is converted to integer type if necessary. Pixels at the edges of *Data* are considered to be zero.

## Keywords

### ALL_NEIGHBORS

Set this keyword to indicate that all adjacent neighbors to a given pixel should be searched. (This is sometimes called 8-neighbor searching when the image is 2-dimensional). The default is to search only the neighbors that are exactly one unit in distance from the current pixel (sometimes called 4-neighbor searching when the image is 2-dimensional).

### EIGHT

*This keyword is now obsolete. It has been replaced by the ALL_NEIGHBORS keyword (because this routine now handles N-dimensional data).*

### ULONG

Set this keyword to specify that the output array should be an unsigned long integer.

## Examples

### Example 1

This example counts the number of distinct regions within an image, and their population. Note that region 0 is the set of zero pixels that are not within a region:

```
image = DIST(40)

; Get blob indices:
b = LABEL_REGION(image)

; Get population of each blob:
h = HISTOGRAM(b)
FOR i=0, N_ELEMENTS(h)-1 DO PRINT, 'Region ',i, $
   ', Population = ', h[i]
```

### Example 2

This example also prints the average value and standard deviation of each region:

```
image = DIST(40)

; Get blob indices:
b = LABEL_REGION(image)

; Get population and members of each blob:
h = HISTOGRAM(b, REVERSE_INDICES=r)

; Each region
FOR i=0, N_ELEMENTS(h)-1 DO BEGIN
   ;Find subscripts of members of region i.
   p = r[r[i]:r[i+1]-1]
```

```
    ; Pixels of region i
    q = image[p]
    PRINT, 'Region ', i, $
       ', Population = ', h[i], $
       ', Standard Deviation = ', STDEV(q, mean), $
       ', Mean = ', mean
ENDFOR
```

## Version History

Introduced: Pre 4.0

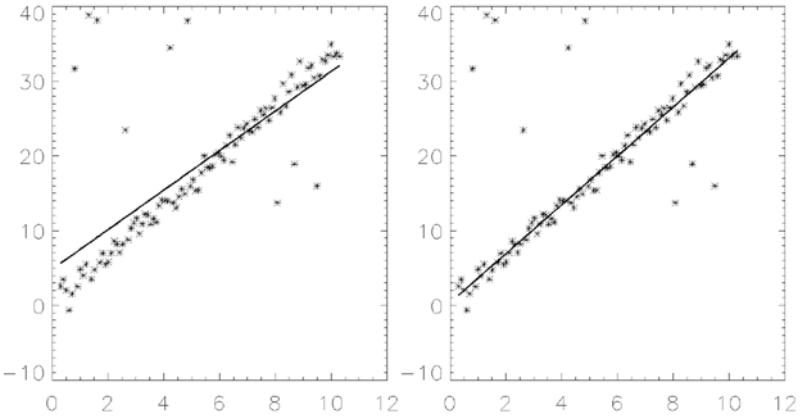
## See Also

ANNOTATE, DEFROI, HISTOGRAM, SEARCH2D

# LADFIT

The LADFIT function fits the paired data {*xi*, *yi*} to the linear model, y = A + Bx, using a “robust” least absolute deviation method.

The figure below displays a two-dimensional distribution that is fitted to the model y = A + Bx, using a minimized Chi-square error criterion (left) and a “robust” least absolute deviation technique (right). The use of the Chi-square error statistic can result in a poor fit due to an undesired sensitivity to outlying data.




This routine is written in the IDL language. Its source code can be found in the file `ladfit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LADFIT( *X*, *Y* [, ABSDEV=*variable*] [, /DOUBLE] )

## Return Value

The result is a two-element vector containing the model parameters, A and B.

# Arguments

## X

An *n*-element integer, single-, or double-precision floating-point vector. Note that the *X* vector must be sorted into ascending order.

## Y

An *n*-element integer, single-, or double-precision floating-point vector. Note that the elements of the *Y* vector must be paired with the appropriate elements of *X*.

# Keywords

## ABSDEV

Set this keyword to a named variable that will contain the mean of the absolute deviation of the *Result* and *Y*.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

```
; Define two n-element vectors of paired data:
X = [-3.20, 4.49, -1.66, 0.64, -2.43, -0.89, -0.12, 1.41, $
      2.95, 2.18, 3.72, 5.26]
Y = [-7.14, -1.30, -4.26, -1.90, -6.19, -3.98, -2.87, -1.66, $
     -0.78, -2.61, 0.31, 1.74]

; Sort the X values into ascending order, and sort the Y values to
; match the new order of the elements in X:
XX = X[SORT(X)]
YY = Y[SORT(X)]

; Compute the model parameters, A and B:
PRINT, LADFIT(XX, YY)
```

IDL prints:

```
-3.15301     0.930440
```

# Version History

Introduced: 4.0

## See Also

COMFIT, CURVEFIT, LINFIT, SORT

# LAGUERRE

The LAGUERRE function returns the value of the associated Laguerre polynomial $L_n^k(x)$. The associated Laguerre polynomials are solutions to the differential equation:

$$xy'' + (k + 1 - x)y' + ny = 0$$

with orthogonality constraint:

$$\int_0^\infty e^{-x} x^{k+1} L_m^k(x) L_n^k(x) dx = \frac{(n+k)!}{n!} \delta_{mn}$$

Laguerre polynomials are used in quantum mechanics, for example, where the wave function for the hydrogen atom is given by the Laguerre differential equation.

This routine is written in the IDL language. Its source code can be found in the file `laguerre.pro` in the `lib` subdirectory of the IDL distribution.

This routine is written in the IDL language. Its source code can be found in the file `laguerre.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LAGUERRE( *X*, *N* [, *K*] [, COEFFICIENTS=*variable*] [, /DOUBLE] )

## Return Value

This function returns a scalar or array with the same dimensions as *X*. If *X* is double-precision or if the DOUBLE keyword is set, the result is double-precision complex, otherwise the result is single-precision complex.

## Arguments

### X

The value(s) at which $L_n^k(x)$ is evaluated. *X* can be either a scalar or an array.

### N

A scalar integer, $N \geq 0$, specifying the order $n$ of $L_n^k(x)$. If $N$ is of type float, it will be truncated.

### K

A scalar, $K \geq 0$, specifying the order $k$ of $L_n^k(x)$. If $K$ is not specified, the default $K = 0$ is used and the Laguerre polynomial, $L_n(x)$, is returned.

## Keywords

### COEFFICIENTS

Set this keyword to a named variable that will contain the polynomial coefficients in the expansion C[0] + C[1]x + C[2]$x^2$ + ... .

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

To compute the value of the Laguerre polynomial at the following $X$ values:

```
;Define the parametric X values:
X = [0.0, 0.2, 0.4, 0.6, 0.8, 1.0]

;Compute the Laguerre polynomial of order N=2, K=1:
result = LAGUERRE(X, 2, 1)

;Print the result:
PRINT, result
```

IDL prints:

```
3.00000   2.42000   1.88000   1.38000   0.920000   0.500000
```

This is the exact solution vector to six-decimal accuracy.

## Version History

Introduced: 5.4

## See Also

LEGENDRE, SPHER_HARM

# LEEFILT

The LEEFILT function performs the Lee filter algorithm on an image array using a box of size 2*N*+1. This function can also be used on vectors. The Lee technique smooths additive image noise by generating statistics in a local neighborhood and comparing them to the expected values.

This routine is written in the IDL language. It is based upon the algorithm published by Lee (*Optical Engineering* 25(5), 636-646, May 1986). Its source code can be found in the file `leefilt.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LEEFILT( *A* [, *N* [, *Sig*]] [, /DOUBLE] [, /EXACT] )

## Return Value

This function returns an array with the same dimensions as *A*. If any of the inputs are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

## Arguments

### A

The input image array or one-dimensional vector.

### N

The size of the filter box is 2*N*+1. The default value is 5.

### Sig

Estimate of the standard deviation. The default is 5. If *Sig* is negative, IDL interactively prompts for a value of `sigma`, and displays the resulting image using TVSCL (for arrays) or PLOT (for vectors). To end this cycle, enter a value of 0 (zero) for `sigma`.

# Keywords

## DOUBLE

Set this keyword to force the computations to be done in double-precision arithmetic.

## EXACT

Set this keyword to apply a more accurate (but slower) implementation of the Lee filter.

# Version History

Introduced: Original

# See Also

DIGITAL_FILTER, MEDIAN, SMOOTH, VOIGT

# LEGENDRE

The LEGENDRE function returns the value of the associated Legendre polynomial $P_l^m(x)$. The associated Legendre functions are solutions to the differential equation:

$$(1-x^2)y'' - 2xy' + \left[ l(l+1) - \frac{m^2}{(1-x^2)} \right] y = 0$$

with orthogonality constraints:

$$\int_{-1}^{+1} P_l^m(x) P_k^n(x) dx = \frac{2}{2l+1} \frac{(l+m)!}{(l-m)!} \delta_{lk} \delta_{mn}$$

The Legendre polynomials are the solutions to the Legendre equation with $m = 0$. For positive $m$, the associated Legendre functions can be written in terms of the Legendre polynomials as:

$$P_l^m(x) = (-1)^m (1-x^2)^{m/2} \frac{d^m}{dx^m} P_l(x)$$

Associated polynomials for negative $m$ are related to positive $m$ by:

$$P_l^{-m}(x) = (-1)^m \frac{(l-m)!}{(l+m)!} P_l^m(x)$$

LEGENDRE is based on the routine *plgndr* described in section 6.8 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = LEGENDRE( *X*, *L* [, *M*] [, /DOUBLE] )

## Return Value

If all arguments are scalar, the function returns a scalar. If all arguments are arrays, the function matches up the corresponding elements of *X*, *L*, and *M*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other arguments are arrays, the function uses the scalar value with each element of the arrays, and returns an array with the same dimensions as the smallest input array.

If any of the arguments are double-precision or if the DOUBLE keyword is set, the result is double-precision, otherwise the result is single-precision.

# Arguments

## X

The expression for which $P_l^m(x)$ is evaluated. Values for *X* must be in the range $-1 \leq X \leq 1$.

## L

An integer scalar or array, $L \geq 0$, specifying the order *l* of $P_l^m(x)$. If *L* is of type float, it will be truncated.

## M

An integer scalar or array, $-L \leq M \leq L$, specifying the order *m* of $P_l^m(x)$. If *M* is not specified, then the default $M = 0$ is used and the Legendre polynomial, $P_l(x)$, is returned. If *M* is of type float, it will be truncated.

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

## Example 1

Compute the value of the Legendre polynomial at the following X values:

```
; Define the parametric X values:
X = [-0.75, -0.5, -0.25, 0.25, 0.5, 0.75]

; Compute the Legendre polynomial of order L=2:
result = LEGENDRE(X, 2)

; Print the result:
PRINT, result
```

The result of this is:

```
0.343750 -0.125000 -0.406250 -0.406250 -0.125000  0.343750
```

### Example 2

Compute the value of the associated Legendre polynomial at the same X values:

```
; Compute the associated Legendre polynomial of order L=2, M=1:
result = LEGENDRE(X, 2, 1)
; Print the result:
PRINT, result
```

IDL prints:

```
 1.48824  1.29904  0.726184  -0.726184  -1.29904  -1.48824
```

This is the exact solution vector to six-decimal accuracy.

## Version History

Introduced: 5.4

## See Also

SPHER_HARM, LAGUERRE

# LINBCG

The LINBCG function is used in conjunction with SPRSIN to solve a set of *n* sparse linear equations with *n* unknowns using the iterative biconjugate gradient method.

LINBCG is based on the routine `linbcg` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

*Numerical Recipes* recommends using double-precision arithmetic to perform this computation.

## Syntax

*Result* = LINBCG( *A*, *B*, *X* [, /DOUBLE] [, ITOL={4 | 5 | 6 | 7}] [, TOL=*value*] [, ITER=*variable*] [, ITMAX=*value*] )

## Return Value

The result is an *n*-element vector.

## Arguments

### A

A row-indexed sparse array created by the SPRSIN function.

### B

An *n*-element vector containing the right-hand side of the linear system **Ax=b**.

### X

An *n*-element vector containing the initial solution of the linear system.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### ITOL

Use this keyword to specify which convergence test should be used. Set ITOL to one of the following:

1. Iteration stops when $|A \cdot x - b| / |b|$ is less than the value specified by TOL.
2. Iteration stops when $|\tilde{A}^{-1} \cdot (A \cdot x - b)| / |\tilde{A}^{-1} \cdot b|$ (where $\tilde{A}$ is a "preconditioning" matrix close to *A*) is less than the value specified by TOL.
3. The routine uses its own estimate of error in *x*. Iteration stops when the magnitude of the error divided by the magnitude of *x* is less than the value specified by TOL. This is the default setting.
4. The same as 3, except that the routine uses the largest (in absolute value) component of the error and the largest component of *x* rather than the vector magnitudes.

### TOL

Use this keyword to specify the desired convergence tolerance. For single-precision calculations, the default value is $1.0 \times 10^{-7}$. For double-precision values, the default is $1.0 \times 10^{-14}$.

### ITER

Use this keyword to specify an output variable that will be set to the number of iterations performed.

### ITMAX

The maximum allowed number of iterations. The default is $n^2$.

## Examples

```
; Begin with an array A:
A = [[ 5.0,  0.0, 0.0,  1.0, -2.0], $
     [ 3.0, -2.0, 0.0,  1.0,  0.0], $
     [ 4.0, -1.0, 0.0,  2.0,  0.0], $
     [ 0.0,  3.0, 3.0,  1.0,  0.0], $
     [-2.0,  0.0, 0.0, -1.0,  2.0]]

; Define a right-hand side vector B:
B = [7.0, 1.0, 3.0, 3.0, -4.0]

; Start with an initial guess at the solution:
X = REPLICATE(1.0, N_ELEMENTS(B))
```

```
; Solve the linear system Ax=b:
result = LINBCG(SPRSIN(A), B, X)

; Print the result:
PRINT, result
```

IDL prints:

```
      1.00000   1.00000   8.94134e-008   -2.37107e-007   -1.00000
```

The exact solution is [1, 1, 0, 0, -1].

## Version History

Introduced: 4.0

## See Also

FULSTR, READ_SPR, SPRSAB, SPRSAX, SPRSIN, SPRSTP, WRITE_SPR

# LINDGEN

The LINDGEN function creates a longword integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = LINDGEN($D_1$ [, ..., $D_8$])

## Return Value

Returns a longword integer array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create L, a 10-element by 10-element longword array where each element is set to the value of its one-dimensional subscript, enter:

```
L = LINDGEN(10, 10)
```

## Version History

Introduced: Original

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, SINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# LINFIT

The LINFIT function fits the paired data {*xi*, *yi*} to the linear model, y = A + Bx, by minimizing the chi-square error statistic.

This routine is written in the IDL language. Its source code can be found in the file `linfit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LINFIT( *X*, *Y* [, CHISQ=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, MEASURE_ERRORS=*vector*] [, PROB=*variable*] [, SIGMA=*variable*] [, YFIT=*variable*] )

## Return Value

The result is a two-element vector containing the linear model parameters [A, B].

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector.

### Y

An *n*-element integer, single-, or double-precision floating-point vector.

## Keywords

### CHISQ

Set this keyword to a named variable that will contain the value of the chi-square goodness-of-fit.

### COVAR

Set this keyword to a named variable that will contain the covariance matrix of the coefficients.

**Note**

The COVAR matrix depends only upon the independent variable X and (optionally) the MEASURE_ERRORS. The values do not depend upon Y. See section 15.4 of *Numerical Recipes in C* (Second Edition) for details.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

**Note**

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(ABS(*Y*)).

## PROB

Set this keyword to a named variable that will contain the probability that the computed fit would have a value of CHISQ or greater. If PROB is greater than 0.1, the model parameters are “believable”. If PROB is less than 0.1, the accuracy of the model parameters is questionable.

## SDEV

*The SDEV keyword is obsolete and has been replaced by the MEASURE_ERRORS keyword. Code that uses the SDEV keyword will continue to work as before, but new code should use the MEASURE_ERRORS keyword. The definition of the MEASURE_ERRORS keyword is identical to that of the SDEV keyword.*

## SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters

**Note**

If MEASURE_ERRORS is omitted, then you are assuming that a straight line is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number

of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

### YFIT

Set this keyword equal to a named variable that will contain the vector of calculated *Y* values.

## Examples

```
; Define two n-element vectors of paired data:
X = [-3.20, 4.49, -1.66, 0.64, -2.43, -0.89, -0.12, 1.41, $
      2.95, 2.18, 3.72, 5.26]
Y = [-7.14, -1.30, -4.26, -1.90, -6.19, -3.98, -2.87, -1.66, $
     -0.78, -2.61, 0.31, 1.74]

; Define an n-element vector of Poisson measurement errors:
measure_errors = SQRT(ABS(Y))

; Compute the model parameters, A and B, and print the result:
result = LINFIT(X, Y, MEASURE_ERRORS=measure_errors)
PRINT, result
```

IDL prints:

```
-3.16574    0.829856
```

## Version History

Introduced: 4.0

## See Also

COMFIT, CURVEFIT, GAUSSFIT, LADFIT, LMFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

# LINKIMAGE

The LINKIMAGE procedure merges routines written in other languages with IDL at run-time. Each call to LINKIMAGE defines a new system procedure or function by specifying the routine's name, the name of the file containing the code, and the entry point name. The name of your routine is added to IDL's internal system routine table, making it available in the same manner as any other IDL built-in routine. LINKIMAGE can also be used to add graphics device drivers.

**Warning**

Using LINKIMAGE requires intimate knowledge of the internals of IDL, and is not for use by the novice user. We recommend use of CALL_EXTERNAL, which has a simpler interface, instead of LINKIMAGE unless your application specifically requires it. To use LINKIMAGE, you should be familiar with the material in the IDL *External Development Guide*.

LINKIMAGE uses the dynamic linking interface supported by the operating system to do its work. Programmers should be familiar with the services supported by their system in order to better understand LINKIMAGE:

- Under UNIX, LINKIMAGE uses the `dlopen()` interface to the dynamic linker in all cases except for HP-UX (which uses `shl_load()`) and AIX (which uses `load()`).
- Under Windows, LINKIMAGE uses `LoadLibrary()` to load a 32-bit, Win32 DLL.

**Note**

Modules must be merged via LINKIMAGE before other procedures and functions that call them are compiled, or the compilation of those routines will fail. Note that because routines merged via LINKIMAGE are considered built-in routines by IDL, declaring the routine with the FORWARD_FUNCTION statement will not eliminate this restriction.

## Syntax

LINKIMAGE, *Name*, *Image* [, *Type* [, *Entry*]] [, /DEVICE] [, /FUNCT] [, /KEYWORDS] [, MAX_ARGS=*value*] [, MIN_ARGS=*value*]

# Arguments

## Name

A string containing the IDL name of the function, procedure or device routine which is to be merged. When loading a device driver, *Name* contains the name of the global DEVICE_DEF structure in the driver. Upon successful loading of the routine, a new procedure or function with the given name will exist, or the new device driver will be loaded.

## Image

A string containing the full path specification of the dynamically loaded object file. See your system documentation on sharable libraries or DLLs for details.

## Type

An optional scalar integer parameter that contains 0 (zero) for a procedure, 1 (one) for a function, and 2 for a device driver. The keyword parameters DEVICE and FUNCT can also be used to indicate the type of routine being merged. The default value is 0, for procedure.

## Entry

An optional string that contains the name of the symbol which is the entry point of the procedure or function. With some compilers or operating systems, this name may require the addition of leading or trailing characters. For example, some UNIX C compilers add a leading underscore to the beginning of a function name, and some UNIX FORTRAN compilers add a trailing underscore.

If *Entry* is not supplied, LINKIMAGE will provide a default name by converting the value suppled for *Name* to lower case and adding any special characters (leading or trailing underscores) typical of the system.

### Warning

Under Microsoft Windows operating systems, only `cdecl` functions can by used with LINKIMAGE. Attempting to use routines with other calling conventions will yield undefined results, including memory corruption or even IDL crashing.

The Windows operating system has two distinct system defined standards that govern how routines pass arguments: `stdcall`, which is used by much of the operating system as well as languages such as Visual Basic, and `cdecl`, which is used widely for programming in the C language. These standards differ in how and when arguments are pushed onto the system stack. The standard used by a given

function is determined when the function is compiled, and can be controlled by the programmer. LINKIMAGE can only be used with `cdecl` functions. Unfortunately, there is no way for IDL to know which convention a given function uses, meaning that LINKIMAGE will quietly accept an entry point of the wrong type. The LINKIMAGE user is responsible for ensuring that Entry is a `cdecl` function.

# Keywords

## DEVICE

Set this keyword to indicate that the module being loaded contains a device driver.

## FUNCT

Set this keyword to indicate that the module being loaded contains a function.

## KEYWORDS

Set this keyword to indicate that the procedure or function being loaded accepts keyword parameters.

## MAX_ARGS

Set this keyword equal to the maximum number of non-keyword arguments the procedure or function accepts. If this keyword is not present, the maximum number of parameters is not checked when the routine is called.

**Note**

It is a very good idea to specify a value for MAX_ARGS. Passing the wrong number of arguments to an external routine may cause unexpected results, including causing IDL to crash. By forcing IDL to check the number of arguments before passing them to the linked routine, you will avoid parameter mismatch problems.

## MIN_ARGS

Set this keyword equal to the minimum number of non-keyword arguments accepted by the procedure or function.

## Obsolete Keywords

The following keywords are obsolete:

- DEFAULT

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Examples

To add a procedure called MY_PROC, whose entry symbol is named `my_proc`, that is contained in the file `/home/smith/my_proc.so`:

```
LINKIMAGE, 'MY_PROC', '/home/smith/my_proc.so'
```

## Version History

Introduced: Pre 4.0

## See Also

CALL_EXTERNAL, SPAWN, and the IDL *External Development Guide*.

# LL_ARC_DISTANCE

The LL_ARC_DISTANCE function returns a two-element vector containing the longitude and latitude [lon, lat] of a point given arc distance ($-\pi \le Arc\_Dist \le \pi$), and azimuth (*Az*), from a specified location *Lon_lat0*. Values are in radians unless the keyword DEGREES is set.

This routine is written in the IDL language. Its source code can be found in the file `ll_arc_distance.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LL_ARC_DISTANCE( *Lon_lat0*, *Arc_Dist*, *Az* [, /DEGREES] )

## Return Value

Returns a two-element vector containing the point longitude and latitude.

## Arguments

### Lon_lat0

A 2-element vector containing the longitude and latitude of the starting point. Values are assumed to be in radians unless the keyword DEGREES is set.

### Arc_Dist

The arc distance from *Lon_lat0*. The value must be between $-\pi$ and $+\pi$. To express distances in arc units, divide by the radius of the globe expressed in the original units. For example, if the radius of the earth is 6371 km, divide the distance in km by 6371 to obtain the arc distance.

### Az

The azimuth from *Lon_lat0*. The value is assumed to be in radians unless the keyword DEGREES is set.

## Keywords

### DEGREES

Set this keyword to express all measurements and results in degrees.

## Examples

```
; Initial point specified in radians:
Lon_lat0 = [1.0, 2.0]

; Arc distance in radians:
Arc_Dist = 2.0

; Azimuth in radians:
Az = 1.0

Result = LL_ARC_DISTANCE(Lon_lat0, Arc_Dist, Az)
PRINT, Result
```

IDL prints:

```
2.91415   -0.622234
```

## Version History

Introduced: Pre 4.0

## See Also

MAP_SET

# LMFIT

The LMFIT function does a non-linear least squares fit to a function with an arbitrary number of parameters. LMFIT uses the Levenberg-Marquardt algorithm, which combines the steepest descent and inverse-Hessian function fitting methods. The function may be any non-linear function.

Iterations are performed until three consecutive iterations fail to change the chi square value by more than the specified tolerance amount, or until a maximum number of iterations have been performed. The LMFIT function returns a vector of values for the dependent variables, as fitted by the function fit.

The initial guess of the parameter values should be as close to the actual values as possible or the solution may not converge. Test the value of the variable specified by the CONVERGENCE keyword to determine whether the algorithm converged, failed to converge, or encountered a singular matrix.

This routine is written in the IDL language. Its source code can be found in the file `lmfit.pro` in the `lib` subdirectory of the IDL distribution. LMFIT is based on the routine `mrqmin` described in section 15.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = LMFIT( *X*, *Y*, *A* [, ALPHA=*variable*] [, CHISQ=*variable*]
[, CONVERGENCE=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, FITA=*vector*]
[, FUNCTION_NAME=*string*] [, ITER=*variable*] [, ITMAX=*value*]
[, ITMIN=*value*] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*]
[, TOL=*value*] )

## Return Value

Returns a vector of values for the dependent variable, resulting from the function fit.

## Arguments

### X

A row vector of independent variables. LMFIT does not manipulate or use values in *X*, it simply passes *X* to the user-written function.

### Y

A row vector containing the dependent variables.

### A

A vector that contains the initial estimate for each coefficient. Upon return, *A* will contain the final estimates for the coefficients.

## Keywords

### ALPHA

Set this keyword equal to a named variable that will contain the value of the curvature matrix.

### CHISQ

Set this keyword equal to a named variable that will contain the final value of the chi-square goodness-of-fit.

### CONVERGENCE

Set this keyword equal to a named variable that will indicate whether the LMFIT algorithm converged. The possible returned values are:

- 1 = the algorithm converged.
- 0 = the algorithm did not converge.
- -1 = the algorithm encountered a singular matrix and did not converge.

**Tip**

If LMFIT fails to converge, try setting the DOUBLE keyword.

### COVAR

Set this keyword equal to a named variable that will contain the value of the covariance matrix.

**Note**

The COVAR matrix depends only upon the independent variable X and (optionally) the MEASURE_ERRORS. The values do not depend upon Y. See section 15.4 of *Numerical Recipes in C* (Second Edition) for details.

## DOUBLE

Set this keyword to force the computations to be performed in double precision.

## FITA

Set this keyword equal to a vector, with as many elements as *A*, which contains a zero for each fixed parameter, and a non-zero value for elements of *A* to fit. If FITA is not specified, all parameters are taken to be non-fixed.

## FUNCTION_NAME

Use this keyword to specify the name of the function to fit. If this keyword is omitted, LMFIT assumes that the IDL routine LMFUNCT is to be used. If LMFUNCT is not already compiled, IDL compiles the function from the file `lmfunct.pro`, located in the `lib` subdirectory of the IDL distribution. LMFUNCT is designed to fit a quadratic equation.

The function to be fit must be written as an IDL function and compiled prior to calling LMFIT. The function must accept a vector *X* (the independent variables) and a vector *A* containing the fitted function's parameter values. It must return an N_ELEMENTS(*A*)+1-element vector in which the first (zeroth) element is the evaluated function value and the remaining elements are the partial derivatives with respect to each parameter in *A*.

**Note**

The returned value must be of the same data type as the input *X* value.

## ITER

Set this keyword equal to a named variable that will contain the actual number of iterations which were performed

## ITMAX

Set this keyword equal to the maximum number of iterations. The default is 50.

## ITMIN

Set this keyword equal to the minimum number of iterations. The default is 5.

## MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

**Note**

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(ABS(*Y*)).

### SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters

**Note**

If MEASURE_ERRORS is omitted, then you are assuming that your user-supplied model (or the default quadratic) is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

### TOL

Set this keyword to the convergence tolerance. The routine returns when the relative decrease in chi-squared is less than TOL in an iteration. The default is $1.0 \times 10^{-6}$ for single-precision, and $1.0 \times 10^{-12}$ for double-precision.

### WEIGHTS

*The WEIGHTS keyword is obsolete and has been replaced by the MEASURE_ERRORS keyword. Code that uses the WEIGHTS keyword will continue to work as before, but new code should use the MEASURE_ERRORS keyword. Note that the definition of the MEASURE_ERRORS keyword is not the same as the WEIGHTS keyword. Using the WEIGHTS keyword, SQRT(1/WEIGHTS[i]) represents the measurement error for each point Y[i]. Using the MEASURE_ERRORS keyword, the measurement error for each point is represented as simply MEASURE_ERRORS[i].*

## Examples

In this example, we fit a function of the form:

f(x)=a[0] * exp(a[1]*x) + a[2] + a[3] * sin(x)

```
; First, define a return function for LMFIT:
FUNCTION myfunct, X, A
```

```
   bx = A[0]*EXP(A[1]*X)
   RETURN,[ [bx+A[2]+A[3]*SIN(X)], [EXP(A[1]*X)], [bx*X], $
      [1.0] ,[SIN(X)] ]
END

PRO lmfit_example

; Compute the fit to the function we have just defined. First,
; define the independent and dependent variables:
X = FINDGEN(40)/20.0
Y = 8.8 * EXP(-9.9 * X) + 11.11 + 4.9 * SIN(X)
measure_errors = 0.05 * Y

; Provide an initial guess for the function's parameters:
A = [10.0, -0.1, 2.0, 4.0]
fita = [1,1,1,1]

; Plot the initial data, with error bars:
PLOTERR, X, Y, measure_errors
coefs = LMFIT(X, Y, A, MEASURE_ERRORS=measure_errors, /DOUBLE, $
   FITA = fita, FUNCTION_NAME = 'myfunct')

; Overplot the fitted data:
OPLOT, X, coefs

END
```

## Version History

Introduced: 5.0

## See Also

CURVEFIT, GAUSSFIT, LINFIT, POLY_FIT, REGRESS, SFIT, SVDFIT

# LMGR

The LMGR function tests whether a particular licensing mode is in effect. Different licensing modes are specified by keyword; see the “Keywords” section below for a description of each licensing mode.

The LMGR function can also force IDL into time demo mode or report the LMHostid number for the machine in use.

For more information on IDL’s licensing methods, consult the *IDL License Management Guide*, which is included in Adobe Acrobat Portable Document Format on your IDL CD-ROM.

## Syntax

*Result* = LMGR( [, /CLIENTSERVER | , /DEMO | , /EMBEDDED | , /RUNTIME | , /STUDENT | , /TRIAL | , /VM] [, EXPIRE_DATE=*variable*] [, /FORCE_DEMO] [, INSTALL_NUM=*variable*] [, LMHOSTID=*variable*] [, SITE_NOTICE=*variable*])

## Return Value

The function returns True (1) if the mode specified is in effect, or False (0) otherwise.

## Arguments

None

## Keywords

### CLIENTSERVER

Set this keyword to test whether the current IDL session is using Client/Server licensing (as opposed to Desktop licensing).

### DEMO

Set this keyword to test whether the current IDL session is running in timed demo mode. Unlicensed copies of IDL and copies running directly from a CD-ROM run in timed demo mode.

## EMBEDDED

Set this keyword to test whether the current IDL session is running in embedded mode. Embedded-mode applications contain a built-in version of the IDL license. Examples of applications running in embedded mode are the IDL demo and the IDL registration program.

## EXPIRE_DATE

Set this keyword to a named variable that will receive a string containing the expiration date of the current IDL session if the session is a trial session. This named variable will be undefined if the IDL session has a permanent license.

## FORCE_DEMO

Set this keyword to force the current session into timed demo mode. Forcing an IDL session into demo mode can be useful if you are testing an application that will be run with an unlicensed copy of IDL. Note that you must exit IDL and restart to return to normal licensed mode after forcing IDL into demo mode.

## INSTALL_NUM

Set this keyword to a named variable that will receive a string containing the installation number of the current IDL session. This named variable will be undefined if the IDL session is unlicensed.

## LMHOSTID

Set this keyword equal to a named variable that will contain a string value representing the LMHostid for the machine in use. The LMHostid is used when creating client/server IDL licenses. This keyword returns the string “0” on machines which do not have a unique LMHostid (some Windows machines that use Desktop licensing.)

## RUNTIME

Set this keyword to test whether the current IDL session is running in runtime mode. Runtime-mode applications do not provide access to the IDL Command Line. See Chapter 21, “Distributing IDL Applications” in the *Building IDL Applications* manual for additional details on runtime applications.

### SITE_NOTICE

Set this keyword to a named variable that will receive a string containing the site notice of the current IDL session. This named variable will be undefined if the IDL session is unlicensed.

### STUDENT

Set this keyword to test whether the current IDL session is running in student mode. The IDL Student version, which provides a subset of IDL's full functionality, is currently the only product that runs in student mode.

### TRIAL

Set this keyword to test whether the current IDL session is running in trial mode. Trial mode licenses allow IDL to operate for a limited time period (generally 30 days) but do not otherwise restrict functionality.

### VM

Set this keyword to test whether the current IDL session is running in IDL Virtual Machine mode. IDL Virtual Machine applications do not provide access to the IDL Command Line. See "The IDL Virtual Machine" in Chapter 21 of the *Building IDL Applications* manual for additional details on IDL Virtual Machine applications.

## Examples

Use the following commands to test whether the current IDL session is running in timed demo mode:

```
Result = LMGR(/DEMO)

IF (Result GT 0) THEN PRINT, "IDL is in Demo Mode"
```

Use the following commands to generate the LMHostid number for the machine in use:

```
Result = LMGR(LMHOSTID = myId)
PRINT, "LMHostid for this machine is: ", myId
```

## Version History

Introduced: Pre 4.0

# LNGAMMA

The LNGAMMA function returns the logarithm of the gamma function of *Z*.

## Syntax

*Result* = LNGAMMA(*Z*)

## Return Value

For negative integers, LNGAMMA returns the correct value of Infinity. If *Z* is double-precision, the result is double-precision (either double or double complex), otherwise the result is single-precision (either float or complex).

**Note**

For negative nonintegers, LNGAMMA will also return Infinity. To compute the actual LNGAMMA of a negative noninteger, you should convert your input to complex first.

## Arguments

### Z

The expression for which the logarithm of the gamma function will be evaluated. *Z* may be complex.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To find the logarithm of the gamma function of 0.5 and store the result in variable A, enter:

```
A = LNGAMMA(0.5)
```

## Version History

Introduced: Pre 4.0

*Z* argument accepts complex input: 5.6

## See Also

BETA, GAMMA, IBETA, IGAMMA

# LNP_TEST

The LNP_TEST function computes the Lomb Normalized Periodogram of two sample populations *X* and *Y* and tests the hypothesis that the populations represent a significant periodic signal against the hypothesis that they represent random noise.

LNP_TEST is based on the routine `fasper` described in section 13.8 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = LNP_TEST( *X*, *Y* [, /DOUBLE] [, HIFAC=*scale_factor*] [, JMAX=*variable*] [, OFAC=*value*] [, WK1=*variable*] [, WK2=*variable*] )

## Return Value

The result is a two-element vector containing the maximum peak in the Lomb Normalized Periodogram and its significance. The significance is a value in the interval [0.0, 1.0]; a small value indicates that a significant periodic signal is present.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector containing equally or unequally spaced time samples.

### Y

An *n*-element integer, single-, or double-precision floating-point vector containing amplitudes corresponding to $X_i$.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### HIFAC

Use this keyword to specify the scale factor of the average Nyquist frequency. The default value is 1.

### JMAX

Use this keyword to specify a named variable that will contain the index of the maximum peak in the Lomb Normalized Periodogram.

### OFAC

Use this keyword to specify the oversampling factor. The default value is 4.

### WK1

Use this keyword to specify a named variable that will contain a vector of increasing linear frequencies.

### WK2

Use this keyword to specify a named variable that will contain a vector of values from the Lomb Normalized Periodogram corresponding to the frequencies in WK1.

## Examples

This example tests the hypothesis that two sample, *n*-element populations X and Y represent a significant periodic signal against the hypothesis that they represent random noise:

```
; Define two n-element sample populations:
X = [ 1.0,  2.0,  5.0,  7.0,  8.0,  9.0, $
     10.0, 11.0, 12.0, 13.0, 14.0, 15.0, $
     16.0, 17.0, 18.0, 19.0, 20.0, 22.0, $
     23.0, 24.0, 25.0, 26.0, 27.0, 28.0]
Y = [ 0.69502, -0.70425,  0.20632,  0.77206, -2.08339,  0.97806, $
      1.77324,  2.34086,  0.91354,  2.04189,  0.53560, -2.05348, $
     -0.76308, -0.84501, -0.06507, -0.12260,  1.83075,  1.41403, $
     -0.26438, -0.48142, -0.50929,  0.01942, -1.29268,  0.29697]

; Test the hypothesis that X and Y represent a significant periodic
; signal against the hypothesis that they represent random noise:
result = LNP_TEST(X, Y, WK1 = wk1, WK2 = wk2, JMAX = jmax)
PRINT, result
```

IDL prints:

```
   4.69296    0.198157
```

The small value of the significance represents the possibility of a significant periodic signal. A larger number of samples for *X* and *Y* would produce a more conclusive result. WK1 and WK2 are both 48-element vectors containing linear frequencies and corresponding Lomb values, respectively. JMAX is the indexed location of the maximum Lomb value in WK2.

## Version History

Introduced: 4.0

## See Also

CTI_TEST, FV_TEST, KW_TEST, MD_TEST, R_TEST, RS_TEST, S_TEST, TM_TEST, XSQ_TEST

# LOADCT

The LOADCT procedure loads one of 41 predefined IDL color tables. These color tables are defined in the file `colors1.tbl`, located in the `\resource\colors` subdirectory of the main IDL directory, unless the FILE keyword is specified. The selected colortable is loaded into the COLORS common block as both the “current” and “original” colortable. If the current device has fewer than 256 colors, the color table data is interpolated to cover the number of colors in the device.

This routine is written in the IDL language. Its source code can be found in the file `loadct.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

LOADCT [, *Table*] [, BOTTOM=*value*] [, FILE=*string*] [, GET_NAMES=*variable*] [, NCOLORS=*value*] [, /SILENT]

## Arguments

### Table

The number of the pre-defined color table to load, from 0 to 40. If this value is omitted, a menu of the available tables is printed and the user is prompted to enter a table number.

## Keywords

### BOTTOM

The first color index to use. LOADCT will use color indices from BOTTOM to BOTTOM+NCOLORS-1. The default is BOTTOM=0.

### FILE

Set this keyword to the name of a colortable file to be used instead of the file `colors1.tbl`. See MODIFYCT to create and modify colortable files.

### GET_NAMES

Set this keyword to a named variable in which the names of the color tables are returned as a string array. No changes are made to the color table.

### NCOLORS

The number of colors to use. The default is all available colors (this number is stored in the system variable !D.TABLE_SIZE).

### SILENT

If this keyword is set, the Color Table message is suppressed.

## Version History

Introduced: Original

## See Also

MODIFYCT, XLOADCT, TVLCT

# LOCALE_GET

The LOCALE_GET function returns the current locale (string) of the operating platform.

## Syntax

*Result* = LOCALE_GET( )

## Return Value

Returns a string containing the current operating platform locale.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.2.1

# LOGICAL_AND

The LOGICAL_AND function performs a logical AND operation on its arguments. It returns True (1) if both of its arguments are non-zero (non-NULL for strings and heap variables), or False (0) otherwise.

The LOGICAL_AND function is similar to the AND operator, except that it performs a logical “and” rather than a bitwise “and” on its arguments.

**Note**

LOGICAL_AND always returns either 0 or 1, unlike the AND operator, which performs a bitwise AND operation on integers, and returns one of the two arguments for other types.

Unlike the && operator, LOGICAL_AND accepts multi-element arrays as its arguments. In addition, where the && operator *short-circuits* if it can determine the result by evaluating only the first argument, all arguments to a function are always evaluated.

## Syntax

*Result* = LOGICAL_AND(*Arg1*, *Arg2*)

## Return Value

Integer zero (false) or one (true) if both arguments are scalars, or an array of zeroes and ones if either argument is an array.

## Arguments

### Arg1, Arg2

The expressions on which the logical AND operation is to be carried out. The arguments can be scalars or arrays of any type other than structure.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL’s *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU

system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix D, “Thread Pool Keywords” for details.

## Example

At the IDL Command line, enter:

```
PRINT, LOGICAL_AND(2,4), LOGICAL_AND(2,0), LOGICAL_AND(0,4), $
   LOGICAL_AND(0,0)
```

IDL Prints:

```
1   0   0   0
```

## Version History

Introduced: 6.0

## See Also

“Logical Operators” in the *Building IDL Applications* manual, “Bitwise Operators” in the *Building IDL Applications* manual, LOGICAL_OR, LOGICAL_TRUE

# LOGICAL_OR

The LOGICAL_OR function performs a logical OR operation on its arguments. It returns True (1) if either of its arguments are non-zero (non-NULL for strings and heap variables), and False (0) otherwise.

The LOGICAL_OR function is similar to the OR operator, except that it performs a logical “or” rather than a bitwise “or” on its arguments.

**Note**

LOGICAL_OR always returns either 0 or 1, unlike the OR operator, which performs a bitwise OR operation on integers, and returns one of the two arguments for other types.

Unlike the || operator, LOGICAL_OR accepts multi-element arrays as its arguments. In addition, where the || operator *short-circuits* if it can determine the result by evaluating only the first argument, all arguments to a function are always evaluated.

## Syntax

*Result* = LOGICAL_OR(*Arg1*, *Arg2*)

## Return Value

Integer zero (false) or one (true) if both operands are scalars, or an array of zeroes and ones if either operand is an array.

## Arguments

### Arg1, Arg2

The expressions on which the logical OR operation is to be carried out. The arguments can be scalars or arrays of any type other than structure.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL’s *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU

system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix D, “Thread Pool Keywords” for details.

## Example

At the IDL Command Line, enter:

```
PRINT, LOGICAL_OR(2,4), LOGICAL_OR(2,0), LOGICAL_OR(0,4), $
   LOGICAL_OR(0,0)
```

IDL Prints:

```
1   1   1   0
```

## Version History

Introduced: 6.0

## See Also

“Logical Operators” in the *Building IDL Applications* manual, “Bitwise Operators” in the *Building IDL Applications* manual, LOGICAL_AND, LOGICAL_TRUE

# LOGICAL_TRUE

The LOGICAL_TRUE function returns True (1) if its arguments are non-zero (non-NULL for strings and heap variables), and False (0) otherwise.

**Note**

For a given argument, the value returned by LOGICAL_TRUE is the opposite of the value returned by the ~ operator.

## Syntax

*Result* = LOGICAL_TRUE(*Arg*)

## Return Value

Integer zero (false) or one (true) if the argument is a scalar, or an array of zeroes and ones if the argument is an array.

## Arguments

### Arg

The expression on which the logical truth evaluation is to be carried out. The argument can be a scalar or an array of any type other than structure.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix D, "Thread Pool Keywords" for details.

## Example

At the IDL Command Line, enter:

```
PRINT, LOGICAL_TRUE(2), LOGICAL_TRUE(0)
```

IDL Prints:

```
1   0
```

## Version History

Introduced: 6.0

## See Also

"Logical Operators" in the *Building IDL Applications* manual, "Bitwise Operators" in the *Building IDL Applications* manual, KEYWORD_SET, LOGICAL_AND, LOGICAL_OR

# LON64ARR

The LON64ARR function returns a 64-bit integer vector or array.

## Syntax

*Result* = LON64ARR( $D_1$ *[, ..., $D_8$]* [, /NOZERO] )

## Return Value

Returns a 64-bit array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### NOZERO

Normally, LON64ARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and LON64ARR executes faster.

## Examples

To create L, a 100-element, 64-bit vector with each element set to 0, enter:

```
L = LON64ARR(100)
```

## Version History

Introduced: 5.2

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# LONARR

The LONARR function returns a longword integer vector or array.

## Syntax

*Result* = LONARR( $D_1$ *[, ..., $D_8$]* [, /NOZERO] )

## Return Value

Returns a long array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### NOZERO

Normally, LONARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and LONARR executes faster.

## Examples

To create L, a 100-element, longword vector with each element set to 0, enter:

```
L = LONARR(100)
```

## Version History

Introduced: Original

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR, ULONARR

# LONG

The LONG function returns a result equal to *Expression* converted to longword integer type.

## Syntax

*Result* = LONG( *Expression[, Offset [, $D_1$ [, ..., $D_8$]]]* )

## Return Value

Returns the conversion of the given scalar or array to a longword integer type.

## Arguments

### Expression

The expression to be converted to longword integer.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as longword integer data.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

If A contains the floating-point value 32000.0, it can converted to a longword integer and stored in the variable B by entering:

```
B = LONG(A)
```

# Version History

Introduced: Original

# See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, STRING, UINT, ULONG, ULONG64

# LONG64

The LONG64 function returns a result equal to *Expression* converted to 64-bit integer type.

## Syntax

*Result* = LONG64( *Expression[, Offset [, $D_1$ [, ..., $D_8$]]]* )

## Return Value

Returns the conversion of the given scalar or array to a 64-bit integer type.

## Arguments

### Expression

The expression to be converted to 64-bit integer.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as 64-bit integer data.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid floating-point value and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

If A contains the floating-point value 32000.0, it can converted to a 64-bit integer and stored in the variable B by entering:

```
B = LONG64(A)
```

# Version History

Introduced: 5.2

# See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, STRING, UINT, ULONG, ULONG64

# LSODE

The LSODE function uses adaptive numerical methods to advance a solution to a system of ordinary differential equations one time-step H, given values for the variables *Y* and *X*.

## Syntax

*Result* = LSODE( *Y, X, H, Derivs*[, *Status*] [, ATOL=*value*] [, RTOL=*value*] )

## Return Value

Returns the solution in a vector with the same number of elements as Y.

## Arguments

### Y

A vector of values for Y at X

### X

A scalar value for the initial condition.

### H

A scalar value giving interval length or step size.

### Derivs

A scalar string specifying the name of a user-supplied IDL function that calculates the values of the derivatives *Dydx* at X. This function must accept two arguments: A scalar floating value *X*, and one n-element vector *Y*. It must return an *n*-element vector result.

For example, suppose the values of the derivatives are defined by the following relations:

$$dy_0 / dx = -0.5y_0, \qquad dy_1 / dx = 4.0 - 0.3y_1 - 0.1y_0$$

We can write a function called `differential` to express these relationships in the IDL language:

```
FUNCTION differential, X, Y
   RETURN, [-0.5 * Y[0], 4.0 - 0.3 * Y[1] - 0.1 * Y[0]]
```

```
END
```

## Status

An index used for input and output to specify the state of the calculation. This argument contains a positive value if the function was successfully completed. Negative values indicate different errors.

| Input Value | Description |
|---|---|
| 1 | This is the first call for the problem; initializations will occur. This is the default value. |
| 2 | This is not the first call. The calculation is to continue normally. |
| 3 | This is not the first call. The calculation is to continue normally, but with a change in input parameters. |

*Table 54: Input Values for Status*

A preliminary call with `tout = t` is not counted as a first call here, as no initialization or checking of input is done. (Such a call is sometimes useful for the purpose of outputting the initial condition *s*.) Thus, the first call for which tout ≠ t requires `STATUS = 1` on input.

| Output Value | Description |
|---|---|
| 1 | Nothing occurred. (However, an internal counter was set to detect and prevent repeated calls of this type.) |
| 2 | The integration was performed successfully, and no roots were found. |
| 3 | The integration was successful, and one or more roots were found. |
| -1 | An excessive amount of work was done on this call, but the integration was otherwise successful. To continue, reset STATUS to a value greater than1 and begin again (the excess work step counter will be reset to 0). |

*Table 55: Output Values for Status*

| Output Value | Description |
|---|---|
| -2 | The precision of the machine being used is insufficient for the requested amount of accuracy. Integration was successful. To continue, the tolerance parameters must be reset, and STATUS must be set to 3. (If this condition is detected before taking any steps, then an illegal input return (STATUS = -3) occurs instead.) |
| -3 | Illegal input was detected, before processing any integration steps. If the solver detects an infinite loop of calls to the solver with illegal input, it will cause the run to stop. |
| -4 | There were repeated error test failures on one attempted step, before completing the requested task, but the integration was successful. The problem may have a singularity, or the input may be inappropriate. |
| -5 | There were repeated convergence test failures on one attempted step, before completing the requested task, but the integration was successful. This may be caused by an inaccurate jacobian matrix, if one is being used. |
| -6 | ewt(i) became zero for some i during the integration. Pure relative error control was requested on a variable which has now vanished. Integration was successful. |

*Table 55: Output Values for Status (Continued)*

**Note**

Since the normal output value of STATUS is 2, it does not need to be reset for normal continuation. Also, since a negative input value of STATUS will be regarded as illegal, a negative output value requires the user to change it, and possibly other inputs, before calling the solver again.

# Keywords

## ATOL

A scalar or array value that specifies the absolute tolerance. The default value is 1.0e-7. Use ATOL = 0.0 (or ATOL[*i*] = 0.0) for pure relative error control, and use

RTOL = 0.0 for pure absolute error control. For an explanation of how to use ATOL and RTOL together, see RTOL below.

### RTOL

A scalar value that specifies the relative tolerance. The default value is 1.0e-7. Use RTOL = 0.0 for pure absolute error control, and use ATOL = 0.0 (or ATOL[*i*] = 0.0) for pure relative error control.

The estimated local error in the Y[*i*] argument will be controlled to be less than

```
ewt[i] = RTOL*abs(Y[i]) + ATOL    ; If ATOL is a scalar.
ewt[i] = RTOL*abs(Y[i]) + ATOL[i] ; If ATOL is an array.
```

Thus, the local error test passes if, in each component, either the absolute error is less than ATOL (or ATOL[*i*]), or if the relative error is less than RTOL.

**Warning**

Actual, or global, errors might exceed these local tolerances, so choose values for ATOL and RTOL conservatively.

## Examples

To integrate the example system of differential equations for one time step, H:

```
PRO LSODETEST

   ; Define the step size:
   H = 0.5

   ; Define an initial X value:
   X = 0.0

   ; Define initial Y values:
   Y = [4.0, 6.0]

   ; Integrate over the interval (0, 0.5):
   result = LSODE(Y, X, H, 'differential')

   ; Print the result:
   PRINT, result

END

FUNCTION differential, X, Y
   RETURN, [-0.5 * Y[0], 4.0 - 0.3 * Y[1] - 0.1 * Y[0]]
END
```

IDL prints:

```
3.11523      6.85767
```

This is the exact solution vector to 5-decimal precision.

## See Also

DERIV, DERIVSIG, RK4

## References


1. Alan C. Hindmarsh, ODEPACK, A Systematized Collection of ODE Solvers, in Scientific Computing, R. S. Stepleman et al. (eds.), North-Holland, Amsterdam, 1983, pp. 55-64.
2. Linda R. Petzold, Automatic Selection of Methods for Solving Stiff and Nonstiff Systems of Ordinary Differential Equations, SIAM J. SCI. STAT. COMPUT. 4 (1983), pp. 136-148.
3. Kathie L. Hiebert and Lawrence F. Shampine, Implicitly Defined Output Points for Solutions of ODE's, Sandia Report SAND80-0180, February, 1980.


## Version History

Introduced: 5.1

# LU_COMPLEX

The LU_COMPLEX function solves an *n* by *n* complex linear system **Az = b** using LU decomposition. The result is an *n*-element complex vector *z*. Alternatively, LU_COMPLEX computes the generalized inverse of an *n* by *n* complex array.

This routine is written in the IDL language. Its source code can be found in the file `lu_complex.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = LU_COMPLEX( *A*, *B* [, /DOUBLE] [, /INVERSE] [, /SPARSE] )

## Return Value

The result is an *n* by *n* complex array.

## Arguments

### A

An *n* by *n* complex array.

### B

An *n*-element right-hand side vector (real or complex).

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### INVERSE

Set this keyword to compute the generalized inverse of *A*. If INVERSE is specified, the input argument *B* is ignored.

### SPARSE

Set this keyword to convert the input array to row-indexed sparse storage format. Computations are done using the iterative biconjugate gradient method. This

keyword is effective only when solving complex linear systems. This keyword has no effect when calculating the generalized inverse.

## Examples

```
; Define a complex array A and right-side vector B:
A = [[COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3,1)], $
     [COMPLEX(1,-2), COMPLEX(2, 2), COMPLEX(1, 0)], $
     [COMPLEX(1, 1), COMPLEX(0, 1), COMPLEX(1, 5)]]
B =  [COMPLEX(1, 1), COMPLEX(3,-2), COMPLEX(1,-2)]

; Solve the complex linear system Az = b:
Z = LU_COMPLEX(A, B)
PRINT, 'Z:'
PRINT, Z

; Compute the inverse of the complex array A by supplying a scalar
; for B (in this example -1):
inv = LU_COMPLEX(A, B, /INVERSE)
PRINT, 'Inverse:'
PRINT, inv
```

IDL prints:

```
Z:
(     0.552267,      1.22818)(    -0.290371,    -0.600974)
(    -0.629824,    -0.340952)

Inverse:
(     0.261521,   -0.0303485)(    0.0138629,     0.329337)
(    -0.102660,    -0.168602)
(     0.102660,     0.168602)(    0.0340952,    -0.162982)
(     0.125890,   -0.0633196)
(   -0.0689397,    0.0108655)(   -0.0666916,   -0.0438366)
(    0.0614462,    -0.161858)
```

## Version History

Introduced: Pre 4.0

## See Also

CRAMER, CHOLSOL, GS_ITER, LUSOL, SVSOL, TRISOL, and "Sparse Arrays" in Chapter 22 of the *Using IDL* manual.

# LUDC

The LUDC procedure replaces an *n* by *n* array, *A*, with the LU decomposition of a row-wise permutation of itself.

LUDC is based on the routine `ludcmp` described in section 2.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, use the LA_LUDC procedure instead.

## Syntax

LUDC, *A*, *Index* [, /COLUMN] [, /DOUBLE] [, INTERCHANGES=*variable*]

## Arguments

### A

An *n* by *n* array of any type except string. Upon output, *A* is replaced with its LU decomposition.

### Index

An output vector that records the row permutations which occurred as a result of partial pivoting.

## Keywords

### COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### INTERCHANGES

An output variable that is set to positive 1 if the number of row interchanges was even, or to negative 1 if the number of interchanges was odd.

## Examples

See the description of LUSOL for an example using this procedure.

## Version History

Introduced: 4.0

## See Also

LA_LUDC, LUSOL

# LUMPROVE

The LUMPROVE function uses LU decomposition to iteratively improve an approximate solution *X* of a set of *n* linear equations in *n* unknowns Ax = b.

LUMPROVE is based on the routine `mprove` described in section 2.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, use the LA_LUMPROVE function instead.

## Syntax

*Result* = LUMPROVE( *A*, *Alud*, *Index*, *B*, *X* [, /COLUMN] [, /DOUBLE] )

## Return Value

The result is a vector, whose type and length are identical to *X*, containing the improved solution.

## Arguments

### A

The *n* by *n* coefficient array of the linear system Ax = b.

### Alud

The *n* by *n* LU decomposition of *A* created by the LUDC procedure.

### Index

An input vector, created by the LUDC procedure, containing a record of the row permutations which occurred as a result of partial pivoting.

### B

An *n*-element vector containing the right-hand side of the linear system Ax = b.

### X

An *n*-element vector containing the approximate solution of the linear system Ax = b.

## Keywords

### COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

This example uses LUMPROVE to improve an approximate solution X to the linear system Ax = B:

```
; Create coefficient array A:
A = [[ 2.0,  1.0,  1.0], $
     [ 4.0, -6.0,  0.0], $
     [-2.0,  7.0,  2.0]]

; Create a duplicate of A:
alud = A
; Define the right-hand side vector B:
B = [3.0, -8.0, 10.0]

; Begin with an estimated solution X:
X = [.89, 1.78, -0.88]

; Decompose the duplicate of A:
LUDC, alud, INDEX

; Compute an improved solution:
result = LUMPROVE(A, alud, INDEX, B, X)

; Print the result:
PRINT, result
```

IDL prints:

```
 1.00000 2.00000 -1.00000
```

This is the exact solution vector.

## Version History

Introduced: 4.0

## See Also

GS_ITER, LA_LUMPROVE, LUDC

# LUSOL

The LUSOL function is used in conjunction with the LUDC procedure to solve a set of *n* linear equations in *n* unknowns Ax = b. The parameter *A* is input not as the original array, but as its LU decomposition, created by the routine LUDC.

LUSOL is based on the routine `lubksb` described in section 2.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, use the LA_LUSOL function instead.

## Syntax

*Result* = LUSOL(*A*, *Index*, *B* [, /COLUMN] [, /DOUBLE])

## Return Value

The result is an *n*-element vector whose type is identical to *A*.

## Arguments

### A

The *n* by *n* LU decomposition of an array created by the LUDC procedure.

### Index

An input vector, created by the LUDC procedure, containing a record of the row permutations which occurred as a result of partial pivoting.

### B

An *n*-element vector containing the right-hand side of the linear system Ax = b.

# Keywords

## COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

This example solves the linear system Ax = b using LU decomposition and back substitution:

```
; Define array A:
A = [[ 2.0,  1.0,  1.0], $
     [ 4.0, -6.0,  0.0], $
     [-2.0,  7.0,  2.0]]

; Define right-hand side vector B:
B = [3.0, -8.0, 10.0]

; Decompose A:
LUDC, A, INDEX

; Compute the solution using back substitution:
result = LUSOL(A, INDEX, B)

; Print the result:
PRINT, result
```

IDL prints:

```
      1.00000   2.00000   -1.00000
```

This is the exact solution vector.

# Version History

Introduced: Pre 4.0

## See Also

CHOLSOL, CRAMER, GS_ITER, LA_LUSOL, LU_COMPLEX, LUDC, SVSOL, TRISOL

# M_CORRELATE

The M_CORRELATE function computes the multiple correlation coefficient of a dependent variable and two or more independent variables.

This routine is written in the IDL language. Its source code can be found in the file `m_correlate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = M_CORRELATE( *X*, *Y* [, /DOUBLE] )

## Return Value

Returns the single or double-precision multiple correlation coefficient.

## Arguments

### X

An integer, single-, or double-precision floating-point array of *m*-columns and *n*-rows that specifies the independent variable data. The columns of this two dimensional array correspond to the *n*-element vectors of independent variable data.

### Y

An *n*-element integer, single-, or double-precision floating-point vector that specifies the dependent variable data.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Example

```
PRO MCORRELATE_TEST

   ; Define the independent (X) and dependent (Y) data:
   X = [[0.477121, 2.0, 13.0], $
        [0.477121, 5.0, 6.0], $
        [0.301030, 5.0, 9.0], $
```

```
          [0.000000, 7.0, 5.5], $
          [0.602060, 3.0, 7.0], $
          [0.698970, 2.0, 9.5], $
          [0.301030, 2.0, 17.0], $
          [0.477121, 5.0, 12.5], $
          [0.698970, 2.0, 13.5], $
          [0.000000, 3.0, 12.5], $
          [0.602060, 4.0, 13.0], $
          [0.301030, 6.0, 7.5], $
          [0.301030, 2.0, 7.5], $
          [0.698970, 3.0, 12.0], $
          [0.000000, 4.0, 14.0], $
          [0.698970, 6.0, 11.5], $
          [0.301030, 2.0, 15.0], $
          [0.602060, 6.0, 8.5], $
          [0.477121, 7.0, 14.5], $
          [0.000000, 5.0, 9.5]]
     Y = [97.682, 98.424, 101.435, 102.266, 97.067, 97.397, $
          99.481, 99.613, 96.901, 100.152, 98.797, 100.796, $
          98.750, 97.991, 100.007, 98.615, 100.225, 98.388, $
          98.937, 100.617]

     ; Compute the multiple correlation of Y on the first column of
     ; X. The result should be 0.798816.
     PRINT, 'Multiple correlation of Y on 1st column of X:'
     PRINT, M_CORRELATE(X[0,*], Y)

     ; Compute the multiple correlation of Y on the first two columns
     ; of X. The result should be 0.875872.
     PRINT, 'Multiple correlation of Y on 1st two columns of X:'
     PRINT, M_CORRELATE(X[0:1,*], Y)

     ; Compute the multiple correlation of Y on all columns of X. The
     ; result should be 0.877197.
     PRINT, 'Multiple correlation of Y on all columns of X:'
     PRINT, M_CORRELATE(X, Y)

END
```

IDL prints:

```
Multiple correlation of Y on 1st column of X:
     0.798816
Multiple correlation of Y on 1st two columns of X:
     0.875872
Multiple correlation of Y on all columns of X:
     0.877196
```

## Version History

Introduced: 4.0

## See Also

A_CORRELATE, CORRELATE, C_CORRELATE, P_CORRELATE, R_CORRELATE

# MACHAR

The MACHAR function determines and returns machine-specific parameters affecting floating-point arithmetic. Information is returned in the form of a structure with the fields listed in the “Return Value” section.

MACHAR is based on the routine `machar` described in section 20.1 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission. See that section for more details on and sample values of the various parameters returned.

## Syntax

*Result* = MACHAR( [, /DOUBLE] )

## Return Value

The following table lists the fields in the structure returned from the MACHAR function:

| Field Name | Description |
|---|---|
| IBETA | The radix in which numbers are represented. A longword integer. |
| IT | The number of base-IBETA digits in the floating-point mantissa M. A longword integer. |
| IRND | A code in the range 0 – 5 giving information on what type of rounding is done and how underflow is handled. A longword integer. |
| NGRD | The number of “guard digits” used when truncating the product of two mantissas. A longword integer. |
| MACHEP | The exponent of the smallest power of IBETA that, added to 1.0, gives something different from 1.0. A longword integer. |
| NEGEP | The exponent of the smallest power of IBETA that, subtracted from 1.0, gives something different from 1.0. A longword integer. |

*Table 56: MACHAR Fields*

| Field Name | Description |
|---|---|
| IEXP | The number of bits in the exponent. A longword integer. |
| MINEXP | The smallest value of IBETA consistent with there being no leading zeros in the mantissa. A longword integer. |
| MAXEXP | The smallest positive value of IBETA that causes overflow. A longword integer. |
| EPS | The floating-point number $IBETA^{MACHEP}$, loosely referred to as the “floating-point precision.” |
| EPSNEG | The floating-point number $IBETA^{NEGEP}$, which is another way of determining floating-point precision. |
| XMIN | The floating-point number $IBETA^{MINEXP}$, generally the magnitude of the smallest usable floating-point value. |
| XMAX | The largest usable floating-point value, defined as the number $(1-EPSNEG)xIBETA^{MAXEXP}$. |

*Table 56: MACHAR Fields*

## Arguments

None

## Keywords

### DOUBLE

The information returned is normally for single-precision floating-point arithmetic. Specify DOUBLE to see double-precision information.

## Version History

Introduced: 4.0

## See Also

CHECK_MATH, “!VALUES” on page 3895, and “Special Floating-Point Values” in Chapter 18 of the *Building IDL Applications* manual.

# MAKE_ARRAY

The MAKE_ARRAY function enables you to dynamically create an array whose characteristics are not known until run time.

## Syntax

*Result* = MAKE_ARRAY ( *[$D_1$ [, ..., $D_8$]]* [, /BYTE | , /COMPLEX | , /DCOMPLEX | , /DOUBLE | , /FLOAT | , /INTEGER | , /L64 | , /LONG | , /OBJ, | , /PTR | , /STRING | , /UINT | , /UL64 | , /ULONG] [, DIMENSION=*vector*] [, /INDEX] [, /NOZERO] [, SIZE=*vector*] [, TYPE=*type_code*] [, VALUE=*value*] )

## Return Value

Returns an array of the specified type, dimensions, and initialization.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

The $D_i$ arguments are optional if the dimensions of the result are specified using the DIMENSION keyword. Note that you should supply either the $D_i$ arguments or a value for the DIMENSION keyword, but not both.

## Keywords

### BYTE

Set this keyword to create a byte array.

### COMPLEX

Set this keyword to create a complex, single-precision, floating-point array.

## DCOMPLEX

Set this keyword to create a complex, double-precision, floating-point array.

## DIMENSION

An array of up to eight scalar elements, specifying the dimensions of the result. Note that you should supply either the $D_i$ arguments or a value for the DIMENSION keyword, but not both.

## DOUBLE

Set this keyword to create a double-precision, floating-point array.

## FLOAT

Set this keyword to create a single-precision, floating-point array.

## L64

Set this keyword to create a 64-bit integer array.

## INDEX

Set this keyword to initialize the array with each element set to the value of its one-dimensional subscript.

## INTEGER

Set this keyword to create an integer array.

## LONG

Set this keyword to create a longword integer array.

## NOZERO

Set this keyword to prevent the initialization of the array. Normally, each element of the resulting array is set to zero.

## OBJ

Set this keyword to create an object reference array.

## PTR

Set this keyword to create a pointer array.

### SIZE

A size vector specifying the type and dimensions of the result. The format of a size vector is given in the description of the SIZE function.

### STRING

Set this keyword to create a string array.

### TYPE

The type code to set the type of the result. See the description of the SIZE function for a list of IDL type codes.

### UINT

Set this keyword to create an unsigned integer array.

### UL64

Set this keyword to create an unsigned 64-bit integer array.

### ULONG

Set this keyword to create an unsigned longword integer array.

### VALUE

The value to initialize each element of the resulting array. VALUE can be a scalar of any type including structure types. The result type is taken from VALUE unless one of the other keywords that specify a type is also set. In that case, VALUE is converted to the type specified by the other keyword prior to initializing the resulting array.

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create a 3-element by 4-element integer array with each element set to the value 5, enter:

```
M = MAKE_ARRAY(3, 4, /INTEGER, VALUE = 5)
```

## Version History

Introduced: 4.0

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, STRARR, UINTARR, ULON64ARR, ULONARR

# MAKE_DLL

The MAKE_DLL procedure builds a sharable library from C language code which is suitable for use by IDL's dynamic linking features such as CALL_EXTERNAL, LINKIMAGE, and dynamically loadable modules (DLMs). MAKE_DLL reduces the complexity of building sharable libraries by providing a stable cross-platform method for the user to describe the desired library, and issuing the necessary operating system commands to build the library.

Although MAKE_DLL is very convenient, it is not intended for use as a general purpose compiler. Instead, MAKE_DLL is specifically targeted to solving the most common IDL dynamic linking problem: building a sharable library from C language source files that are usable by IDL. Because of this, the following requirements apply:

- You must have a C compiler installed on your system. It is easiest to use the compiler used to build IDL, because MAKE_DLL already knows how to use that compiler without any additional configuring. To determine which compiler was used, query the !MAKE_DLL system variable with a print statement such as the following:

  ```
  PRINT, !MAKE_DLL.COMPILER_NAME
  ```

- MAKE_DLL only compiles programs written in the C language; it does not understand Fortran, C++, or any other languages.
- MAKE_DLL provides only the functionality necessary to build C code intended to be linked with IDL. Not every possible option supported by the C compiler or system linker is addressed, only those commonly needed by IDL-related C code.

MAKE_DLL solves the most common IDL-centric problem of linking C code with IDL. To do more than this or to use a different language requires a system-specific building process (e.g. make files, projects, etc...).

## Syntax

MAKE_DLL, *InputFiles* [, *OutputFile*], *ExportedRoutineNames* [, CC=*string*]
[, COMPILE_DIRECTORY=*path*] [, DLL_PATH=*variable*]
[, EXPORTED_DATA=*string*] [, EXTRA_CFLAGS=*string*]
[, EXTRA_LFLAGS=*string*] [, INPUT_DIRECTORY=*path*] [, LD=*string*]
[, /NOCLEANUP] [, OUTPUT_DIRECTORY=*path*] [, /REUSE_EXISTING]
[, /SHOW_ALL_OUTPUT] [, /VERBOSE]

# Arguments

## InputFiles

A string (scalar or array) giving the names of the input C program files to be compiled by MAKE_DLL. These names should not include any directory path information or the `.c` suffix, they are simply the base file names.

The input directory is specified using the INPUT_DIRECTORY keyword, and the `.c` file suffix is assumed.

## OutputFile

The base name of the resulting sharable library. This name should not include any directory path information or the sharable library suffix, which differs between platforms (for example: `.so`, `.a`, `.sl`, `.exe`, `.dll`).

The output directory can be specified using the OUTPUT_DIRECTORY keyword.

If the *OutputFile* argument is omitted, the first name given by *InputFile* is used as the base name of output file.

## ExportedRoutineNames

A string (scalar or array) specifying the names of the routines to be exported (i.e., that are visible for linking) from the resulting sharable library.

# Keywords

## CC

If present, a template string to use in generating the C compiler commands to compile *InputFiles*. If CC is not specified, the value given by the !MAKE_DLL.CC system variable is used by default. See the discussion of !MAKE_DLL for a description of how to write the format string for CC.

## COMPILE_DIRECTORY

To build a sharable library, MAKE_DLL requires a place to create the necessary intermediate files and possibly the final library itself. If COMPILE_DIRECTORY is specified, the directory specified is used. If COMPILE_DIRECTORY is not specified, the directory given by the !MAKE_DLL.COMPILE_DIRECTORY system variable is used.

## DLL_PATH

If present, the name of a variable to receive the complete file path for the newly created sharable library. The location of the resulting sharable library depends on the setting of the OUTPUT_DIRECTORY or COMPILE_DIRECTORY keywords as well as the !MAKE_DLL.COMPILE_DIRECTORY system variable, and different platforms use different file suffixes to indicate sharable libraries. Use of the DLL_PATH keyword makes it possible to determine the resulting file path in a simple and portable manner.

## EXPORTED_DATA

A string (scalar or array) containing the names of variables to be exported (i.e., are visible for linking) from the resulting sharable library.

## EXTRA_CFLAGS

If present, a string supplying extra options for the command used to execute the C compiler to compile the files given by *InputFiles*. This keyword is frequently used to specify header file include directories. This text is inserted in place of the %X format code in the compile string. See the discussion of the CC keyword and !MAKE_DLL.CC system variable for more information.

## EXTRA_LFLAGS

If present, a string supplying extra options for the command used to execute the linker when combining the object files to produce the sharable library. This keyword is frequently used to specify libraries to be included in the link, and is inserted in place of the %X format code in the linker string. See the discussion of the LD keyword and !MAKE_DLL.LD system variable for more information.

## INPUT_DIRECTORY

If present, the path to the directory containing the source C files listed in *InputFiles*. If INPUT_DIRECTORY is not specified, the directory given by COMPILE_DIRECTORY is assumed to contain the files.

## LD

If present, a template string to use when generating the linker command to generate the resulting sharable library. If LD is not specified, the value given by the !MAKE_DLL.LD system variable is used by default. See the discussion of !MAKE_DLL for a description of how to write the format string for LD.

## NOCLEANUP

To produce a sharable library, MAKE_DLL produces several intermediate files:

1. A shell script (UNIX) or batch file (Windows) that is then executed via SPAWN to build the library.
2. A linker options file. This file is used to control the linker. MAKE_DLL uses it to cause the routines given by the *ExportedRoutineNames* argument (and EXPORTED_DATA keyword) to be exported from the resulting sharable library. The general platform terminology is shown below.

| Platform | Linker Options File Terminology |
|---|---|
| UNIX | export file, or linker map file |
| Windows | a `.DEF` file |

*Table 57: Platform Terminology for Linker Options File*

3. Object files, resulting from compiling the source C files given by the *InputFiles* argument.
4. A log file that captures the output from executing the script, and which can be used for debugging in case of error.

By default, MAKE_DLL deletes all of these intermediate files once the sharable library has been successfully built. Setting the NOCLEANUP keyword prevents MAKE_DLL from removing them.

**Note**

Set the NOCLEANUP keyword (possibly in conjunction with VERBOSE) for troubleshooting, or to read the files for additional information on how MAKE_DLL works.

## OUTPUT_DIRECTORY

By default, MAKE_DLL creates the resulting sharable library in the compile directory specified by the COMPILE_DIRECTORY keyword or the !MAKE_DLL.COMPILE_DIRECTORY system variable. The OUTPUT_DIRECTORY keyword can be used to override this and explicitly specify where the library file should go.

### REUSE_EXISTING

If this keyword is set, and the sharable library file specified by *OutputFile* already exists, MAKE_DLL returns without building the sharable library again. Use this keyword in situations where you wish to ensure that a library exists, but only want to build it if it does not. Combining the REUSE_EXISTING and DLL_PATH keywords allows you to get a path to the library in a platform independent manner, building the library only if necessary.

### SHOW_ALL_OUTPUT

MAKE_DLL normally produces no output unless an error prevents successful building of the sharable library. Set SHOW_ALL_OUTPUT to see all output produced by the spawned process building the library.

### VERBOSE

If set, VERBOSE causes MAKE_DLL to issue informational messages as it carries out the task of building the sharable library. These messages include information on the intermediate files created to build the library and how they are used.

### Obsolete Keywords

The following keywords are obsolete:

- VAX_FLOAT

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Examples

### Example 1: Testmodule DLM

The IDL distribution contains an example of a simple DLM (dynamically loadable module) in the `external/dlm` subdirectory. This example consists of a single C source file, and the desired sharable library exports a single function called IDL_Load. The following MAKE_DLL statement builds this sharable library, leaving the resulting file in the directory given by !MAKE_DLL.COMPILE_DIRECTORY:

```
; Locate the source file:
INDIR = FILEPATH('', SUBDIRECTORY=['external', 'dlm'])
; Build the sharable library:
MAKE_DLL, 'testmodule', 'IDL_Load', INPUT_DIRECTORY=INDIR
```

### Example 2: Using GCC

IDL is built with the standard vendor-supported C compiler in order to get maximum integration with the target system. MAKE_DLL assumes that you have the same compiler installed on your system and its defaults are targeted to use it. To use other compilers, you tell MAKE_DLL how to use them.

For example, many IDL users have the gcc compiler installed on their systems. This example (tested under 32-bit Solaris 7 using gcc 2.95.2) shows how to use gcc to build the testmodule sharable library from the previous example:

```
; We need the include directory for the IDL export.h header
; file. One way to get this is to extract it from the
; !MAKE_DLL system variable using the STREGEX function
INCLUDE=STREGEX(!MAKE_DLL.CC, '-I[^ ]+', /EXTRACT)
; Locate the source file
INDIR = FILEPATH('', SUBDIRECTORY=['external', 'dlm'])
; Build the sharable library, using the CC keyword to specify gcc:
MAKE_DLL, 'testmodule', 'IDL_Load', INPUT_DIRECTORY=INDIR, $
   CC='gcc -c -fPIC '+ INCLUDE + '%C -o %O'
```

## Version History

Introduced: 5.4

REUSE_EXISTING keyword added: 5.6

## See Also

!MAKE_DLL

# MAP_2POINTS

The MAP_2POINTS function returns parameters such as distance, azimuth, and path relating to the great circle or rhumb line connecting two points on a sphere.

This routine is written in the IDL language. Its source code can be found in the file `map_2points.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = MAP_2POINTS( *lon0*, *lat0*, *lon1*, *lat1* [, DPATH=*value* | , /METERS | , /MILES | , NPATH=*integer*{2 or greater} | , /PARAMETERS | , RADIUS=*value*] [, /RADIANS] [, /RHUMB] )

## Return Value

This function returns a two-element vector containing the distance and azimuth of the great circle or rhumb line connecting the two points, P0 to P1, in the specified angular units, unless one or more of the keywords NPATH, DPATH, METERS, MILES, PARAMETERS, or RADIUS is specified. See the keyword descriptions for the return value associated with each of these keywords.

If MILES, METERS, or RADIUS is not set, distances are angular distance, from 0 to 180 degrees (or 0 to !DPI if the RADIANS keyword is set). Azimuth is measured in degrees or radians, east of north.

## Arguments

### Lon0, Lat0

Longitude and latitude of the first point, P0.

### Lon1, Lat1

Longitude and latitude of the second point, P1.

## Keywords

### DPATH

Set this keyword to a value specifying the maximum angular distance between the points on the path in the prevalent units, degrees or radians.

## METERS

Set this keyword to return the distance between the two points in meters, calculated using the Clarke 1866 equatorial radius of the earth.

## MILES

Set this keyword to return the distance between the two points in miles, calculated using the Clarke 1866 equatorial radius of the earth.

## NPATH

Set this keyword to a value specifying the number of points to return. If this keyword is set, the function returns a (2, NPATH) array containing the longitude/latitude of the points on the great circle or rhumb line connecting P0 and P1. For a great circle, the points will be evenly spaced in distance, while for a rhumb line, the points will be evenly spaced in longitude.

**Note**

This keyword must be set to an integer of 2 or greater.

## PARAMETERS

Set this keyword to return the parameters determining the great circle connecting the two points, [sin(c), cos(c), sin(az), cos(az)], where c is the great circle angular distance, and az is the azimuth of the great circle at P0, in degrees east of north.

## RADIANS

Set this keyword if inputs and angular outputs are to be specified in radians. The default is degrees.

## RADIUS

Set this keyword to a value specifying the radius of the sphere to be used to calculate the distance between the two points. If this keyword is specified, the function returns the distance between the two points calculated using the given radius.

## RHUMB

Set this keyword to return the distance and azimuth of the rhumb line connecting the two points, P0 to P1. The default is to return the distance and azimuth of the great circle connecting the two points. A rhumb line is the line of constant direction connecting two points.

# Examples

The following examples use the geocoordinates of two points, Boulder and London:

```
B = [ -105.19, 40.02]   ;Longitude, latitude in degrees.
L = [ -0.07,   51.30]
```

### Example 1

Print the angular distance and azimuth, from B, of the great circle connecting the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1])
```

IDL prints `67.854333    40.667833`

### Example 2

Print the angular distance and course (azimuth), connecting the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1],/RHUMB)
```

IDL prints `73.966283    81.228057`

### Example 3

Print the distance in miles between the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1],/MILES)
```

IDL prints `4693.5845`

### Example 4

Print the distance in miles along the rhumb line connecting the two points:

```
PRINT, MAP_2POINTS(B[0], B[1], L[0], L[1], /MILES, /RHUMB)
```

IDL prints `5116.3571`

### Example 5

Display a map containing the two points, and annotate the map with both the great circle and the rhumb line path between the points, drawn at one degree increments:

```
MAP_SET, /MOLLWEIDE, 40,-50, /GRID, SCALE=75e6,/CONTINENTS
PLOTS, MAP_2POINTS(B[0], B[1], L[0], L[1],/RHUMB, DPATH=1)
PLOTS, MAP_2POINTS(B[0], B[1], L[0], L[1],DPATH=1)
```

This displays the following map:

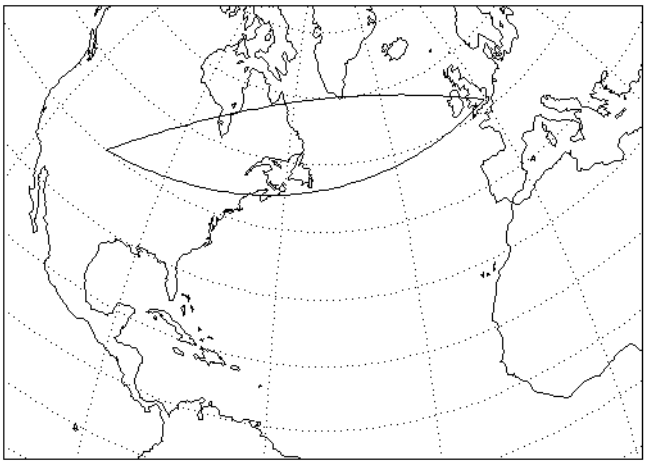


*Figure 11: Map annotated with great circle and rhumb line path between Boulder and London, drawn at one degree increments.*

## Version History

Introduced: 5.4

## See Also

MAP_SET

# MAP_CONTINENTS

The MAP_CONTINENTS procedure draws continental boundaries, filled continents, political boundaries, coastlines, and/or rivers, over an existing map projection established by MAP_SET. Outlines can be drawn in low or high-resolution (if the optional high-resolution CIA World Map database is installed). If MAP_CONTINENTS is called without any keywords, it draws low-resolution, unfilled continent outlines.

MAP_SET must be called before MAP_CONTINENTS to establish the projection type, the center of the projection, polar rotation and geographic limits.

## Syntax

MAP_CONTINENTS [, /COASTS] [, COLOR=*index*] [, /CONTINENTS] [, /COUNTRIES] [ ,FILL_CONTINENTS={1 | 2}[, ORIENTATION=*value*]] [, /HIRES] [, LIMIT=*vector*] [, MLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, MLINETHICK=*value*] [, /RIVERS] [, SPACING=*centimeters*] [, /USA]

**Graphics Keywords:** [, /T3D] [, ZVALUE=*value*{0 to 1}]

## Keywords

### COASTS

Set this keyword to draw coastlines, islands, and lakes instead of the default continent outlines. Note that if you are using the low-resolution map database (if the HIRES keyword is *not* set), many islands are drawn even when COASTS is not set. If you are using the high-resolution map database (if the HIRES keyword *is* set), no islands are drawn unless COASTS is set.

### COLOR

Set this keyword to the color index of the lines being drawn.

### CONTINENTS

Set this keyword to plot the continental boundaries. This is the default, unless COASTS, COUNTRIES, RIVERS and/or USA is set.

**Note**

If you are using the low-resolution map database (if the HIRES keyword is *not* set), outlines for continents, islands, and lakes are drawn when the CONTINENTS

keyword is set. If you are using the high-resolution map database (if the HIRES keyword *is* set), only continental outlines are drawn when the CONTINENTS keyword is set. To draw islands and lakes when using the high-resolution map database, use the COASTS keyword.

**Note**

If you are using the USA and CONTINENTS keywords in conjunction to map the outline of each state in the United States onto an existing outline of the continent, you may see discrepancies in the coastline. This is due to the fact that the two outlines are derived from different databases (the USA keyword uses a geographical database, and the CONTINENTS keyword uses a geological database).

## COUNTRIES

Set this keyword to draw political boundaries as of 1993.

## FILL_CONTINENTS

Set this keyword to 1 to fill continent boundaries with a solid color. The color is set by the COLOR keyword. Set this keyword to 2 to fill continent boundaries with a line fill. For line filling, the COLOR, MLINESTYLE, MLINETHICK, ORIENTATION, and SPACING keywords can be used to control the type of line fill.

**Note**

When using this keyword in conjunction with the HIRES keyword, lakes on continents will be filled and islands will not be filled.

## HIRES

Set this keyword to use high-resolution map data instead of the default low-resolution data. This option is only available if you have installed the optional high-resolution map datasets. If the high-resolution data is not available, a warning is printed and the low-resolution data is used instead.

This keyword can be used in conjunction with the COASTS, COUNTRIES, FILL_CONTINENTS, and RIVERS keywords.

## LIMIT

Set this keyword to a four-element vector [$Lat_{min}$, $Lon_{min}$, $Lat_{max}$, $Lon_{max}$] to only plot continents that pass through the LIMIT rectangle. The points ($Lat_{min}$, $Lon_{min}$) and ($Lat_{max}$, $Lon_{max}$) are the latitudes and longitudes of two points diagonal from

each other on the region’s boundary. The default is to use the limits from the current map projection.

**Note**

Line segments for continents which extend outside of the LIMIT rectangle will still be plotted.

## MLINESTYLE

The line style of the boundaries being drawn. The default is solid lines. Valid linestyles are shown in the table below:

| Index | Linestyle |
|---|---|
| 0 | Solid |
| 1 | Dotted |
| 2 | Dashed |
| 3 | Dash Dot |
| 4 | Dash Dot Dot |
| 5 | Long Dashes |

*Table 58: IDL Linestyles*

## MLINETHICK

The thickness of the boundary or fill lines. The default thickness is 1.

## ORIENTATION

Set this keyword to the counterclockwise angle in degrees from horizontal that the line fill should be drawn. The default is 0. This keyword only has effect if the FILL_CONTINENTS keyword is set to 2.

## RIVERS

Set this keyword to draw rivers.

## SPACING

Set this keyword to the spacing, in centimeters, for a line fill. This keyword only has effect if the FILL_CONTINENTS keyword is set to 2. The default is 0.5 centimeters.

### USA

Set this keyword to draw borders for each state in the United States in addition to continental boundaries.

**Note**

If you are using the USA and CONTINENTS keywords in conjunction to map the outline of each state in the United States onto an existing outline of the continent, you may see discrepancies in the coastline. This is due to the fact that the two outlines are derived from different databases (the USA keyword uses a geographical database, and the CONTINENTS keyword uses a geological database).

### Graphics Keywords Accepted

See Appendix B, "Graphics Keywords", for descriptions of graphics and plotting keywords not listed above. T3D, ZVALUE.

## Examples

The following example demonstrates the use of map outlines to embellish a map projection:

```
; Handle TrueColor displays:
DEVICE, DECOMPOSED=0

; Load discrete color table:
tek_color

; Match color indices to colors we want to use:
black=0 & white=1 & red=2
green=3 & dk_blue=4 & lt_blue=5

; Set up an orthographic projection centered over the north
; Atlantic.Fill the hemisphere with dark blue. Specify black
; gridlines:
MAP_SET,  /ORTHO, 40, -30, 23, /ISOTROPIC, $
   /HORIZON, E_HORIZON={FILL:1, COLOR:dk_blue}, $
   /GRID, COLOR=black

; Fill the continent boundaries with solid white:
MAP_CONTINENTS, /FILL_CONTINENTS, COLOR=white

; Overplot coastline data:
MAP_CONTINENTS, /COASTS, COLOR=black

; Add rivers, in light blue:
```

```
MAP_CONTINENTS, /RIVERS, COLOR=lt_blue

; Show national borders:
MAP_CONTINENTS, /COUNTRIES, COLOR=red, MLINETHICK=2
```

## Version History

Introduced: Pre 4.0

## See Also

MAP_GRID, MAP_IMAGE, MAP_PATCH, MAP_SET

# MAP_GRID

The MAP_GRID procedure draws the graticule of parallels and meridians, according to the specifications established by MAP_SET. MAP_SET must be called before MAP_GRID to establish the projection type, the center of the projection, polar rotation and geographical limits.

## Syntax

MAP_GRID [, /BOX_AXES | [, CLIP_TEXT=0] [, LATALIGN=*value*{0.0 to 1.0}] [, LONALIGN=*value*{0.0 to 1.0}] [, LATLAB=*longitude*] [, LONLAB=*latitude*] [, ORIENTATION=*clockwise_degrees_from_horiz*]] [, CHARSIZE=*value*] [, COLOR=*index*] [, /FILL_HORIZON] [, GLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, GLINETHICK=*value*] [, /HORIZON] [, INCREMENT=*value*] [, LABEL=*n*{label_every_*n*th_gridline}] [, LATDEL=*degrees*] [, LATNAMES=*array*, LATS=*vector*] [, LONDEL=*degrees*] [, LONNAMES=*array*, LONS=*vector*] [, /NO_GRID]

**Graphics Keywords:** [, /T3D] [, ZVALUE=*value*{0 to 1}]

## Keywords

### BOX_AXES

Set this keyword to create box-style axes for map plots where the parallels intersect the sides, and the meridians intersect the bottom and top edges of the box.

### CHARSIZE

Set this keyword to the size of the characters used for the labels. The default is 1.

### CLIP_TEXT

Set this keyword to a zero value to turn off clipping of text labels. By default, text labels are clipped. This keyword is ignored if the BOX_AXES keyword is set.

### COLOR

Set this keyword to the color index for the grid lines.

### FILL_HORIZON

Set this keyword to fill the current map_horizon.

## GLINESTYLE

If set, the line style used to draw the grid of parallels and meridians. See "LINESTYLE" on page 3875 for a list of available linestyles. The default index is 1, drawing a dotted line.

## GLINETHICK

Set this keyword to the thickness of the grid lines. Default is 1.

## HORIZON

Set this keyword to draw the current map horizon.

## INCREMENT

Set this keyword to the spacing between graticle points.

## LABEL

Set this keyword to label the parallels and meridians with their corresponding latitudes and longitudes. Setting this keyword to an integer will cause every LABEL gridline to be labeled (that is, if LABEL=3 then every third gridline will be labeled). The starting point for determining which gridlines are labeled is the minimum latitude or longitude (-180 to 180), unless the LATS or LONS keyword is set to a single value. In this case, the starting point is the value of LATS or LONS.

## LATALIGN

This keyword controls the alignment of the text baseline for latitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it. This keyword is ignored if the BOX_AXES keyword is set.

## LATDEL

Set this keyword equal to the spacing (in degrees) between parallels of latitude in the grid. If this keyword is not set, a suitable value is determined from the current map projection.

## LATLAB

The longitude at which to place latitude labels. The default is the center longitude on the map. This keyword is ignored if the BOX_AXES keyword is set.

## LATNAMES

Set this keyword equal to an array specifying the names to be used for the latitude labels. By default, this array is automatically generated in units of degrees. The LATNAMES array can be either type string or any single numeric type, but should not be of mixed type.

When LATNAMES is specified, the LATS keyword must also be specified. The number of elements in the two arrays need not be equal. If there are more elements in the LATNAMES array than in the LATS array, the extra LATNAMES are ignored. If there are more elements in the LATS array than in the LATNAMES array, labels in degrees will be automatically provided for the missing latitude labels.

The LATNAMES keyword can be also used when the LATS keyword is set to a single value. It this case, the first label supplied will be used at the specified latitude; subsequent names will be placed at the next latitude line to the north, wrapping around the globe if appropriate. Caution should be used when using LATNAMES in conjunction with a single LATS value, since the number of visible latitude gridlines is dependent on many factors.

## LATS

Set this keyword equal to a one or more element vector of latitudes for which lines will be drawn (and optionally labeled). If LATS is omitted, appropriate latitudes will be generated based on the value of the (optional) LATDEL keyword. If LATS is set to a single value, that latitude and a series of automatically generated latitudes will be drawn (and optionally labeled). Automatically generated latitudes have the values:

```
[...,LATS-LATDEL,LATS,LATS+LATDEL,...]
```

over the extent of the map. If LATS is a single value, that value is taken to be the starting point for labelling (See the LABEL keyword).

## LONALIGN

This keyword controls the alignment of the text baseline for longitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it. This keyword is ignored if the BOX_AXES keyword is set.

## LONDEL

Set this keyword equal to the spacing (in degrees) between meridians of longitude in the grid. If this keyword is not set, a suitable value is determined from the current map projection.

## LONLAB

The latitude at which to place longitude labels. The default is the center latitude on the map. This keyword is ignored if the BOX_AXES keyword is set.

## LONNAMES

Set this keyword equal to an array specifying the names to be used for the longitude labels. By default, this array is automatically generated in units of degrees. The LONNAMES array can be either type string or any single numeric type, but should not be of mixed type.

When LONNAMES is specified, the LONS keyword must also be specified. The number of elements in the two arrays need not be equal. If there are more elements in the LONNAMES array than in the LONS array, the extra LONNAMES are ignored. If there are more elements in the LONS array than in the LONNAMES array, labels in degrees will be automatically provided for the missing longitude labels.

The LONNAMES keyword can be also used when the LONS keyword is set to a single value. It this case, the first label supplied will be used at the specified longitude; subsequent names will be placed at the next longitude line to the east, wrapping around the globe if appropriate. Caution should be used when using LONNAMES in conjunction with a single LONS value, since the number of visible longitude gridlines is dependent on many factors.

## LONS

Set this keyword equal to a one or more element vector of longitudes for which lines will be drawn (and optionally labeled). If LONS is omitted, appropriate longitudes will be generated based on the value of the (optional) LONDEL keyword. If LONS is set to a single value, that longitudes and a series of automatically generated longitudes will be drawn (and optionally labeled). Automatically generated longitudes have the values:

```
[...,LONS-LONDEL,LONS,LONS+LONDEL,...]
```

over the extent of the map. If LONS is a single value, that value is taken to be the starting point for labelling (See the LABEL keyword).

## NO_GRID

Set this keyword if you only want labels but not gridlines.

### ORIENTATION

Set this keyword equal to an angle in degrees from horizontal (in the clockwise direction) to rotate the labels. This keyword is ignored if the BOX_AXES keyword is set.

### Graphics Keywords Accepted

See Appendix B, “Graphics Keywords”, for descriptions of graphics and plotting keywords not listed above. T3D, ZVALUE.

## Examples

The following example creates an orthographic projection, defines which latitudes to label, and provides text labels. Note that the text labels are rotated to match the orientation of the map projection.

```
; Set up an orthographic projection:
MAP_SET, /ORTHO, 10, 20, 30, /ISOTROPIC, /CONTINENTS, /HORIZON
; Define latitudes of interest:
lats = [ -80, -45, -30, -20, 0, 15, 27, 35, 45, 55, 75]
; Create string equivalents of latitudes:
latnames = strtrim(lats, 2)
; Label the equator:
latnames(where(lats eq 0)) = 'Equator'
; Draw the grid:
MAP_GRID, LABEL=2, LATS=lats, LATNAMES=latnames, LATLAB=7, $
   LONLAB=-2.5, LONDEL=20, LONS=-15, ORIENTATION=-30
```

## Version History

Introduced: Pre 4.0

## See Also

MAP_CONTINENTS, MAP_IMAGE, MAP_PATCH, MAP_SET

# MAP_IMAGE

The MAP_IMAGE function warps an image (or other dataset) to the current map projection. This function provides an easy method for displaying geographical data as an image on a map. The MAP_SET procedure should be called prior to calling MAP_IMAGE.

MAP_IMAGE works in image (graphic) space. For each destination pixel (when COMPRESS is set to one) MAP_IMAGE calculates the latitude and longitude by applying the inverse map projection. This latitude and longitude are then used to index and interpolate the *Image* argument, obtaining an interpolated value for the destination pixel. The time required by MAP_IMAGE depends mainly on the number of pixels in the destination and the setting of the COMPRESS parameter.

**Note**

MAP_IMAGE is more efficient than MAP_PATCH when the input data set is large compared to the destination area. If the converse is true, MAP_PATCH is more efficient.

## Syntax

*Result* = MAP_IMAGE( *Image* [, *Startx*, *Starty* [, *Xsize*, *Ysize*]]
[, LATMIN=*degrees*{-90 to 90}] [, LATMAX=*degrees*{-90 to 90}]
[, LONMIN=*degrees*{-180 to 180}] [, LONMAX=*degrees*{-180 to 180}]
[, /BILINEAR] [, COMPRESS=*value*] [, SCALE=*value*] [, MAX_VALUE=*value*]
[, MIN_VALUE=*value*] [, MISSING=*value*] )

## Return Value

Returns the image or dataset warped to the current map projection.

## Arguments

### Image

A two-dimensional array containing the image to be overlaid on the map.

### Startx

A named variable that, upon return, contains the X coordinate position where the left edge of the image should be placed on the screen.

### Starty

A named variable that, upon return, contains the Y coordinate position where the left edge of the image should be placed on the screen.

### Xsize

A named variable that, upon return, contains the width of the image expressed in graphic coordinate units. If the current graphics device uses scalable pixels, the values of *Xsize* and *Ysize* should be passed to the TV procedure.

### Ysize

A named variable that, upon return, contains the height of the image expressed in graphic coordinate units. If the current graphics device uses scalable pixels, the values of *Xsize* and *Ysize* should be passed to the TV procedure.

## Keywords

### LATMIN

The latitude corresponding to the first row of *Image*. The default is -90 degrees. Note also that -90° ≤ LATMIN < LATMAX ≤ 90°.

### LATMAX

The latitude corresponding to the last row of *Image*. The default value is 90 degrees. Note also that -90° ≤ LATMIN < LATMAX ≤ 90°.

### LONMIN

The longitude corresponding to the first (leftmost) column of the *Image* argument. Select LONMIN so that -180° ≤ LONMIN ≤ 180°. The default value is -180.

### LONMAX

The longitude corresponding to the last (rightmost) column of the *Image* argument. Select LONMAX so that it is larger than LONMIN. If the longitude of the last column is equal to (LONMIN - (360. /*Nx*)) MODULO 360, it is assumed that the image covers all longitudes (*Nx* being the total number of columns in the *Image* argument).

### BILINEAR

Set this flag to use bilinear interpolation to soften edges in the returned image, otherwise, nearest neighbor sampling is used.

### COMPRESS

This keyword, the interpolation compression flag, controls the accuracy of the results from MAP_IMAGE. The default is 4 for output devices with fixed pixel sizes. The inverse projection transformation is applied to each *i*th row and column. Setting this keyword to a higher number saves time while lower numbers produce more accurate results. Setting this keyword to 1 solves the inverse map transformation for every pixel of the output image.

### SCALE

Set this keyword to the pixel/graphics scale factor for devices with scalable pixels (e.g., PostScript). The default is 0.02 pixels/graphic coordinate. This setting yields an approximate output image size of 350 x 250. Make this number larger for more resolution (and larger PostScript files and images), or smaller for faster, smaller, and less accurate images.

### MAX_VALUE

Data points with values equal to or greater than this value will be treated as missing data, and will be set to the value specified by the MISSING keyword.

### MIN_VALUE

Data points with values equal to or less than this value will be treated as missing data, and will be set to the value specified by the MISSING keyword.

### MISSING

The pixel value to set areas outside the valid map coordinates. If this keyword is omitted, areas outside the map are set to 255 (white) if the current graphics device is PostScript, otherwise they are set to 0.

## Examples

The following lines of code set up an orthographic map projection and warp a simple image to it.

```
; Create a simple image to be warped:
image = BYTSCL(SIN(DIST(400)/10))
```

```
; Display the image so we can see what it looks like before
; warping:
TV, image
latmin = -65
latmax = 65

; Left edge is 160 East:
lonmin = 160

; Right edge is 70 West = +360:
lonmax = -70 + 360
MAP_SET, 0, -140, /ORTHOGRAPHIC, /ISOTROPIC, $
   LIMIT=[latmin, lonmin, latmax, lonmax]
result = MAP_IMAGE(image,Startx,Starty, COMPRESS=1, $
   LATMIN=latmin, LONMIN=lonmin, $
   LATMAX=latmax, LONMAX=lonmax)

; Display the warped image on the map at the proper position:
TV, result, Startx, Starty

; Draw gridlines over the map and image:
MAP_GRID, latdel=10, londel=10, /LABEL, /HORIZON

; Draw continent outlines:
MAP_CONTINENTS, /coasts
```

## Version History

Introduced: Pre 4.0

## See Also

MAP_CONTINENTS, MAP_GRID, MAP_PATCH, MAP_SET

# MAP_PATCH

The MAP_PATCH function warps an image (or other dataset) to the current map projection. Mapping coordinates should be setup via a call to MAP_SET before using MAP_PATCH.

MAP_PATCH works in object (data) space. It divides the input data set, *Image_Orig*, into triangular patches, either directly from the implicit rectangular grid, or by triangulating the data points on the surface of the sphere using the TRIANGULATE procedure. These triangular patches are then projected to the map plane in the image space of the destination array and then interpolated. The time required by MAP_PATCH depends mainly on the number of elements in the input array.

**Note**

MAP_PATCH is more efficient than MAP_IMAGE when the destination area is large compared to the input data set. If the converse is true, MAP_IMAGE is more efficient.

This routine is written in the IDL language. Its source code can be found in the file `map_patch.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = MAP_PATCH( *Image_Orig* [, *Lons*, *Lats*] [, LAT0=*value*] [, LAT1=*value*] [, LON0=*value*] [, LON1=*value*] [, MAX_VALUE=*value*] [, MISSING=*value*] [, /TRIANGULATE] [, XSIZE=*variable*] [, XSTART=*variable*] [, YSIZE=*variable*] [, YSTART=*variable*] )

## Return Value

Returns the image or dataset warped to the current map projection.

## Arguments

### Image_Orig

A one- or two-dimensional array that contains the data to be overlaid on the map. If the TRIANGULATE keyword is not set, *Image_Orig* must be a two-dimensional array. Rows and columns must be arranged in increasing longitude and latitude order. Also, the corner points of each cell must be contiguous. This means that the seam of a map must lie on a cell boundary, not in its interior, splitting the cell.

### Lons

An optional vector that contains the longitude value for each column in *Image_Orig*. If *Lons* is a one-dimensional vector, longitude (*Image_Orig*[i,j]) = *Lons*[i]; if *Lons* is a two-dimensional vector, longitude (*Image_Orig*[i,j]) = *Lons*[i,j].

This argument can be omitted if the longitudes are equally-spaced and the beginning and ending longitudes are specified with the LON0 and LON1 keywords.

### Lats

An optional vector that contains the latitude value for each row in *Image_Orig*. If *Lats* is a one-dimensional vector, latitude (*Image_Orig*[i,j]) = *Lats*[i]; if *Lats* is a two-dimensional vector, latitude (*Image_Orig*[i,j]) = *Lats*[i,j].

This argument can be omitted if the latitudes are equally-spaced and the beginning and ending latitudes are specified with the LAT0 and LAT1 keywords.

## Keywords

### LAT0

The latitude of the first row of data. The default is -90.

### LAT1

The latitude of the last row of data. The default is +90.

### LON0

The longitude of the first column of data. The default is -180.

### LON1

The longitude of the last column of data. The default is 180 - (360/Number-of-Rows)

### MAX_VALUE

The largest data value to be warped. Values in *Image_Orig* greater than this value are considered missing. Pixels in the output image that correspond to these missing values are set to the value specified by the MISSING keyword.

### MISSING

Set this keyword to a value to be used for areas outside the valid map coordinates (i.e., the “background color”). If the current plotting device is PostScript, the default is 255 (white). Otherwise, the default is 0 (usually black).

### TRIANGULATE

Set this keyword to convert the input data to device space and triangulate them. This keyword must be specified if the connectivity of the data points is not rectangular and monotonic in device space.

### XSIZE

Set this keyword to a named variable in which the width of the output image is returned, in graphic coordinate units. If the current graphics device has scalable pixels (e.g., PostScript), the values returned by XSIZE and YSIZE should be passed to the TV procedure.

### XSTART

Set this keyword to a named variable in which the X coordinate where the left edge of the image should be placed on the screen is returned.

### YSIZE

Set this keyword to a named variable in which the height of the output image is returned, in graphic coordinate units. If the current graphics device has scalable pixels (e.g., PostScript), the values returned by XSIZE and YSIZE should be passed to the TV procedure.

### YSTART

Set this keyword to a named variable in which the Y coordinate where the bottom edge of the image should be placed on the screen is returned.

## Examples

```
; Form a 24 x 24 dataset on a sphere:
n = 24

; Specify equally gridded latitudes:
lat = replicate(180./(n-1),n) # findgen(n) - 90
```

```
; Specify equally gridded longitudes:
lon = findgen(n) # replicate(360./(n-1), n)

; Convert to Cartesian coordinates:
x = cos(lon * !dtor) * cos(lat * !dtor)
y = sin(lon * !dtor) * cos(lat * !dtor)
z = sin(lat * !dtor)

; Set interpolation function to scaled distance squared
; from (1,1,0):
f = BYTSCL((x-1)^2 + (y-1)^2 + z^2)

; Set up projection:
MAP_SET, 90, 0, /STEREO, /ISOTROPIC, /HORIZ

; Grid and display the data:
TV, MAP_PATCH(f, XSTART=x0, YSTART=y0), x0, y0

; Draw gridlines over the map and image:
MAP_GRID

; Draw continent outlines:
MAP_CONTINENTS

; Draw a horizon line:
MAP_HORIZON
```

## Version History

Introduced: 4.0

## See Also

MAP_CONTINENTS, MAP_GRID, MAP_IMAGE, MAP_SET

# MAP_PROJ_FORWARD

The MAP_PROJ_FORWARD function transforms map coordinates from longitude and latitude to Cartesian (x, y) coordinates, using either the !MAP system variable or a supplied map projection structure.

## Syntax

*Result* = MAP_PROJ_FORWARD(*Longitude* [, *Latitude*]
[, CONNECTIVITY=*vector*] [, MAP_STRUCTURE=*value*]
[, POLYGONS=*variable*] [, POLYLINES=*variable*] [, /RADIANS] )

## Return Value

The result is a (2, *n*) array containing the Cartesian (x, y) coordinates.

**Note**

If the POLYGONS or POLYLINES keyword is present, the number of points in the result may be different than the number of input points, depending upon whether clipping and splitting occurs.

## Arguments

### Longitude

An *n*-element vector containing the longitude values. If the *Latitude* argument is omitted, *Longitude* must be a (2, *n*) array of longitude and latitude pairs.

### Latitude

An *n*-element vector containing latitude values. If this argument is omitted, *Longitude* must be a (2, *n*) array of longitude and latitude pairs.

## Keywords

### CONNECTIVITY

Set this keyword to a vector containing an input connectivity list for polygons or polylines. The CONNECTIVITY keyword allows you to specify multiple polygons or polylines using a single array. The CONNECTIVITY list is a one-dimensional integer array of the form:

$$\left[m_1, i_0, i_1, \ldots, i_{m_1-1}, m_2, i_0, i_1, \ldots, i_{m_2-1}, \ldots, m_n, i_0, i_1, \ldots, i_{m_n-1}\right]$$

where each $m_j$ is an integer specifying the number of vertices that define the polyline or polygon (the *vertex count*), and each associated set of $i_0 \ldots i_{m-1}$ are indices into the arrays of vertices specified by the *Longitude* and *Latitude* arguments.

For example, to draw polylines between the first, third, and sixth longitude and latitude values and the fourth, sixth, ninth, and tenth longitude and latitude values, set the CONNECTIVITY array equal to `[3,0,2,5,4,3,5,8,9]`.

To ignore a set of entries in the CONNECTIVITY array, set the vertex count, $m_j$, equal to zero. (Note that if you set an *m* equal to zero, you must remove the associated set of $i_0 \ldots i_{m-1}$ values as well.) To ignore the remaining entries in the CONNECTIVITY array, set the vertex count, $m_j$, equal to -1.

This keyword is ignored if neither POLYGONS nor POLYLINES are present.

## MAP_STRUCTURE

Set this keyword to a !MAP structure variable containing the projection parameters, as constructed by the MAP_PROJ_INIT. If this keyword is omitted, the !MAP system variable is used.

## POLYGONS

Set this keyword to a named variable that will contain a connectivity array of the form described above in the CONNECTIVITY keyword.

If this keyword is present, the arrays specified by the *Longitude* and *Latitude* arguments are assumed to be the vertices of a closed polygon. In this case, polygon clipping and splitting is performed in addition to the map transform, and the connectivity array is returned in the specified variable.

If this keyword is not present, the arrays specified by the *Longitude* and *Latitude* arguments are assumed to be independent points and no clipping or splitting is performed.

## POLYLINES

Set this keyword to a named variable that will contain a connectivity array of the form described above in the CONNECTIVITY keyword.

If this keyword is present, the arrays specified by the *Longitude* and *Latitude* arguments are assumed to be the vertices of a polyline. In this case, polyline clipping and splitting is performed in addition to the map transform, and the connectivity array is returned in the specified variable.

If this keyword is not present, the arrays specified by the *Longitude* and *Latitude* arguments are assumed to be independent points and no clipping or splitting is performed.

### RADIANS

Set this keyword to indicate that the input longitude and latitude coordinates are in radians. By default, coordinates are assumed to be in degrees.

## Example

The following example creates a latitude and longitude grid with labels for the Goodes Homolosine map projection.

```
; Helper function. Constructs the polyline objects.
PRO Ex_Map_AddPolyline, label, $
  gridLon, gridLat, sMap, oModel, oContainer, oFont, $
  LONGITUDE = longitude

longitude = KEYWORD_SET(longitude)

  ; Transform from lat/lon to X/Y cartesian.
gridUV = MAP_PROJ_FORWARD(gridLon, gridLat, $
    MAP=sMap, POLYLINES = gridPoly)
IF (N_ELEMENTS(gridUV) LT 2) THEN $
    RETURN

  ; Construct label object if desired.
IF (label NE '') THEN BEGIN
    oLabel = OBJ_NEW('IDLgrText', label, $
      ALIGN = longitude ? 0.5 : 1, $
      FONT = oFont, VERTICAL_ALIGN=0.5)
    oContainer->Add, oLabel
ENDIF

; Create the polyline object.
oModel->Add, OBJ_NEW('IDlgrPolyline', gridUV, $
    LABEL_OBJ = oLabel, $
    LABEL_OFFSET = longitude ? 0.35 : 0, $
    /USE_LABEL_ORIENTATION, /USE_TEXT_ALIGN, $
    POLYLINE = gridPoly)
```

```
END

; Main function. Creates a grid over a map projection.
PRO Ex_Map_Proj_Forward

; Construct !MAP structure containing the projection.
sMap = MAP_PROJ_INIT('Goodes Homolosine')

; Create a graphics model to hold the visualizations.
oModel = OBJ_NEW('IDLgrModel')
oContainer = OBJ_NEW('IDL_Container')
oFont = OBJ_NEW('IDLgrFont', SIZE = 4)
oContainer -> Add, oFont
deg = STRING(176b)  ; degrees symbol in Truetype

; Latitude lines.
gridLon = DINDGEN(361) - 180
latitude = 15*(INDGEN(11) - 5)

FOR i = 0,(N_ELEMENTS(latitude) - 1) DO BEGIN
  lat = latitude[i]
  gridLat = REPLICATE(lat, 361)

  ; Create the latitude label.
  label = (lat EQ 0) ? 'Equ' : $
    STRTRIM(ABS(lat),2) + deg + (['N','S'])[lat LT 0]
  Ex_Map_Addpolyline, label, gridLon, gridLat, $
    sMap, oModel, oContainer, oFont
ENDFOR

; Longitude lines.
gridLat = DINDGEN(181) - 90

; Add in some extra lines for the Goode projections.
longitude = [20*(DINDGEN(18) - 9), $
  -179.999d, -20.001d, -100.001d, -40.001d, 80.001d]

FOR i = 0,N_ELEMENTS(longitude) - 1 DO BEGIN
  lon = longitude[i]
  gridLon = REPLICATE(lon, 181)

  ; Create the longitude label.
  label = STRTRIM(ROUND(ABS(lon)),2) + deg
  IF ((lon mod 180) NE 0) THEN $
    label = label + (['E','W'])[lon LT 0]
  IF (lon NE FIX(lon)) THEN label = ''

  Ex_Map_Addpolyline, label, gridLon, gridLat, $
    sMap, oModel, oContainer, oFont, /LONGITUDE
```

```
ENDFOR

; Visualize our map projection.
XOBJVIEW, oModel, SCALE = 0.9, /BLOCK

; Clean up our objects.
OBJ_DESTROY, [oModel, oContainer]

END
```

## Version History

Introduced: 5.6

## See Also

MAP_PROJ_INIT, MAP_PROJ_INVERSE

# MAP_PROJ_INFO

The MAP_PROJ_INFO procedure returns information about the current map and/or the available projections. To establish a current projection, mapping parameters should be setup via a call to MAP_SET.

## Syntax

MAP_PROJ_INFO [, *iproj*] [, AZIMUTHAL=*variable*] [, CIRCLE=*variable*] [, CYLINDRICAL=*variable*] [, /CURRENT] [, LL_LIMITS=*variable*] [, NAME=*variable*] [, PROJ_NAMES=*variable*] [, UV_LIMITS=*variable*] [, UV_RANGE=*variable*]

## Arguments

### Iproj

The projection index. If the CURRENT keyword is set, then the index of the current map projection is returned in Iproj.

## Keywords

### AZIMUTHAL

Set this keyword to a named variable that, upon return, will be set to 1 if the projection is azimuthal and 0 otherwise.

### CIRCLE

Set this keyword to a named variable that, upon return, will be set to 1 if the projection is circular or elliptical and 0 otherwise.

### CURRENT

Set this keyword to use the current projection index and return that index in *Iproj*.

### CYLINDRICAL

Set this keyword to a named variable that, upon return, will be set to 1 if the projection is cylindrical and 0 otherwise.

### LL_LIMITS

Set this keyword to a named variable that will contain the geocoordinate rectangle of the current map in degrees, [Latmin, Lonmin, Latmax, Lonmax]. This range may not always be available, especially if the LIMIT keyword was not specified in the call to MAP_SET. If either or both the longitude and latitude range are not available, the minimum and maximum values will be set to zero.

### NAME

Set this keyword to a named variable that will contain the name of the projection.

### PROJ_NAMES

Set this keyword to a named variable that will contain a string array containing the names of the available projections, ordered by their indices. The first projection name is stored in element one.

### UV_LIMITS

Set this keyword to a named variable that will contain the UV bounding box of the current map, [Umin, Vmin, Umax, Vmax].

### UV_RANGE

Set this keyword to a named variable that will contain the UV coordinate limits of the selected map projection, [Umin, Vmin, Umax, Vmax]. UV coordinates are mapped to normalized coordinates using the system variables !X.S and !Y.S. These limits are dependent upon the selected projection, but independent of the current map.

## Examples

```
; Establish a projection
MAP_SET, /MERCATOR

;Obtain projection characteristics
MAP_PROJ_INFO, /CURRENT, NAME=name, AZIMUTHAL=az, $
CYLINDRICAL=cyl, CIRCLE=cir
```

On return, the variables will be set as follows:

```
AZIM     INT  =  0
CIRC     INT  =  0
CYL      INT  =  1
NAME     STRING  'Mercator'
```

## Version History

Introduced: 5.0

## See Also

MAP_SET

# MAP_PROJ_INIT

The MAP_PROJ_INIT function initializes a mapping projection, using either IDL's own map projections or map projections from the U.S. Geological Survey's General Cartographic Transformation Package (GCTP). GCTP version 2.0 is included with IDL.

**Note**

The !MAP system variable is unaffected by MAP_PROJ_INIT. To use the map projection returned by MAP_PROJ_INIT for direct or object graphics, use the MAP_PROJ_FORWARD and MAP_PROJ_INVERSE functions to convert longitude/latitude values into Cartesian (x, y) coordinates before visualization.

This routine is written in the IDL language. Its source code can be found in `map_proj_init.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = MAP_PROJ_INIT(*Projection* [, DATUM=*value*] [, /GCTP]
[, LIMIT=*vector*] [, /RADIANS] [, /RELAXED] )

**Keywords—Projection Parameters:**

[, CENTER_AZIMUTH=*value*] [, CENTER_LATITUDE=*value*]
[, CENTER_LONGITUDE=*value*] [, FALSE_EASTING=*value*]
[, FALSE_NORTHING=*value*] [, HEIGHT=*value*]
[, HOM_AZIM_LONGITUDE=*value*] [, HOM_AZIM_ANGLE=*value*]
[, HOM_LATITUDE1=*value*] [, HOM_LATITUDE2=*value*]
[, HOM_LONGITUDE1=*value*] [, HOM_LONGITUDE2=*value*]
[, IS_ZONES=*value*] [, IS_JUSTIFY=*value*] [, MERCATOR_SCALE=*value*]
[, OEA_ANGLE=*value*] [, OEA_SHAPEM=*value*] [, OEA_SHAPEN=*value*]
[, ROTATION=*value*] [, SEMIMAJOR_AXIS=*value*] [, SEMIMINORAXIS=*value*]
[, SOM_INCLINATION=*value*] [, SOM_LONGITUDE=*value*]
[, SOM_PERIOD=*value*] [, SOM_RATIO=*value*] [, SOM_FLAG=*value*]
[, SOM_LANDSAT_NUMBER=*value*] [, SOM_LANDSAT_PATH=*value*]
[, SPHERE_RADIUS=*value*] [, STANDARD_PARALLEL=*value*]
[, STANDARD_PAR1=*value*] [, STANDARD_PAR2=*value*] [, SAT_TILT=*value*]
[, TRUE_SCALE_LATITUDE=*value*] [, ZONE=*value*]

# Return Value

The result is a !MAP structure containing the map parameters, which can be used as input to the map transformation functions MAP_PROJ_FORWARD and MAP_PROJ_INVERSE.

# Arguments

## Projection

Set this argument to either a projection index or a scalar string containing the name of the map projection, as described in following tables:

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 1 | Stereographic | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 2 | Orthographic | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 3 | Lambert Conic | SPHERE_RADIUS, STANDARD_PAR1, STANDARD_PAR2, CENTER_LONGITUDE, CENTER_LATITUDE |
| 4 | Lambert Azimuthal | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 5 | Gnomonic | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 6 | Azimuthal Equidistant | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |

*Table 59: IDL Projections*

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 7 | Satellite | SPHERE_RADIUS, HEIGHT, SAT_TILT, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 8 | Cylindrical | SPHERE_RADIUS, CENTER_AZIMUTH, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 9 | Mercator | SPHERE_RADIUS, CENTER_AZIMUTH, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 10 | Mollweide | SPHERE_RADIUS, CENTER_AZIMUTH, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 11 | Sinusoidal | SPHERE_RADIUS, CENTER_AZIMUTH, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 12 | Aitoff | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 13 | Hammer Aitoff | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 14 | Albers Equal Area Conic | SPHERE_RADIUS, STANDARD_PAR1, STANDARD_PAR2, CENTER_LONGITUDE, CENTER_LATITUDE |
| 15 | Transverse Mercator | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, MERCATOR_SCALE, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 16 | Miller Cylindrical | SPHERE_RADIUS, CENTER_AZIMUTH, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |

*Table 59: IDL Projections (Continued)*

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 17 | Robinson | SPHERE_RADIUS, CENTER_AZIMUTH, CENTER_LONGITUDE, CENTER_LATITUDE, ROTATION |
| 18 | Lambert Ellipsoid Conic | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, STANDARD_PAR1, STANDARD_PAR2, CENTER_LONGITUDE, CENTER_LATITUDE |
| 19 | Goodes Homolosine | SPHERE_RADIUS, CENTER_LONGITUDE |

*Table 59: IDL Projections (Continued)*

The following are GCTP projections:

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 101 | UTM | CENTER_LONGITUDE, CENTER_LATITUDE, ZONE |
| 102 | State Plane | ZONE |
| 103 | Albers Equal Area | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, STANDARD_PAR1, STANDARD_PAR2, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 104 | Lambert Conformal Conic | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, STANDARD_PAR1, STANDARD_PAR2, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 105 | Mercator | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, CENTER_LONGITUDE, TRUE_SCALE_LATITUDE, FALSE_EASTING, FALSE_NORTHING |

*Table 60: GCTP Projections*

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 106 | Polar Stereographic | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 107 | Polyconic | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 108 | Equidistant Conic A | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, STANDARD_PARALLEL, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 208 | Equidistant Conic B | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, STANDARD_PAR1, STANDARD_PAR2, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 109 | Transverse Mercator | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, MERCATOR_SCALE, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 110 | Stereographic | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 111 | Lambert Azimuthal | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |

*Table 60: GCTP Projections (Continued)*

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 112 | Azimuthal | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 113 | Gnomonic | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 114 | Orthographic | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 115 | Near Side Perspective | SPHERE_RADIUS, HEIGHT, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 116 | Sinusoidal | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING |
| 117 | Equirectangular | SPHERE_RADIUS, CENTER_LONGITUDE, TRUE_SCALE_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 118 | Miller Cylindrical | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING |
| 119 | Van der Grinten | SPHERE_RADIUS, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |

*Table 60: GCTP Projections (Continued)*

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 120 | Hotine Oblique Mercator A | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, MERCATOR_SCALE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING, HOM_LONGITUDE1, HOM_LATITUDE1, HOM_LONGITUDE2, HOM_LATITUDE2 |
| 220 | Hotine Oblique Mercator B | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, MERCATOR_SCALE, HOM_AZIM_ANGLE, HOM_AZIM_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING |
| 121 | Robinson | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING |
| 122 | Space Oblique Mercator A | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, SOM_INCLINATION, SOM_LONGITUDE, FALSE_EASTING, FALSE_NORTHING, SOM_PERIOD, SOM_RATIO, SOM_FLAG |
| 222 | Space Oblique Mercator B | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, SOM_LANDSAT_NUMBER, SOM_LANDSAT_PATH, FALSE_EASTING, FALSE_NORTHING |
| 123 | Alaska Conformal | SEMIMAJOR_AXIS, SEMIMINOR_AXIS, FALSE_EASTING, FALSE_NORTHING |
| 124 | Interrupted Goode | SPHERE_RADIUS |
| 125 | Mollweide | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING |
| 126 | Interrupted Mollweide | SPHERE_RADIUS |

*Table 60: GCTP Projections (Continued)*

| # | Projection Name | Allowed Keyword Parameters |
|---|---|---|
| 127 | Hammer | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING |
| 128 | Wagner IV | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING |
| 129 | Wagner VII | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING |
| 130 | Oblated Equal Area | SPHERE_RADIUS, OEA_SHAPEM, OEA_SHAPEN, CENTER_LONGITUDE, CENTER_LATITUDE, FALSE_EASTING, FALSE_NORTHING, OEA_ANGLE |
| 131 | Integerized Sinusoidal | SPHERE_RADIUS, CENTER_LONGITUDE, FALSE_EASTING, FALSE_NORTHING, IS_ZONES, IS_JUSTIFY |

*Table 60: GCTP Projections (Continued)*

# Keywords

**Note**

The following keywords apply to all projections.

## DATUM

Set this keyword to either an integer code or a scalar string containing the name of the datum to use for the ellipsoid. The default value depends upon the projection selected, but is either the Clarke 1866 ellipsoid (datum 0), or a sphere of radius 6370.997 km (datum 19).

The following datums (or spheroids) are available for use with the DATUM keyword:

| Index | Name | Semimajor axis (m) | Seminor axis (m) |
|---|---|---|---|
| 0 | Clarke 1866 | 6378206.4 | 6356583.8 |
| 1 | Clarke 1880 | 6378249.145 | 6356514.86955 |
| 2 | Bessel | 6377397.155 | 6356078.96284 |
| 3 | International 1967 | 6378157.5 | 6356772.2 |
| 4 | International 1909 | 6378388.0 | 6356911.94613 |
| 5 | WGS 72 | 6378135.0 | 6356750.519915 |
| 6 | Everest | 6377276.3452 | 6356075.4133 |
| 7 | WGS 66 | 6378145.0 | 6356759.769356 |
| 8 | GRS 1980/WGS 84 | 6378137.0 | 6356752.31414 |
| 9 | Airy | 6377563.396 | 6356256.91 |
| 10 | Modified Everest | 6377304.063 | 6356103.039 |
| 11 | Modified Airy | 6377340.189 | 6356034.448 |
| 12 | Walbeck | 6378137.0 | 6356752.314245 |
| 13 | Southeast Asia | 6378155.0 | 6356773.3205 |
| 14 | Australian National | 6378160.0 | 6356774.719 |
| 15 | Krassovsky | 6378245.0 | 6356863.0188 |
| 16 | Hough | 6378270.0 | 6356794.343479 |
| 17 | Mercury 1960 | 6378166.0 | 6356784.283666 |
| 18 | Modified Mercury 1968 | 6378150.0 | 6356768.337303 |
| 19 | Sphere | 6370997.0 | 6370997.0 |

*Table 61: Datums available for use by MAP_PROJ_INIT.*

**Note**

For many projections, you can specify your own datum by using either the SEMIMAJOR_AXIS and SEMIMINOR_AXIS or the SPHERE_RADIUS keywords.

## GCTP

Set this keyword to indicate that the GCTP library should be used for the projection. By default, MAP_PROJ_INIT uses the IDL projection library. This keyword is ignored if the projection exists only in one system (GCTP or IDL), or if the *Projection* argument is specified as an index.

## LIMIT

Set this keyword to a four-element vector of the form

```
[Latmin, Lonmin, Latmax, Lonmax]
```

that specifies the boundaries of the region to be mapped. (*Lonmin*, *Latmin*) and (*Lonmax*, *Latmax*) are the longitudes and latitudes of two points diagonal from each other on the region's boundary.

**Note**

When using MAP_PROJ_FORWARD, if the longitude range in LIMIT is less than or equal to 180 degrees, map clipping is performed in lat/lon coordinates *before* the transform. If the longitude range is greater than 180 degrees, map clipping is done in Cartesian coordinates *after* the transform. For non-cylindrical projections, clipping *after* the transformation to Cartesian coordinates means that some lat/lon points that fall outside the bounds specified by LIMIT may not be clipped. This occurs when the *transformed* lat/lon points fall inside the cartesian clipping rectangle.

## RADIANS

Set this keyword to indicate that all parameters that represent angles are specified in radians rather than degrees.

## RELAXED

If this keyword is set, any projection parameters which do not apply to the specified projection will be quietly ignored. By default, MAP_PROJ_INIT will issue errors for parameters that do not apply to the specified projection.

# Projection Keywords

The following keywords apply only to some projections. Consult the list under "Projection" on page 1235 to determine which keywords apply to the projection you have selected.

**Note**

Unless the RADIANS keyword is set, all angles are measured in degrees, specified as a floating-point value.

## CENTER_AZIMUTH

Set this keyword to the angle of the central azimuth, in degrees east of North. The default is 0 degrees. The pole is placed at an azimuth of CENTRAL_AZIMUTH degrees counterclockwise of North, as specified by the ROTATION keyword.

## CENTER_LATITUDE

Set this keyword to the latitude of the point on the earth's surface to be mapped to the center of the projection plane. Latitude is measured in degrees North of the equator and must be in the range: -90 to +90. The default value is zero.

## CENTER_LONGITUDE

Set this keyword to the longitude of the point on the earth's surface to be mapped to the center of the map projection. Longitude is measured in degrees east of the Greenwich meridian and must be in the range: -360 to +360. The default value is zero.

## FALSE_EASTING

Set this keyword to the false easting value (in meters) to be added to each x coordinate for the forward transform, or subtracted from each x coordinate for the inverse transform.

## FALSE_NORTHING

Set this keyword to the false northing value (in meters) to be added to each y coordinate for the forward transform, or subtracted from each y coordinate for the inverse transform.

## HEIGHT

Set this keyword to the height (in meters) above the earth's surface for satellite projections.

## HOM_AZIM_LONGITUDE

Set this keyword to the longitude in degrees of the central meridian point where the azimuth occurs.

## HOM_AZIM_ANGLE

Set this keyword to the azimuth angle, measured in degrees, east of a north-south line that intersects the center line. The center line is defined as the great circle path along which the Mercator cylinder touches the sphere.

## HOM_LATITUDE1

Set this keyword to the latitude in degrees of the first point on the center line. The center line is defined as the great circle path along which the Mercator cylinder touches the sphere.

## HOM_LATITUDE2

Set this keyword to the latitude in degrees of the second point on the center line. The center line is defined as the great circle path along which the Mercator cylinder touches the sphere.

## HOM_LONGITUDE1

Set this keyword to the longitude in degrees of the first point on the center line. The center line is defined as the great circle path along which the Mercator cylinder touches the sphere.

## HOM_LONGITUDE2

Set this keyword to the longitude in degrees of the second point on the center line. The center line is defined as the great circle path along which the Mercator cylinder touches the sphere.

## IS_ZONES

Set this keyword to the number of longitudinal zones to include in the projection.

## IS_JUSTIFY

Set this keyword to a flag indicating what to do with rows with an odd number of columns. The possible values are:

| Value | Description |
|---|---|
| 0 | Indicates the extra column is on the right of the projection Y axis. |
| 1 | Indicates the extra column is on the left of the projection Y axis. |
| 2 | Calculate an even number of columns. |

*Table 62: IS_JUSTIFY Keyword Values*

## MERCATOR_SCALE

Set this keyword to the scale factor at the central meridian (Transverse Mercator projection) or the center of the projection (Hotine Oblique Mercator projection). For the Transverse Mercator projection, the default scale is 0.9996.

## OEA_ANGLE

Set this keyword to the Oblated Equal Area oval rotation angle in degrees.

## OEA_SHAPEM

Set this keyword to the Oblated Equal Area shape parameter *m*. The value of OEA_SHAPEM determines the horizontal flatness of the oblong region, and is usually set to a value between one and three.

## OEA_SHAPEN

Set this keyword to the Oblated Equal Area oval shape parameter *n*. The value of OEA_SHAPEN determines the vertical flatness of the oblong region, and is usually set to a value between one and three.

**Note**

Setting both OEA_SHAPEM and OEA_SHAPEN equal to two is equivalent to using the Lambert Azimuthal projection.

## ROTATION

Set this keyword to the angle through which the North direction should be rotated around the line between the earth's center and the point (CENTER_LONGITUDE, CENTER_LATITUDE). ROTATION is measured in degrees with the positive direction being clockwise rotation around the line. Values should be in the range -180 to +180. The default value is zero.

**Note**

If the center of the map is at the North pole, North is in the direction CENTER_LONGITUDE + 180. If the origin is at the South pole, North is in the direction CENTER_LONGITUDE.

## SEMIMAJOR_AXIS

Set this keyword to the length (in meters) of the semimajor axis of the reference ellipsoid. The default is either the Clarke 1866 datum (6378206.4 m) or the Sphere radius (6370997 m), depending upon the projection.

## SEMIMINOR_AXIS

Set this keyword to the length (in meters) of the semiminor axis of the reference ellipsoid. The default is either the Clarke 1866 datum (6356583.8 m) or the Sphere radius (6370997 m), depending upon the projection.

## SOM_INCLINATION

Set this keyword to the orbit inclination angle in degrees of the ascending node, counter-clockwise from equator.

## SOM_LONGITUDE

Set this keyword to the longitude in degrees of the ascending orbit at the equator.

## SOM_PERIOD

Set this keyword to the period in minutes of the satellite revolution.

## SOM_RATIO

Set this keyword to the Landsat ratio to compensate for confusion at the northern end of orbit. A typical value is 0.5201613.

## SOM_FLAG

Set this keyword to the end of path flag for Landsat, where 0 is the start and 1 is the end.

## SOM_LANDSAT_NUMBER

Set this keyword to the Landsat satellite number.

## SOM_LANDSAT_PATH

Set this keyword to the Landsat path number (use 1 for Landsat 1, 2 and 3; use 2 for Landsat 4, 5 and 6).

## SPHERE_RADIUS

Set this keyword to the radius (in meters) of the reference sphere. The default is 6370997 m.

## STANDARD_PARALLEL

Set this keyword to the latitude in degrees of the standard parallel along which the scale is true.

## STANDARD_PAR1

Set this keyword to the latitude in degrees of the first standard parallel along which the scale is true.

## STANDARD_PAR2

Set this keyword to the latitude in degrees of the second standard parallel along which the scale is true.

## SAT_TILT

Set this keyword to the downward tilt in degrees of the camera, in degrees from the projection horizontal.

## TRUE_SCALE_LATITUDE

Set this keyword to the latitude in degrees of true scale.

### ZONE

Set this keyword to an integer giving the zone for the GCTP UTM projection or GCTP State Plane projection.

**Note**

For the UTM projection, you may also use the CENTER_LONGITUDE and CENTER_LATITUDE keywords to set the zone. Internally, the ZONE value will be computed from the longitude and latitude.

## Example

See MAP_PROJ_FORWARD for an example of using this function.

## Version History

Introduced: 5.6

## See Also

MAP_PROJ_FORWARD, MAP_PROJ_INVERSE, MAP_SET

# MAP_PROJ_INVERSE

The MAP_PROJ_INVERSE function transforms map coordinates from Cartesian (x, y) coordinates to longitude and latitude, using either the !MAP system variable or a supplied map projection variable.

## Syntax

*Result* = MAP_PROJ_INVERSE (*X* [, *Y*] [, MAP_STRUCTURE=*value*] [, /RADIANS] )

## Return Value

The result is a (2, *n*) array containing the longitude/latitude coordinates.

## Arguments

### X

An *n*-element vector containing the x values. If the *Y* argument is omitted, *X* must be a (2, *n*) array of X and Y pairs.

### Y

An *n*-element vector containing y values. If this argument is omitted, *X* must be a (2, *n*) array of X and Y pairs.

## Keywords

### MAP_STRUCTURE

Set this keyword to a !MAP structure variable containing the projection parameters, as constructed by the MAP_PROJ_INIT. If this keyword is omitted, the !MAP system variable is used.

### RADIANS

Set this keyword to indicate that the returned longitude and latitude coordinates should be expressed in radians. By default, returned coordinates are expressed in degrees.

## Version History

Introduced: 5.6

## See Also

MAP_PROJ_FORWARD, MAP_PROJ_INIT

# MAP_SET

The MAP_SET procedure establishes the axis type and coordinate conversion mechanism for mapping points on the earth's surface, expressed in latitude and longitude, to points on a plane, according to one of several possible map projections.

The type of map projection, the map center, polar rotation and geographical limits can all be customized. The system variable !MAP retains the information needed to effect coordinate conversions to the plane and, inversely, from the projection plane to points on the earth in latitude and longitude. Users should not change the values of the fields in !MAP directly.

MAP_SET can also be made to plot the grid of latitude and longitude lines and continental boundaries by setting the keywords GRID and CONTINENTS. Many other types of boundaries can be overplotted on maps using the MAP_CONTINENTS procedure.

**Note**

Using MAP_SET changes the !X.TYPE system variable.

**Note**

If the graphics device is changed, MAP_SET (and all other mapping calls) must be re-called for the projection to be set up properly for the new device.

## Syntax

MAP_SET [, *P0lat*, *P0lon*, *Rot*]

**Keywords—Projection Types:** [ [, /AITOFF | , /ALBERS | , /AZIMUTHAL | , /CONIC | , /CYLINDRICAL | , /GNOMIC | , /GOODESHOMOLOSINE | , /HAMMER | , /LAMBERT | , /MERCATOR | , /MILLER_CYLINDRICAL | , /MOLLWEIDE | , /ORTHOGRAPHIC | , /ROBINSON | , /SATELLITE | , /SINUSOIDAL | , /STEREOGRAPHIC | , /TRANSVERSE_MERCATOR ] | [, NAME=*string*] ]

**Keywords—Map Characteristics:** [, /ADVANCE] [, CHARSIZE=*value*] [, /CLIP] [, COLOR=*index*] [, /CONTINENTS [, CON_COLOR=*index*] [, /HIRES]] [, E_CONTINENTS=*structure*] [, E_GRID=*structure*] [, E_HORIZON=*structure*] [, GLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, GLINETHICK=*value*] [, /GRID] [, /HORIZON] [, LABEL=*n*{label every *n*th gridline}] [, LATALIGN=*value*{0.0 to 1.0}] [, LATDEL=*degrees*] [, LATLAB=*longitude*] [, LONALIGN=*value*{0.0 to 1.0}] [, LONDEL=*degrees*] [, LONLAB=*latitude*]

[, MLINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, MLINETHICK=*value*] [, /NOBORDER] [, /NOERASE] [, REVERSE={0 | 1 | 2 | 3}] [, TITLE=*string*] [, /USA] [, XMARGIN=*value*] [, YMARGIN=*value*]

**Keywords—Projection Parameters:**
[, CENTRAL_AZIMUTH=*degrees_east_of_north*] [, ELLIPSOID=*array*] [, /ISOTROPIC] [, LIMIT=*vector*] [, SAT_P=*vector*] [, SCALE=*value*] [, STANDARD_PARALLELS=*array*]

**Graphics Keywords:** [, POSITION=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, /T3D] [, ZVALUE=*value*{0 to 1}]

# Arguments

## $P_{0lat}$

The latitude of the point on the earth's surface to be mapped to the center of the projection plane. Latitude is measured in degrees North of the equator and $P_{0lat}$ must be in the range: $-90° \le P_{0lat} \le 90°$.

If $P_{0lat}$ is not set, the default value is 0.

## $P_{0lon}$

The longitude of the point on the earth's surface to be mapped to the center of the map projection. Longitude is measured in degrees east of the Greenwich meridian and $P_{0lon}$ must be in the range: $-180° \le P_{0lon} \le 180°$.

If $P_{0lon}$ is not set, the default value is zero.

## Rot

*Rot* is the angle through which the North direction should be rotated around the line *L* between the earth's center and the point ($P_{0lat}$, $P_{0lon}$). *Rot* is measured in degrees with the positive direction being clockwise rotation around line *L*. *Rot* can have values from -180° to 180°.

If the center of the map is at the North pole, North is in the direction $P_{0lon} + 180°$. If the origin is at the South pole, North is in the direction $P_{0lon}$.

The default value of *Rot* is 0 degrees.

# Keywords

## Projection Type Keywords:

### AITOFF

Set this keyword to select the Aitoff projection.

### ALBERS

Set this keyword to select the Albers equal-area conic projection. To specify the latitude of the standard parallels, see “STANDARD_PARALLELS” on page 1262.

### AZIMUTHAL

Set this keyword to select the azimuthal equidistant projection.

### CONIC

Set this keyword to select Lambert’s conformal conic projection with one or two standard parallels. To specify the latitude of the standard parallels, see “STANDARD_PARALLELS” on page 1262. This keyword can be used with the ELLIPSOID keyword.

### CYLINDRICAL

Set this keyword to select the cylindrical equidistant projection. Cylindrical is the default map projection.

### GOODESHOMOLOSINE

Set this keyword to select the Goode’s Homolosine Projection. The central latitude for this projection is fixed on the equator, 0 degrees latitude. This projection is interrupted, as the inventor originally intended, and is best viewed with the central longitude set to 0.

### GNOMIC

Set this keyword to select the gnomonic projection. If default clipping is enabled, this projection will display a maximum of ± 60° from the center of the projection area when the center is at either the equator or one of the poles.

### HAMMER

Set this keyword to select the Hammer-Aitoff equal area projection.

## LAMBERT

Set this keyword to select Lambert's azimuthal equal area projection.

## MERCATOR

Set this keyword to select the Mercator projection. Note that this projection will not display regions within ± 10° of the poles of projection.

## MILLER_CYLINDRICAL

Set this keyword to select the Miller Cylindrical projection.

## MOLLWEIDE

Set this keyword to select the Mollweide projection.

## NAME

Set this keyword to a string indicating the projection that you wish to use. A list of available projections can be found using `MAP_PROJ_INFO, PROJ_NAMES=names`. This keyword will override any of the individual projection keywords.

## ORTHOGRAPHIC

Set this keyword to select the orthographic projection. Note that this projection will display a maximum of ± 90° from the center of the projection area.

## ROBINSON

Set this keyword to select the Robinson pseudo-cylindrical projection.

## SATELLITE

Set this keyword to select the satellite projection.

For the satellite projection, P0LAT and P0LON represent the latitude and longitude of the sub-satellite point. Three additional parameters, *P*, *Omega*, and *Gamma* (supplied as a three-element vector argument to the SAT_P keyword), are also required.

**Note**

Since all meridians and parallels are oblique lines or arcs, the LIMIT keyword must be supplied as an eight-element vector representing four points that delineate the

limits of the map. The extent of the map limits, when expressed in latitude/longitude is a complicated polygon, rather than a simple quadrilateral.

### SINUSOIDAL

Set this keyword to select the sinusoidal projection.

### STEREOGRAPHIC

Set this keyword to select the stereographic projection. Note that if default clipping is enabled, this projection will display a maximum of ± 90° from the center of the projection area.

### TRANSVERSE_MERCATOR

Set this keyword to select the Transverse Mercator projection, also called the UTM or Gauss-Krueger projection. This projection works well with the ellipsoid form. The default ellipsoid is the Clarke 1866 ellipsoid. To change the default ellipsoid characteristics, see "ELLIPSOID" on page 1261.

## Map Characteristic Keywords:

### ADVANCE

Set this keyword to advance to the next frame when the screen is set to display multiple plots. Otherwise the entire screen is erased.

### CHARSIZE

The size of the characters used for the labels. The default is 1.

### CLIP

Set this keyword to clip the map using the map-specific graphics technique. The default is to perform map-specific clipping. Set CLIP=0 to disable clipping.

**Note**

Clipping controlled by the CLIP keyword applies only to the map itself. In order to disable general clipping within the plot window, you must set the system variable !P.NOCLIP=1. For more information, see "NOCLIP" on page 3876.

### COLOR

The color index of the map border in the plotting window.

## CONTINENTS

Set this keyword to plot the continental boundaries. Note that if you are using the low-resolution map database (if the HIRES keyword is *not* set), outlines for continents, islands, and lakes are drawn when the CONTINENTS keyword is set. If you are using the high-resolution map database (if the HIRES keyword *is* set), only continental outlines are drawn when the CONTINENTS keyword is set. To draw islands and lakes when using the high-resolution map database, use the COASTS keyword to the MAP_CONTINENTS procedure.

## CON_COLOR

The color index for continent outlines if CONTINENTS is set.

## E_CONTINENTS

Set this keyword to a structure containing extra keywords to be passed to MAP_CONTINENTS. For example, to fill continents, the FILL keyword of MAP_CONTINENTS is set to 1. To fill the continents with MAP_SET, specify E_CONTINENTS={FILL:1}.

## E_GRID

Set this keyword to a structure containing extra keywords to be passed to MAP_GRID. For example, to label every other gridline on a grid of parallels and meridians, the LABEL keyword of MAP_GRID is set to 2. To do the same with MAP_SET, specify E_GRID={LABEL:2}.

## E_HORIZON

Set this keyword to a structure containing extra keywords to be set as modifiers to the HORIZON keyword.

### Example

To draw a Stereographic map, with the sphere filled in color index 3, enter:

```
MAP_SET, 0, 0, /STEREO, /HORIZON, /ISOTROPIC, $
   E_HORIZON={FILL:1, COLOR:3}
```

## GLINESTYLE

Set this keyword to a line style index used to draw the grid of parallels and meridians. See MLINESTYLE for a list of available linestyles. The default is 1, drawing a grid of dotted lines.

## GLINETHICK

Set this keyword to the thickness of the gridlines drawn if the GRID keyword is set. The default is 1.

## GRID

Set this keyword to draw the grid of parallels and meridians.

## HIRES

Set this keyword to use the high-resolution continent outlines when drawing continents. This keyword only has effect if the CONTINENTS keyword is also set.

## HORIZON

Set this keyword to draw a horizon line, when the projection in use permits. The horizon delineates the boundary of the sphere. See E_HORIZON for more options.

## LABEL

Set this keyword to label the parallels and meridians with their corresponding latitudes and longitudes. Setting this keyword to an integer will cause every LABEL gridline to be labeled (that is, if LABEL=3 then every third gridline will be labeled). The starting point for determining which gridlines are labeled is the minimum latitude or longitude (-180 to 180).

## LATALIGN

The alignment of the text baseline for latitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it.

## LATLAB

The longitude at which to place latitude labels. The default is the center longitude of the map.

## LATDEL

Set this keyword equal to the spacing (in degrees) between parallels of latitude drawn by the MAP_GRID procedure. If this keyword is not set, a suitable value is determined from the current map projection.

## LONALIGN

The alignment of the text baseline for longitude labels. A value of 0.0 left justifies the label, 1.0 right justifies it, and 0.5 centers it.

## LONDEL

Set this keyword equal to the spacing (in degrees) between meridians of longitude drawn by the MAP_GRID procedure. If this keyword is not set, a suitable value is determined from the current map projection.

## LONLAB

The latitude at which to place longitude labels. The default is the center latitude of the map.

## MLINESTYLE

The line style index used for continental boundaries. Linestyles are described in the table below. The default is 0 for solid.

| Index | Linestyle |
|---|---|
| 0 | Solid |
| 1 | Dotted |
| 2 | Dashed |
| 3 | Dash Dot |
| 4 | Dash Dot Dot |
| 5 | Long Dashes |

*Table 63: IDL Linestyles*

## MLINETHICK

The line thickness used for continental boundaries. The default is 2.

## NOBORDER

Set this keyword to not draw a border around the map. The map will fill the extent of the plotting region. If NOBORDER is *not* specified, a margin equalling 1% of the plotting region will be placed between the map and the border.

## NOERASE

Set this keyword to have MAP_SET not erase the current plot window. The default is to erase before drawing the map.

## REVERSE

Set this keyword to one of the following values to reverse the X and/or Y axes:

- 0 = no reversal (the default)
- 1 = reverse X
- 2 = reverse Y
- 3 = reverse both.

## TITLE

A string containing the main title for the map. The title appears centered above the map window.

## USA

Set this keyword to draw borders for each state in the United States.

## XMARGIN

A scalar or two-element vector that specifies the vertical margin between the map and screen border in character units. If a scalar is specified, the same margin will be used on both sides of the map.

## YMARGIN

A scalar or two-element vector that specifies in the horizontal margin between the map and screen border in character units. If a scalar is specified, the same margin will be used on the top and bottom of the map.

## Projection Parameter Keywords:

## CENTRAL_AZIMUTH

Set this keyword to the angle of the central azimuth, in degrees east of North. This keyword can be used with the following projections: Cylindrical, Mercator, Miller, Mollweide, and Sinusoidal. The default is 0 degrees. The pole is placed at an azimuth of CENTRAL_AZIMUTH degrees CCW of North, as specified by the *Rot* argument.

## ELLIPSOID

Set this keyword to a 3-element array, [a, $e^2$, $k_0$], defining the ellipsoid for the Transverse Mercator or Lambert Conic projections.

- a: equatorial radius, in meters.
- $e^2$: eccentricity squared. $e^2 = 2 * f - f^2$, where f = 1 - b/a (a: equatorial radius, b: polar radius; in meters).
- $k_0$: scale on the central meridian.

The default is the Clarke 1866 ellipsoid, [6378206.4, 0.00676866, 0.9996].

This keyword can be used with either the CONIC or TRANSVERSE_MERCATOR keywords.

## ISOTROPIC

Set this keyword to produce a map that has the same scale in the X and Y directions.

**Note**

The X and Y axes will be scaled isotropically and then fit within the rectangle defined by the POSITION keyword; one of the axes may be shortened. See "POSITION" on page 3877 for more information.

## LIMIT

A four- or eight-element vector that specifies the limits of the map.

As a four-element vector, LIMIT has the form [$Lat_{min}$, $Lon_{min}$, $Lat_{max}$, $Lon_{max}$] that specifies the boundaries of the region to be mapped. ($Lat_{min}$, $Lon_{min}$) and ($Lat_{max}$, $Lon_{max}$) are the latitudes and longitudes of two points diagonal from each other on the region's boundary.

As an eight-element vector, LIMIT has the form: [$Lat_0$, $Lon_0$, $Lat_1$, $Lon_1$, $Lat_2$, $Lon_2$, $Lat_3$, $Lon_3$]. These four latitude/longitude pairs describe, respectively, four points on the left, top, right, and bottom edges of the map extent.

## SAT_P

A three-element vector containing three parameters, *P*, *Omega*, and *Gamma*, that must be supplied when using the SATELLITE projection where:

- *P* is the distance of the point of perspective (camera) from the center of the globe, expressed in units of the radius of the globe.

- *Omega* is the downward tilt of the camera, in degrees from the new horizontal. If both *Gamma* and *Omega* are 0, a Vertical Perspective projection results.
- *Gamma* is the angle, expressed in degrees clockwise from north, of the Earth's rotation. This parameter is equivalent to the *Rot* argument.

### SCALE

Set this keyword to construct an isotropic map with the given scale, set to the ratio of 1:*scale*. If SCALE is not specified, the map is fit to the window. The typical scale for global maps is in the ratio of between 1:100 million and 1:200 million. For continents, the typical scale is in the ratio of approximately 1:50 million. For example, `SCALE=100E6` sets the scale at the center of the map to 1:100 million, which is in the same ratio as 1 inch to 1578 miles (1 cm to 1000 km).

### STANDARD_PARALLELS

Set this keyword to a one- or two-element array defining, respectively, one or two standard parallels for conic projections.

### Graphics Keywords Accepted

See Appendix B, "Graphics Keywords", for descriptions of graphics and plotting keywords not listed above. POSITION, T3D, ZVALUE.

## Examples

To draw a Stereographic map, with the sphere filled in color index 3:

```
MAP_SET, 0, 0, /STEREO, /HORIZON, /ISOTROPIC, E_HORIZON={FILL:1,
COLOR:3}
```

## Version History

Introduced: Pre 4.0

## See Also

MAP_CONTINENTS, MAP_GRID, MAP_IMAGE, MAP_PROJ_INIT

# MATRIX_MULTIPLY

The MATRIX_MULTIPLY function calculates the IDL # operator of two (possibly transposed) arrays. The transpose operation (if desired) is done simultaneously with the multiplication, thus conserving memory and increasing the speed of the operation. If the arrays are not transposed, then MATRIX_MULTIPLY is equivalent to using the # operator.

## The # Operator vs. MATRIX_MULTIPLY

The following table illustrates how various operations are performed using the # operator versus the MATRIX_MULTIPLY function:

| # Operator | Function |
|---|---|
| A # B | MATRIX_MULTIPLY(*A*, *B*) |
| transpose(A) # B | MATRIX_MULTIPLY(*A*, *B*, /ATRANSPOSE) |
| A # transpose(B) | MATRIX_MULTIPLY(*A*, *B*, /BTRANSPOSE) |
| transpose(A) # transpose(B) | MATRIX_MULTIPLY(*A*, *B*, /ATRANSPOSE, /BTRANSPOSE) |

*Table 64: The # Operator vs. MATRIX_MULTIPLY*

**Note**

MATRIX_MULTIPLY can also be used in place of the ## operator. For example, A ## B is equivalent to MATRIX_MULTIPLY(*B*, *A*), and A ## TRANSPOSE(B) is equivalent to MATRIX_MULTIPLY(*B*, *A*, /ATRANSPOSE).

# Syntax

*Result* = MATRIX_MULTIPLY( *A*, *B* [, /ATRANSPOSE] [, /BTRANSPOSE] )

# Return Value

The type for the result depends upon the input type. For byte or integer arrays, the result has the type of the next-larger integer type that could contain the result (for example, byte, integer, or long input returns type long integer). For floating-point, the result has the same type as the input.

For the case of no transpose, the resulting array has the same number of columns as the first array and the same number of rows as the second array. The second array must have the same number of columns as the first array has rows.

**Note**

If A and B arguments are vectors, then C = MATRIX_MULTIPLY(*A*, *B*) is a matrix with $C_{ij} = A_i B_j$. Mathematically, this is equivalent to the outer product, usually denoted by A⊗B.

# Arguments

## A

The left operand for the matrix multiplication. Dimensions higher than two are ignored.

## B

The right operand for the matrix multiplication. Dimensions higher than two are ignored.

# Keywords

## ATRANSPOSE

Set this keyword to multiply using the transpose of *A*.

## BTRANSPOSE

Set this keyword to multiply using the transpose of *B*.

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Version History

Introduced: 5.4

## See Also

MATRIX_POWER, “Multiplying Arrays” in Chapter 22 of the *Using IDL* manual .

# MATRIX_POWER

The MATRIX_POWER function computes the product of a matrix with itself. For example, the fifth power of array *A* is *A # A # A # A # A*. Negative powers are computed using the matrix inverse of the positive power.

## Syntax

*Result* = MATRIX_POWER(*Array, N* [, /DOUBLE] [, STATUS=*value*])

## Return Value

The result is a square array containing the value of the matrix raised to the specified power. A power of zero returns the identity matrix.

## Arguments

### Array

A square, two-dimensional array of any numeric type.

### N

An integer representing the power. *N* may be positive or negative.

## Keywords

### DOUBLE

Set this keyword to return a double-precision result. Explicitly set this keyword equal to zero to return a single-precision result. The default return type depends upon the precision of *Array.*

**Note**

Computations are always performed using double-precision arithmetic.

### STATUS

Set this keyword equal to a named variable that will contain the status of the matrix inverse for negative powers. Possible values are:

| Value | Description |
|---|---|
| 0 | Successful completion. |
| 1 | Singular array (which indicates that the inversion is invalid). |
| 2 | Warning that a small pivot element was used and that significant accuracy was probably lost. |

*Table 65: STATUS Keyword Values*

For non-negative powers, STATUS is always set to 0.

## Example

Print an array to the one millionth power:

```
array = [ [0.401d, 0.600d], $
          [0.525d, 0.475d] ]
PRINT, MATRIX_POWER(array, 1e6)
```

IDL prints:

```
  2.4487434e+202  2.7960773e+202
  2.4465677e+202  2.7935929e+202
```

## Version History

Introduced: 5.6

## See Also

MATRIX_MULTIPLY, "Multiplying Arrays" in Chapter 22 of the *Using IDL* manual

# MAX

The MAX function returns the value of the largest element of *Array.*

## Syntax

*Result* = MAX( *Array* [, *Max_Subscript*] [, DIMENSION=*value*] [, MIN=*variable*] [, /NAN] [, SUBSCRIPT_MIN=*variable*])

## Return Value

Return the largest array element value. The type of the result is the same as the type of *Array.*

## Arguments

### Array

The array to be searched.

### Max_Subscript

A named variable that, if supplied, is converted to a long integer containing the one-dimensional subscript of the maximum element. Otherwise, the system variable !C is set to the one-dimensional subscript of the maximum element.

## Keywords

### DIMENSION

Set this keyword to the dimension over which to find the maximum values of an array. If this keyword is not present or is zero, the maximum is found over the entire array and is returned as a scalar value. If this keyword is present and nonzero, the result is the “slice” of the input array that contains the maximum value element, and the return values for *Result*, *Max_Subscript*, MIN, and SUBSCRIPT_MIN will all be arrays of one dimension less than the input array. That is, if the dimensions of *Array* are *N1*, *N2*, *N3*, and DIMENSION=2, the dimensions of the result are (*N1*, *N3*), and element (*i*,*j*) of the result contains the maximum value of *Array*[*i*, *, *j*].

For example:

```
arr = FINDGEN(2,3,2)
PRINT, arr
```

IDL prints:

```
0.00000     1.00000
2.00000     3.00000
4.00000     5.00000

6.00000     7.00000
8.00000     9.00000
10.0000     11.0000
```

```
PRINT, MAX(arr, DIMENSION=2)
```

IDL prints:

```
4.00000     5.00000
10.0000     11.0000
```

```
PRINT, MAX(arr, DIMENSION=1)
```

IDL prints:

```
1.00000     3.00000     5.00000
7.00000     9.00000     11.0000
```

## MIN

A named variable to receive the value of the minimum array element. If you need to find both the minimum and maximum array values, use this keyword to avoid scanning the array twice with separate calls to MAX and MIN.

## NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

**Note**

If the MAX function is run on an array containing NaN values and the NAN keyword is not set, an invalid result will occur.

## SUBSCRIPT_MIN

Set this keyword equal to a named variable that will contain the one-dimensional subscript of the minimum element, the value of which is available via the MIN keyword.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

### Example 1

This example prints the maximum value in an array, and the subscript of that value:

```
; Create a simple two-dimensional array:
D = DIST(100)

; Print the maximum value in array D and its linear subscript:
PRINT, 'Maximum value in array D is:', MAX(D, I)
PRINT, 'The subscript of the maximum value is', I
```

#### IDL Output

```
Maximum value in array D is:      70.7107
The subscript of the maximum value is        5050
```

### Example 2

To convert I to a two-dimensional subscript, use the commands:

```
IX = I MOD 100
IY = I/100
PRINT, 'The maximum value of D is at location ('+ STRTRIM(IX, 1) $
   + ', ' + STRTRIM(IY, 1) + ')'
```

#### IDL Output

```
The maximum value of D is at location (50, 50)
```

## Version History

Introduced: Original

## See Also

ARRAY_INDICES, MIN, WHERE

# MD_TEST

The MD_TEST function tests the hypothesis that a sample population is random against the hypothesis that it is not random. This two-tailed function is an extension of the “Runs Test for Randomness” and is often referred to as the Median Delta Test.

This routine is written in the IDL language. Its source code can be found in the file `md_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = MD_TEST( *X* [, ABOVE=*variable*] [, BELOW=*variable*] [, MDC=*variable*] )

## Return Value

The result is a two-element vector containing the nearly-normal test statistic *Z* and its associated probability.

## Arguments

### X

An *n*-element integer, single- or double-precision floating-point vector.

## Keywords

### ABOVE

Use this keyword to specify a named variable that will contain the number of sample population values greater than the median of *X*.

### BELOW

Use this keyword to specify a named variable that will contain the number of sample population values less than the median of *X*.

### MDC

Use this keyword to specify a named variable that will contain the number of Median Delta Clusters (sequential values of *X* above and below the median).

## Examples

This example tests the hypothesis that *X* represents a random population against the hypothesis that it does not represent a random population at the 0.05 significance level:

```
; Define a sample population:
X = [ 2.00,  0.90, -1.44, -0.88, -0.24,  0.83, -0.84, -0.74, $
       0.99, -0.82, -0.59, -1.88, -1.96,  0.77, -1.89, -0.56, $
      -0.62, -0.36, -1.01, -1.36]

; Test the hypothesis that X represents a random population against
; the hypothesis that it does not represent a random population at
; the 0.05 significance level:
result = MD_TEST(X, MDC = mdc)
PRINT, result
```

IDL prints:

```
0.459468    0.322949
```

The computed probability (0.322949) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that *X* represents a random population.

## Version History

Introduced: 4.0

## See Also

CTI_TEST, FV_TEST, KW_TEST, R_TEST, RS_TEST, S_TEST, TM_TEST, XSQ_TEST

# MEAN

The MEAN function computes the mean of a numeric vector. MEAN calls the IDL function MOMENT.

## Syntax

*Result* = MEAN( *X* [, /DOUBLE] [, /NAN] )

## Return Value

Returns the average value of a set of numbers.

## Arguments

### X

An *n*-element, integer, double-precision or floating-point vector.

## Keywords

### DOUBLE

If this keyword is set, computations are done in double precision arithmetic.

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## Examples

```
; Define the n-element vector of sample data:
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]

; Compute the average:
result = MEAN(x)

; Print the result:
PRINT, result
```

IDL prints:

```
66.7333
```

## Version History

Introduced: 5.1

## See Also

KURTOSIS, MEANABSDEV, MOMENT, STDDEV, SKEWNESS, VARIANCE

# MEANABSDEV

The MEANABSDEV function computes the mean absolute deviation of an *n*-element vector.

## Syntax

*Result* = MEANABSDEV( *X* [, /DOUBLE] [, /MEDIAN] [, /NAN] )

## Return Value

Returns the average deviation.

## Arguments

### X

An *n*-element, floating-point or double-precision vector.

## Keywords

### DOUBLE

Set this keyword to force computations to be done in double precision arithmetic and to return a double precision result. If this keyword is not set, the computations and result depend upon the type of the input data (integer and float data return float results, while double data returns double results). This has no effect if the MEDIAN keyword is set.

### MEDIAN

Set this keyword to return the average deviation from the median. By default, if MEDIAN is not set, MEANABSDEV will return the average deviation from the mean.

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See “Special Floating-Point Values” in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## Examples

```
; Define an n-element vector:
x = [1, 1, 1, 2, 5]

; Compute average deviation from the mean:
result = MEANABSDEV(x)

; Print the result:
PRINT, result
```

IDL prints:

```
1.20000
```

## Version History

Introduced: 5.1

## See Also

KURTOSIS, MEAN, MOMENT, STDDEV, SKEWNESS, VARIANCE

# MEDIAN

The MEDIAN function computes the median value. In an ordered set of values, the median is a value with an equal number of values above and below it. Median smoothing replaces each point with the median of the one- or two-dimensional neighborhood of a given width. It is similar to smoothing with a boxcar or average filter but does not blur edges larger than the neighborhood.

In addition, median filtering is effective in removing salt and pepper noise, (isolated high or low values). The scalar median is simply the middle value, which should not be confused with the average value (e.g., the median of the array [1,10,4] is 4, while the average is 5.)

**Note**

The MEDIAN function treats NaN values as missing data.

## Syntax

*Result* = MEDIAN( *Array* [, *Width*] [, DIMENSION=*value*] [, /EVEN] )

## Return Value

Returns the median value (element *n*/2) of *Array* if one parameter is present, or applies a one- or two-dimensional median filter of the specified width to *Array* and returns the result.

## Arguments

### Array

The array to be processed. If *Width* is also supplied, and *Array* is of byte type, the result is of byte type. All other types are converted to single-precision floating-point, and the result is floating-point. *Array* can have only one or two dimensions.

If *Width* is not given, *Array* can have any valid number of dimensions. The array is converted to single-precision floating-point, and the median value is returned as a floating-point value.

### Width

The size of the one or two-dimensional neighborhood to be used for the median filter. The neighborhood has the same number of dimensions as *Array.*

# Keywords

## DIMENSION

Set this keyword to the dimension over which to find the median values of an array. If this keyword is not present or is zero, the median is found over the entire array and is returned as a scalar value. If this keyword is present and nonzero, the result is a "slice" of the input array that contains the median value elements, and the return value will be an array of one dimension less than the input array.

For example, if the dimensions of *Array* are N1, N2, N3, and DIMENSION = 2, the dimensions of the result are (N1, N3), and element (i,j) of the result contains the median value of *Array*[i, *, j]. This keyword is ignored if the *Width* argument is present.

## EVEN

If the EVEN keyword is set when *Array* contains an even number of points (i.e. there is no middle number), MEDIAN returns the average of the two middle numbers. The returned value may not be an element of *Array.* If *Array* contains an odd number of points, MEDIAN returns the median value. The returned value will always be an element of *Array*—even if the EVEN keyword is set—since an odd number of points will always have a single middle value.

# Examples

```
; Create a simple image and display it:
D = SIN(DIST(200)^0.8) & TVSCL, D

; Display D median-filtered with a width of 9:
TVSCL, MEDIAN(D, 9)

; Print the median of a four-element array, with and without
; the EVEN keyword:
PRINT, MEDIAN([1, 2, 3, 4], /EVEN)
PRINT, MEDIAN([1, 2, 3, 4])
```

IDL prints:

```
2.50000
3.00000
```

## Version History

Introduced: Original

DIMENSION keyword added: 5.6

## See Also

DIGITAL_FILTER, LEEFILT, MOMENT, SMOOTH

# MEMORY

The MEMORY function returns information on the amount of dynamic memory currently in use by the IDL session if no keywords are set. If a keyword is set, MEMORY returns the specified quantity.

## Syntax

*Result* = MEMORY( [, /CURRENT | , /HIGHWATER | , /NUM_ALLOC | , /NUM_FREE | , /STRUCTURE ] [, /L64] )

## Return Value

The return value is a vector that is always of integer type. The following table describes the information returned if no keywords are set:

| Element | Contents |
|---|---|
| *Result*[0] | Amount of dynamic memory (in bytes) currently in use by the IDL session. |
| *Result*[1] | The number of times IDL has made a memory allocation request from the underlying system. |
| *Result*[2] | The number of times IDL has made a request to free memory from the underlying system. |
| *Result*[3] | High water mark: The maximum amount of dynamic memory used since the last time the MEMORY function or HELP, /MEMORY procedure was called. |

*Table 66: MEMORY Function Return Values*

## Arguments

None.

# Keywords

**Note**

The following keywords determine the return value of the MEMORY function. Except for L64, all of the keywords are mutually exclusive — specify at most one of the following.

## CURRENT

Set this keyword to return the amount of dynamic memory (in bytes) currently in use by the IDL session.

## HIGHWATER

Set this keyword to return the maximum amount of dynamic memory used since the last time the MEMORY function or HELP,/MEMORY procedure was called. This can be used to determine maximum memory use of a code sequence as shown in the example below.

## L64

By default, the result of MEMORY is 32-bit integer when possible, and 64-bit integer if the size of the returned values requires it. Set L64 to force 64-bit integers to be returned in all cases.

**Note**

Only 64-bit versions of IDL are capable of using enough memory to require 64-bit MEMORY output. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

## NUM_ALLOC

Returns the number of times IDL has requested dynamic memory from the underlying system.

## NUM_FREE

Returns the number of times IDL has returned dynamic memory to the underlying system.

### STRUCTURE

Set this keyword to return all available information about Expression in a structure. The result will be an IDL_MEMORY (32-bit) structure when possible, and an IDL_MEMORY64 structure otherwise. Set L64 to force an IDL_MEMORY64 structure to be returned in all cases.

The following are descriptions of the fields in the returned structure:

| Field | Description |
|---|---|
| CURRENT | Current dynamic memory in use. |
| NUM_ALLOC | Number of calls to allocate memory. |
| NUM_FREE | Number of calls to free memory. |
| HIGHWATER | Maximum dynamic memory used since last call for this information. |

*Table 67: STRUCTURE Field Descriptions*

## Examples

To determine how much dynamic memory is required to execute a sequence of IDL code:

```
; Get current allocation and reset the high water mark:
start_mem = MEMORY(/CURRENT)

; Arbitrary code goes here.

PRINT, 'Memory required: ', MEMORY(/HIGHWATER) - start_mem
```

The MEMORY function can also be used in conjunction with DIALOG_MESSAGE as follows:

```
; Get current dymanic memory in use:
mem = MEMORY(/CURRENT)
; Prepare dialog message:
message = 'Current amount of dynamic memory used is '
sentence = message + STRTRIM(mem,2)+' bytes.'
; Display the dialog message containing memory usage statement:
status = DIALOG_MESSAGE (sentence, /INFORMATION)
```

## Version History

Introduced: Original

## See Also

HELP

# MESH_CLIP

The MESH_CLIP function clips a polygonal mesh to an arbitrary plane in space and returns a polygonal mesh of the remaining portion. An auxiliary array of data may also be passed and clipped. This array can have multiple values for each vertex. The portion of the mesh below the plane, satisfying $ax+by+cz+d<0$, remains after the clipping operation.

## Syntax

*Result* = MESH_CLIP (*Plane*, *Vertsin*, *Connin*, *Vertsout*, *Connout*
[, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*] [, CUT_VERTS=*variable*] )

## Return Value

The return value is the number of triangles in the returned mesh.

## Arguments

### Plane

Input four element array describing the equation of the plane to be clipped to. The elements are the coefficients ($a,b,c,d$) of the equation $ax+by+cz+d=0$.

### Vertsin

Input array of polygonal vertices [3, *n*].

### Connin

Input polygonal mesh connectivity array.

### Vertsout

Output array of polygonal vertices.

### Connout

Output polygonal mesh connectivity array.

# Keywords

## AUXDATA_IN

Input array of auxiliary data. If present, these values are interpolated and returned through AUXDATA_OUT. The trailing array dimension must match the number of vertices in the Vertsin array.

## AUXDATA_OUT

Set this keyword to a named variable that will contain an output array of interpolated auxiliary data.

## CUT_VERTS

Set this keyword to a named variable that will contain an output array of vertex indices (into Vertsout) of the vertices which are considered to be “on” the clipped surface.

# Example

This example clips an octahedral mesh (an eight-sided, three-dimensional shape similar to a cut diamond). The original mesh contains one rectangle and eight triangles. The connectivity list is formed with the rectangle listed first followed by the triangles. The mesh is placed in a polygon object, which is added to a model. The model is displayed in the XOBJVIEW utility, which allows you to click-and-drag the polygon object to rotate and translate it. See XOBJVIEW in the *IDL Reference Guide* for more information on this utility.

When you quit out of the first XOBJVIEW display, the second XOBJVIEW display will appear. This display shows the mesh clipped with an oblique plane. The final XOBJVIEW display shows the results of using the TRIANGULATE routine to cover the clipped area. See TRIANGULATE in the *IDL Reference Guide* for more information in this routine.

```
PRO ClippingAMesh

; Create a mesh of an octahedron.
vertices = [[0, -1, 0], [1, 0, 0], [0, 1, 0], $
   [-1, 0, 0], [0, 0, 1], [0, 0, -1]]
connectivity = [4, 0, 1, 2, 3, 3, 0, 1, 4, 3, 1, 2, 4, $
   3, 2, 3, 4, 3, 3, 0, 4, 3, 1, 0, 5, 3, 2, 1, 5, $
   3, 3, 2, 5, 3, 0, 3, 5]
```

```
; Initialize model for display.
oModel = OBJ_NEW('IDLgrModel')

; Initialize polygon and polyline outline to contain
; the mesh of the octahedron.
oPolygon = OBJ_NEW('IDLgrPolygon', vertices, $
   POLYGONS = connectivity, SHADING = 1, $
   COLOR = [0, 255, 0])
oPolyline = OBJ_NEW('IDLgrPolyline', vertices, $
   POLYLINES = connectivity, COLOR = [0, 0, 0])

; Add the polygon and the polyline to the model.
oModel -> Add, oPolygon
oModel -> Add, oPolyline

; Rotate model for better initial perspective.
oModel -> Rotate, [-1, 0, 1], 22.5

; Display model.
XOBJVIEW, oModel, /BLOCK, SCALE = 1, $
   TITLE = 'Original Octahedron Mesh'

; Clip mesh.
clip = MESH_CLIP([1., 1., 1., 0.], vertices, connectivity, $
   clippedVertices, clippedConnectivity, $
   CUT_VERTS = cutVerticesIndex)

; Update polygon with the resulting clipped mesh.
oPolygon -> SetProperty, DATA = clippedVertices, $
   POLYGONS = clippedConnectivity

; Display the updated model.
XOBJVIEW, oModel, /BLOCK, SCALE = 1, $
   TITLE = 'Clipped Octahedron Mesh'

; Determine the vertices of the clipped plane.
cutVertices = clippedVertices[*, cutVerticesIndex]

; Derive the x and y components of the clipped plane's
; vertices.
x = cutVertices[0, *]
y = cutVertices[1, *]

; Triangulate the connectivity of the clipped plane.
TRIANGULATE, x, y, triangles

; Derive the connectivity of the clipped plane from the
; results of the triangulation.
arraySize = SIZE(triangles, /DIMENSIONS)
```

```
array = FLTARR(4, arraySize[1])
array[0, *] = 3
array[1, 0] = triangles
cutConnectivity = REFORM(array, N_ELEMENTS(array))

; Initialize the clipped plane's polygon and polyline.
oCutPolygon = OBJ_NEW('IDLgrPolygon', cutVertices, $
   POLYGONS = cutConnectivity, SHADING = 1, $
   COLOR = [0, 0, 255])
oCutPolyline = OBJ_NEW('IDLgrPolyline', cutVertices, $
   POLYLINES = cutConnectivity, COLOR = [255, 0, 0], $
   THICK = 3.)

; Add polyline and polygon to model.
oModel -> Add, oCutPolyline
oModel -> Add, oCutPolygon

; Display updated model.
XOBJVIEW, oModel, /BLOCK, SCALE = 1, $
   TITLE = 'Clipped Octahedron Mesh with Clipping Plane'

; Clean-up object references.
OBJ_DESTROY, [oModel]

END
```

The results for this example are shown in the following figure. The original octahedron is on the left and the two clipped results are shown to the right.

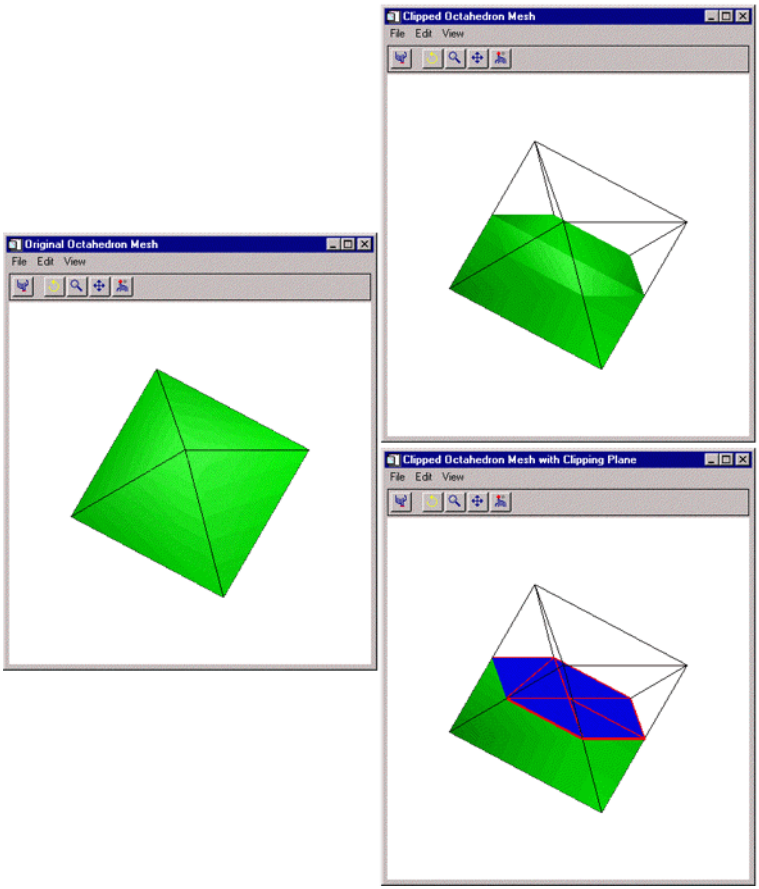



*Figure 12: The Original Octahedron (left) and the Two Clipped Results (right)*

## Version History

Introduced: 5.5

## See Also

MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

# MESH_DECIMATE

The MESH_DECIMATE function reduces the density of geometry while preserving as much of the original data as possible. The classic case is to thin out a polygonal mesh to use fewer polygons while preserving the mesh form. The decimation algorithm removes triangles from the mesh. This is done in such a way as to preserve the mesh edges and to remove roughly planar polygons.

Decimation is a memory and CPU intensive process. Expect the decimation of large models to require large amounts of memory and dozens of seconds to complete. As a reference, a model with approximately 36,000 vertices and 70,000 faces requires 20-30 seconds to decimate to 10% of its original size on a typical NT PC with 64Mb RAM and 333MHz Pentium processor.

If the input polygons are not all triangles, IDL converts the polygons to triangles before decimating. For best results, the polygons should all be convex. Note that if the input polygons are not all triangles, then IDL may return more polygons (as triangles) than were submitted as input, even after decimating a percentage of the polygons. IDL applies the PERCENT_POLYGONS keyword value to the polygon list after converting the list to triangles to approximate the same visual effect of decimating the requested percentage of polygons.

IDL takes steps to deal with input data with a wide variation in magnitude. For example, a troublesome input polygon list may have X and Y values in the 10^1 to 10^2 range, while the Z values may have magnitudes of about 10^20. If the results of the decimation are unacceptable, consider scaling the input data so that the magnitudes of the data are closer together.

## Syntax

*Result* = MESH_DECIMATE (*Verts*, *Conn*, *Connout* [, VERTICES=*variable*] [, PERCENT_VERTICES=*percent* | , PERCENT_POLYGONS=*percent*] [, PROGRESS_CALLBACK=*string*] [, PROGRESS_METHOD=*string*] [, PROGRESS_OBJECT=*objref*] [, PROGRESS_PERCENT=*percent*{0 to 100}] [, PROGRESS_USERDATA=*value*])

## Return Value

The return value is the number of triangles in the output connectivity array.

# Arguments

## Verts

Input array of polygonal vertices [3, *n*].

## Conn

Input polygonal mesh connectivity array.

## Connout

Output polygonal mesh connectivity array.

**Note**

Some of the vertices in the Verts array may not be referenced by the Connout array.

# Keywords

## PERCENT_VERTICES

Set this keyword to the percent of the original vertices to be returned in the Connout array. It specifies the amount of decimation to perform.

## PERCENT_POLYGONS

Set this keyword to the percent of the original polygons to be returned in the Connout array. It specifies the amount of decimation to perform.

**Note**

PERCENT_VERTICES and PERCENT_POLYGONS are mutually exclusive keywords.

## PROGRESS_CALLBACK

Set this keyword to a scalar string containing the name of the IDL function that MESH_DECIMATE calls at PROGRESS_PERCENT intervals as it decimates the polygonal mesh.

The PROGRESS_CALLBACK function returns a zero to signal MESH_DECIMATE to stop decimating, which causes MESH_DECIMATE to return the partially decimated mesh. If the callback function returns a non-zero, MESH_DECIMATE continues to decimate the mesh.

The PROGRESS_CALLBACK function must specify a single argument, *Percent*, which MESH_DECIMATE sets to an integer between 0 and 100, inclusive.

The PROGRESS_CALLBACK function may specify an optional USERDATA keyword, which MESH_DECIMATE sets to the variable provided in the PROGRESS_USERDATA keyword.

The following code show an example of a progress callback function:

```
FUNCTION myProgressCallback, percent,$    USERDATA = myStruct

oProgressBar = myStruct.oProgressBar

; This method updates the progress bar
; graphic and returns TRUE if the user has
; NOT pressed the cancel button.
keepGoing = oProgressBar -> $
   UpdateProgressValue(percent)

RETURN, keepGoing

END
```

## PROGRESS_METHOD

Set this keyword to a scalar string containing the name of a function method that MESH_DECIMATE calls at PROGRESS_PERCENT intervals as it decimates the mesh. If this keyword is set, then the PROGRESS_OBJECT keyword must be set to an object reference that is an instance of a class that defines the specified method.

The PROGRESS_METHOD function method callback has the same specification as the callback described in the PROGRESS_CALLBACK keyword, except that it is defined as an object class method:

```
FUNCTION myClass::myProgressCallback, $
   percent, USERDATA = myStruct
```

## PROGRESS_OBJECT

Set this keyword to an object reference that is an instance of a class that defines the method specified with the PROGRESS_METHOD keyword. If this keyword is set, then the PROGRESS_METHOD keyword must also be set.

## PROGRESS_PERCENT

Set this keyword to a scalar in the range [1, 100] to specify the interval between invocations of the callback function. The default value is 5 and IDL silently clamps other values to the range [1, 100].

For example, a value of 5 (the default) specifies MESH_DECIMATE will call the callback function when the decimation is 0% complete, 5% complete, 10% complete, ..., 95% complete, and 100% complete.

### PROGRESS_USERDATA

Set this property to any IDL variable that MESH_DECIMATE passes to the callback function in the callback function's USERDATA keyword parameter. If this keyword is specified, then the callback function must be able to accept keyword parameters.

### VERTICES

Set this keyword to a named variable that will contain an output array of the vertices generated by the MESH_DECIMATE function. If this keyword is specified, the function is not restricted to using the original set of vertices specified in the *Verts* parameter when generating the decimated mesh, allowing it to generate a more optimal mesh by determining its own placement of vertices. If this keyword is specified, the *Connout* argument will consist of a polygon connectivity list whose indices refer to the vertex list stored in the named variable specified with this keyword. Otherwise, the *Connout* argument will consist of a polygon connectivity list that refers to the original vertex list *Verts*.

## Examples

This example decimates a DEM (digital elevation model) mesh. The DEM in this example comes from the `elevbin.dat` file found in the `examples/data` directory. The DEM is converted into a mesh with the MESH_OBJ procedure. The results of this routine are placed in a polygon object, which is added to a model. The models are displayed in the XOBJVIEW utility. The XOBJVEW utility allows you to click-and-drag the polygon object to rotate and translate it. See XOBJVIEW in the *IDL Reference Guide* for more information on this utility.

The first display contains a wire outline of the DEM as a mesh. When you quit out of the first XOBJVIEW display, the second XOBJVIEW display will appear showing a filled mesh. The colors correspond to the change in elevation. The third display is the result of decimating the mesh down to 20 percent of the original number of vertices. The final display is the resulting mesh filled with the elevation colors.

```
PRO DecimatingAMesh

; Determine path to data file.
elevbinFile = FILEPATH('elevbin.dat', $
   SUBDIRECTORY = ['examples', 'data'])
```

```
; Initialize data parameters.
elevbinSize = [64, 64]
elevbinData = BYTARR(elevbinSize[0], elevbinSize[1])

; Open file, read in data, and close file.
OPENR, unit, elevbinFile, /GET_LUN
READU, unit, elevbinData
FREE_LUN, unit

; Convert data into a mesh, which is defined by
; vertice locations and their connectivity.
MESH_OBJ, 1, vertices, connectivity, elevbinData

; Initialize a model for display.
oModel = OBJ_NEW('IDLgrModel')

; Form a polygon from the mesh.
oPolygon = OBJ_NEW('IDLgrPolygon', vertices, $
   POLYGONS = connectivity, SHADING = 1.5, $
   COLOR = [0, 255, 0], STYLE = 1)

; Add polygon to model.
oModel -> Add, oPolygon

; Rotate model for better initial perspective.
oModel -> Scale, 1, 1, 0.25
oModel -> Rotate, [-1, 0, 1], 45.

; Display model in the XOBJVIEW utility.
XOBJVIEW, oModel, /BLOCK, SCALE = 1., $
   TITLE = 'Original Mesh from Elevation Data'

; Derive a color table for the filled polygon.
oPalette = OBJ_NEW('IDLgrPalette')
oPalette -> LOADCT, 29

; Fill in the polygon mesh with the colors of the table
; (the colors correspond to the z-values of the polygon).
oPolygon -> SetProperty, STYLE = 2, $
   VERT_COLORS = BYTSCL(vertices[2, *]), $
   PALETTE = oPalette

; Display model in the XOBJVIEW utility.
XOBJVIEW, oModel, /BLOCK, SCALE = 1., $
  TITLE = 'Filled Original Mesh'

; Decimate the mesh down to 20 percent of the original
; number of vertices.
numberVertices = MESH_DECIMATE(vertices, connectivity, $
```

```
   decimatedConnectivity, VERTICES = decimatedVertices, $
   PERCENT_VERTICES = 20)

; Update the polygon with the resulting decimated mesh.
oPolygon -> SetProperty, DATA = decimatedVertices, $
   POLYGONS = decimatedConnectivity, STYLE = 1, $
   VERT_COLORS = 0, COLOR = [0, 255, 0]

; Display updated model in the XOBJVIEW utility.
XOBJVIEW, oModel, /BLOCK, SCALE = 1., $
   TITLE = 'Decimation Results (by 80%)'

; Fill in the updated polygon mesh with the colors of
; the table (the colors correspond to the z-values of
; the updated polygon).
oPolygon -> SetProperty, STYLE = 2, $
   VERT_COLORS = BYTSCL(decimatedVertices[2, *]), $
   PALETTE = oPalette

; Display model in the XOBJVIEW utility.
XOBJVIEW, oModel, /BLOCK, SCALE = 1., $
  TITLE = 'Filled Decimation Results'

; Cleanup all the objects by destroying the model.
OBJ_DESTROY, [oModel, oPalette]

END
```

The results of the decimation are shown in the bottom row of the following figure.

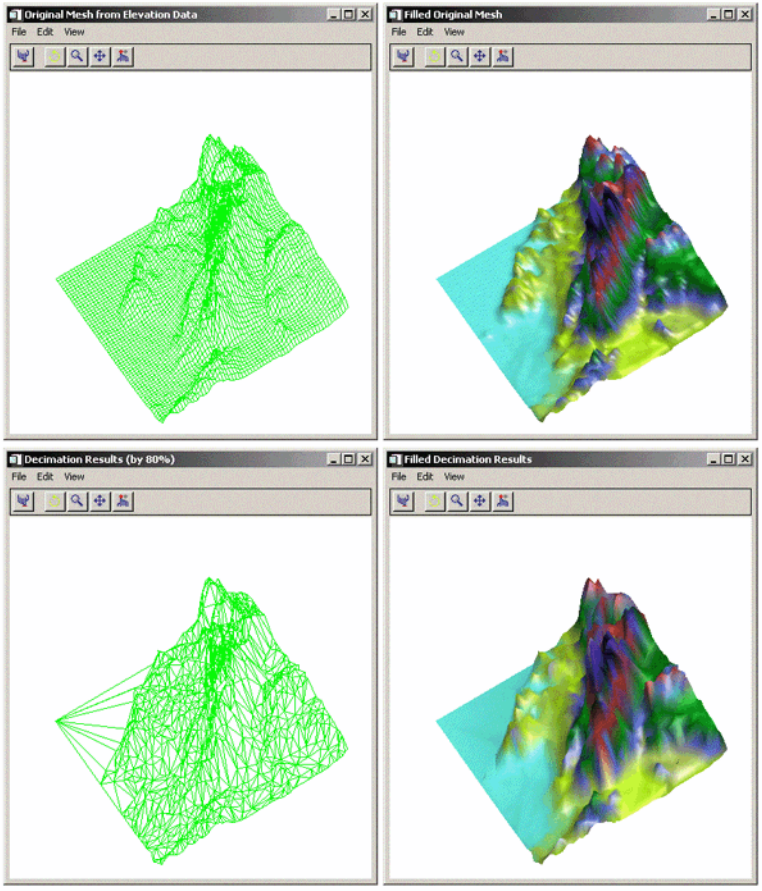



*Figure 13: Before Decimating (top row) and After Decimating (bottom row)*

## Version History

Introduced: 5.5

## See Also

MESH_CLIP, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

# MESH_ISSOLID

The MESH_ISSOLID function computes various mesh properties and enables IDL to determine if a mesh encloses space (is a solid). If the mesh can be considered a solid, routines can compute the volume of the mesh.

## Syntax

*Result* = MESH_ISSOLID (*Conn*)

## Return Value

Returns 1 if the input mesh fully encloses space (assuming no polygonal interpenetration) or 0 otherwise. A mesh is defined to fully enclose space if each edge in the input mesh appears an even number of times in the mesh.

**Note**

The input polygonal mesh is assumed to contain only planar, convex polygons.

## Arguments

### Conn

This is an integer or longword array that represents a series of polygon descriptions. Each polygon description takes the form [$n$, $i_0$, $i_1$, ..., $i_{n-1}$], where $n$ is the number of vertices that define the polygon, and $i_0$...$i_{n-1}$ are indices into the vertex array.

## Keywords

None.

## Version History

Introduced: 5.5

## See Also

MESH_CLIP, MESH_DECIMATE, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

# MESH_MERGE

The MESH_MERGE function merges two polygonal meshes.

## Syntax

*Result* = MESH_MERGE (*Verts*, *Conn*, *Verts1*, *Conn1* [, /COMBINE_VERTICES] [, TOLERANCE=*value*] )

## Return Value

The function return value is the number of triangles in the modified polygonal mesh connectivity array.

## Arguments

### Verts

Input/Output array of polygonal vertices [3, *n*]. These are potentially modified and returned to the user.

### Conn

Input/Output polygonal mesh connectivity array. This array is modified and returned to the user.

### Verts1

Additional input polygonal vertex array [3, *n*].

### Conn1

Additional input polygonal mesh connectivity array.

# Keywords

## COMBINE_VERTICES

If this keyword is set, the routine will attempt to collapse vertices which are at the same location in space into single vertices. If the expression

$$\max(|x_i - x_{i+1}|, |y_i - y_{i+1}|, |z_i - z_{i+1}|) < tolerance$$

is true, the points (*i*) and (*i*+1) can be collapsed into a single vertex. The result is returned as a modification of the *Verts* argument.

## TOLERANCE

This keyword is used to specify the tolerance value used with the COMBINE_VERTICES keyword. The default value is 0.0.

# Examples

This example merges two simple meshes: a single square and a single right triangle. The right side of the square is in the same location as the left side of the triangle. Each mesh is originally its own polygon object. These objects are then added to a model object. The model is displayed in the XOBJVIEW utility. The XOBJVEW utility allows you to click-and-drag the polygon object to rotate and translate it. See XOBJVIEW in the *IDL Reference Guide* for more information on this utility.

When you quit out of the first XOBJVIEW display, the second XOBJVIEW display will appear. The meshes are merged into a single polygon object. After you quit out of the second display, the final display shows the results of decimating the merged mesh to obtain the least number connections for these vertices. Decimation can often be used to refine the results of merging.

```
PRO MergingMeshes

; Create a mesh of a single square (4 vertices
; connected counter-clockwise from the lower left
; corner of the mesh.
vertices = [[-2., -1., 0.], [0., -1., 0.], $
   [0., 1., 0.], [-2., 1., 0.]]
connectivity = [4, 0, 1, 2, 3]
```

```
; Create a separate mesh of a single triangle (3
; vertices connected counter-clockwise from the lower
; left corner of the mesh.
triangleVertices = [[0., -1., 0.], [2., -1., 0.], $
   [0., 1., 0.]]
triangleConnectivity = [3, 0, 1, 2]

; Initialize model for display.
oModel = OBJ_NEW('IDLgrModel')

; Initialize polygon for the square mesh.
oPolygon = OBJ_NEW('IDLgrPolygon', vertices, $
   POLYGONS = connectivity, COLOR = [0, 128, 0], $
   STYLE = 1)

; Initialize polygon for the triangle mesh.
oTrianglePolygon = OBJ_NEW('IDLgrPolygon', $
   triangleVertices, POLYGONS = triangleConnectivity, $
   COLOR = [0, 0, 255], STYLE = 1)

; Add both polygons to the model.
oModel -> Add, oPolygon
oModel -> Add, oTrianglePolygon

; Display the model in the XOBJVIEW utility.
XOBJVIEW, oModel, /BLOCK, $
   TITLE = 'Two Separate Meshes'

; Merge the square and triangle into a single mesh.
numberTriangles = MESH_MERGE(vertices, $
   connectivity, triangleVertices, $
   triangleConnectivity, /COMBINE_VERTICES)

; Output number of resulting vertices and triangles.
numberVertices = SIZE(vertices, /DIMENSIONS)
PRINT, 'numberVertices = ', numberVertices[1]
PRINT, 'numberTriangles = ', numberTriangles

; Cleanup triangle polygon object, which is no longer
; needed.
OBJ_DESTROY, [oTrianglePolygon]

; Update remaining polygon object with the results from
; merging the two meshes together.
oPolygon -> SetProperty, DATA = vertices, $
   POLYGONS = connectivity, COLOR = [0, 128, 128]
```

```
; Display results.
XOBJVIEW, oModel, /BLOCK, $
   TITLE = 'Result of Merging the Meshes into One'

; Decimate polygon to 75 percent of the original
; number of vertices.
numberTriangles = MESH_DECIMATE(vertices, connectivity, $
   decimatedConnectivity, PERCENT_POLYGONS = 75)

; Output number of resulting triangles.
PRINT, 'After Decimation:  numberTriangles = ', numberTriangles

; Update polygon with results from decimating.
oPolygon -> SetProperty, DATA = vertices, $
   POLYGONS = decimatedConnectivity, COLOR = [0, 0, 0]

; Display decimation results.
XOBJVIEW, oModel, /BLOCK, $
  TITLE = 'Decimation of Mesh'

; Cleanup object references.
OBJ_DESTROY, [oModel]

END
```

The results for this example are shown in the following figure: original, separate meshes (left), merged mesh (center) and decimated mesh (right).

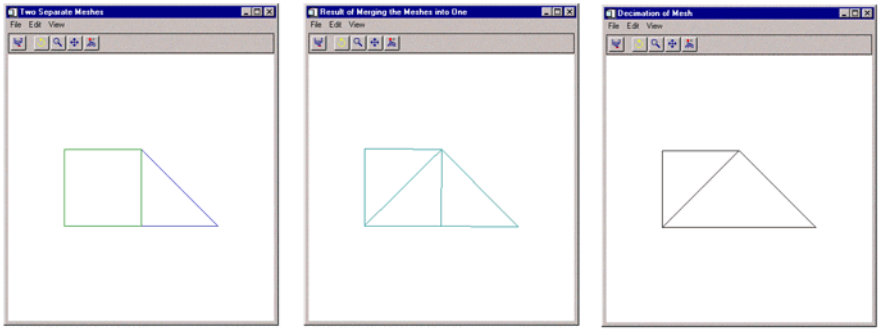



*Figure 14: Original (left), Merged (center), and Decimated Meshes (right)*

## Version History

Introduced: 5.5

## See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

# MESH_NUMTRIANGLES

The MESH_NUMTRIANGLES function computes the number of triangles in a polygonal mesh.

## Syntax

*Result* = MESH_NUMTRIANGLES (*Conn*)

## Return Value

Returns the number of triangles in the mesh (a quad is considered two triangles).

## Arguments

### Conn

Polygonal mesh connectivity array.

## Keywords

None.

## Version History

Introduced: 5.5

## See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

# MESH_OBJ

The MESH_OBJ procedure generates a polygon mesh (vertex list and polygon list) that represent the desired primitive object. The available primitive objects are: triangulated surface, rectangular surface, polar surface, cylindrical surface, spherical surface, surface of extrusion, surface of revolution, and ruled surface.

This routine is written in the IDL language. Its source code can be found in the file `mesh_obj.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

MESH_OBJ, *Type*, *Vertex_List*, *Polygon_List*, *Array1* [, *Array2*] [, /CLOSED] [, /DEGREES] [, P1=*value*] [, P2=*value*] [, P3=*value*] [, P4=*value*] [, P5=*value*]

## Arguments

### Type

An integer that specifies what type of object to create. The various surface types are described in the table below.

| Type | Surface Type |
|---|---|
| 0 | Triangulated |
| 1 | Rectangular |
| 2 | Polar |
| 3 | Cylindrical |
| 4 | Spherical |
| 5 | Extrusion |
| 6 | Revolution |
| 7 | Ruled |
| Other values | None |

*Table 68: Surface Types*

## Vertex_List

A named variable that will contain the mesh vertices. *Vertex_List* has the same format as the lists returned by the SHADE_VOLUME procedure.

## Polygon_List

A named variable that will contain the mesh indexes. *Polygon_List* has the same format as the lists returned by the SHADE_VOLUME procedure.

## Array1

An array whose use depends on the type of object being created. The following table describes the differences.

| Surface Type | *Array1* Type |
|---|---|
| Triangulated | A (3, *n*) array containing random [*x, y, z*] points to build a triangulated surface from. The resulting polygon mesh will have *n* vertices. When shading a triangulated mesh, the shading array should have (*n*) elements. |
| Rectangular | A two dimensional (*n, m*) array containing *z* values. The resulting polygon mesh will have *n* x *m* vertices. When shading a rectangular mesh, the shading array should have (*n, m*) elements. |
| Polar | A two dimensional (*n, m*) array containing *z* values. The resulting polygon mesh will have *n* x *m* vertices. The *n* dimension of the array is mapped to the polar angle, and the *m* dimension is mapped to the polar radius. When shading a polar mesh, the shading array should have (*n, m*) elements. |
| Cylindrical | A two dimensional (*n, m*) array containing radius values. The resulting polygon mesh will have *n* x *m* vertices. The *n* dimension of the array is mapped to the polar angle, and the m dimension is mapped to the Z axis. When shading a cylindrical mesh, the shading array should have (*n, m*) elements. |

*Table 69: Array 1 Type*

| Surface Type | *Array1* Type |
|---|---|
| Spherical | A two dimensional (*n, m*) array containing radius values. The resulting polygon mesh will have *n* x *m* vertices. The *n* dimension of the array is mapped to the longitude (0.0 to 360.0 degrees), and the *m* dimension is mapped to the latitude (-90.0 to +90.0 degrees). When shading a spherical mesh, the shading array should have (*n, m*) elements. |
| Extrusion | A (3, *n*) array of connected 3D points which define the shape to extrude. The resulting polygon mesh will have *n* x (steps+1) vertices (where steps is the number of “segments” in the extrusion). (See the P1 keyword). If the order of the elements in *Array1* is reversed, then the polygon facing is reversed. When shading an extrusion mesh, the shading array should have (*n*, steps+1) elements. |
| Revolution | A (3, *n*) array of connected 3D points which define the shape to revolve. The resulting polygon mesh will have *n* x ((steps>3)+1) vertices (where steps is the number of “steps” in the revolution). (See the P1 keyword). If the order of the elements in *Array1* is reversed, then the polygon facing is reversed. When shading a revolution mesh, the shading array should have (*n*, (steps>3)+1) elements. |
| Ruled | A (3, *n*) array of connected 3D points which define the shape of the first ruled vector. The optional (3, *m*) *Array2* parameter defines the shape of the second ruled vector. The resulting polygon mesh will have (*n* > *m*)*(steps+1) vertices (where steps is the number of intermediate “steps”). (See the P1 keyword). When shading a ruled mesh, the shading array should have (*n* > *m*, steps+1) elements. |

*Table 69: Array 1 Type (Continued)*

## Array2

If the object type is 7 (Ruled Surface) then *Array2* is a (3, *m*) array containing the 3D points which define the second ruled vector. If *Array2* has fewer elements than *Array1* then *Array2* is processed with CONGRID to give it the same number of elements as *Array1*. If *Array1* has fewer elements than *Array2* then *Array1* is processed with CONGRID to give it the same number of elements as *Array2*. *Array2* must be supplied if the object type is 7. Otherwise, *Array2* is ignored.

# Keywords

## CLOSED

Set this keyword to “close” the polygonal mesh topologically by using the first vertex in a given row for both the first and last polygons in that row. This keyword is only applicable to the CYLINDRICAL, SPHERICAL, REVOLUTION, and EXTRUSION surface types. Setting the CLOSED keyword removes the discontinuity when the mesh wraps back around on itself, which can improve the mesh’s appearance when viewing it as a shaded object. For the EXTRUSION surface type, this procedure handles input polygons that form a closed loop with the last vertex being a copy of the first vertex, as well as those that do not.

## DEGREES

If set, then the input parameters are in degrees (where applicable). Otherwise, the angles are in radians.

## P1 - P5

The meaning of the keywords P1 through P5 vary depending upon the object type. The table below describes the differences.

| Surface Type | Keywords |
|---|---|
| Triangulated | P1 through P5 are ignored. |
| Rectangular | If *Array1* is an (*n*, *m*) array, and if P1 has n elements, then the values contained in P1 are the X coordinates for each column of vertices. Otherwise, FINDGEN(*n*) is used for the X coordinates. If P2 has *m* elements, then the values contained in P2 are the Y coordinates for each row of vertices. Otherwise, FINDGEN(*m*) is used for the Y coordinates. The polygon facing is reversed if the order of either P1 or P2 (but not both) is reversed. P3, P4, and P5 are ignored. |

*Table 70: P1-P5 Keywords*

| Surface Type | Keywords |
|---|---|
| Polar | P1 specifies the polar angle of the first column of *Array1* (the default is 0). P2 specifies the polar angle of the last column of *Array1* (the default is 2*PI). If P2 is less than P1 then the polygon facing is reversed. P3 specifies the radius of the first row of *Array1* (the default is 0). P4 specifies the radius of the last row of *Array1* (the default is *m*-1). If P4 is less than P3 then the polygon facing is reversed. P5 is ignored. |
| Cylindrical | P1 specifies the polar angle of the first column of *Array1* (the default is 0). P2 specifies the polar angle of the last column of *Array1* (the default is 2*PI). If P2 is less than P1 then the polygon facing is reversed. P3 specifies the Z coordinate of the first row of *Array1* (the default is 0). P4 specifies the Z coordinate of the last row of *Array1* (the default is *m*-1). If P4 is less than P3 then the polygon facing is reversed. P5 is ignored. |
| Spherical | P1 specifies the longitude of the first column of *Array1* (the default is 0). P2 specifies the longitude of the last column of *Array1* (the default is 2*PI). IF P2 is less than P1 then the polygon facing is reversed. P3 specifies the latitude of the first row of *Array1* (the default is -PI/2). P4 specifies the latitude of the last row of *Array1* (the default is +PI/2). If P4 is less than P3 then the polygon facing is reversed. P5 is ignored. |
| Extrusion | P1 specifies the number of steps in the extrusion (the default is 1). P2 is a three element vector specifying the direction (and length) of the extrusion (the default is [0, 0, 1]). P3, P4, and P5 are ignored. |
| Revolution | P1 specifies the number of “facets” in the revolution (the default is 3). If P1 is less than 3 then 3 is used. P2 is a three element vector specifying a point that the rotation vector passes through (the default is [0, 0, 0]). P3 is a three element vector specifying the direction of the rotation vector (the default is [0, 0, 1]). P4 specifies the starting angle for the revolution (the default is 0). P5 specifies the ending angle for the revolution (the default is 2*PI). If P5 is less than P4 then the polygon facing is reversed. |

*Table 70: P1-P5 Keywords (Continued)*

| Surface Type | Keywords |
|---|---|
| Ruled | P1 specifies the number of “steps” in the ruling (the default is 1). P2, P3, P4, and P5 are ignored. |

*Table 70: P1-P5 Keywords (Continued)*

# Examples

```
; Create a 48x64 cylinder with a constant radius of 0.25:
MESH_OBJ, 3, Vertex_List, Polygon_List, $
   Replicate(0.25, 48, 64), P4=0.5

; Transform the vertices:
T3D, /RESET
T3D, ROTATE=[0.0, 30.0, 0.0]
T3D, ROTATE=[0.0, 0.0, 40.0]
T3D, TRANSLATE=[0.25, 0.25, 0.25]
VERTEX_LIST = VERT_T3D(Vertex_List)

; Create the window and view:
WINDOW, 0, XSIZE=512, YSIZE=512
CREATE_VIEW, WINX=512, WINY=512

; Render the mesh:
SET_SHADING, LIGHT=[-0.5, 0.5, 2.0], REJECT=0
TVSCL, POLYSHADE(Vertex_List, Polygon_List, /NORMAL)

; Create a cone (surface of revolution):
MESH_OBJ, 6, Vertex_List, Polygon_List, $
   [[0.75, 0.0, 0.25], [0.5, 0.0, 0.75]], $
   P1=16, P2=[0.5, 0.0, 0.0]

; Create the window and view:
WINDOW, 0, XSIZE=512, YSIZE=512
CREATE_VIEW, WINX=512, WINY=512, AX=30.0, AY=(140.0), ZOOM=0.5

; Render the mesh:
SET_SHADING, LIGHT=[-0.5, 0.5, 2.0], REJECT=0
TVSCL, POLYSHADE(Vertex_List, Polygon_List, /DATA, /T3D)
```

# Version History

Introduced: Pre 4.0

## See Also

CREATE_VIEW, MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME, SET_SHADING, VERT_T3D

# MESH_SMOOTH

The MESH_SMOOTH function performs spatial smoothing on a polygon mesh. This function smooths a mesh by applying Laplacian smoothing to each vertex, as described by the following formula:

$$\vec{x}_{i_{(n+1)}} = \vec{x}_{i_n} + \frac{\lambda}{M} \sum_{j=0}^{M} (\vec{x}_{j_n} - \vec{x}_{i_n})$$

where:

| | |
|---|---|
| $\vec{x}_{i_n}$ | is vertex *i* for iteration *n* |
| $\lambda$ | is the smoothing factor |
| ***M*** | is the number of vertices that share a common edge with $x_{i_n}$. |

## Syntax

*Result* = MESH_SMOOTH (*Verts*, *Conn* [, ITERATIONS=*value*] [, FIXED_VERTICES=*array*] [, /FIXED_EDGE_VERTICES] [, LAMBDA=*value*])

## Return Value

The output of this function is resulting [3, *n*] array of modified vertices.

## Arguments

### Verts

Input array of polygonal vertices [3, *n*].

### Conn

Input polygonal mesh connectivity array.

## Keywords

### ITERATIONS

Number of iterations to smooth. The default value is 50.

### FIXED_VERTICES

Set this keyword to an array of vertex indices which are not to be modified by the smoothing.

### FIXED_EDGE_VERTICES

Set this keyword to specify that mesh outer edge vertices are not to be modified by the smoothing.

### LAMBDA

Smoothing factor. The default value is 0.05.

## Examples

This example smooths a rectangular mesh containing a spike. First, we create a rectangular mesh made up 10 columns and 5 rows of vertices. The vertices are connected with right triangles. The mesh is placed in a polygon object, which is added to a model object. The model is displayed in the XOBJVIEW utility. The XOBJVEW utility allows you to click-and-drag the polygon object to rotate and translate it. See XOBJVIEW in the *IDL Reference Guide* for more information on this utility.

When you quit out of the first XOBJVIEW display, the second XOBJVIEW display will appear. The center vertex of the top row is displaced in the y-direction. This displacement causes the center of the top to spike out away from the mesh. After you quit out of the second display, the third display shows the result of smoothing the entire mesh. The final display shows the results of smoothing the spike with all the other vertices fixed.

```
PRO SmoothingMeshes

; Initialize mesh size parameters.
nX = 10
nY = 5

; Initialize the x coordinates of the mesh's vertices.
xVertices = FINDGEN(nX) # REPLICATE(1., nY)
PRINT, 'xVertices:  '
PRINT, xVertices, FORMAT = '(10F6.1)'

; Initialize the y coordinates of the mesh's vertices.
yVertices = REPLICATE(1., nX) # FINDGEN(nY)
PRINT, 'yVertices:  '
PRINT, yVertices, FORMAT = '(10F6.1)'
```

```
; Derive the overall vertices of the mesh.
vertices = FLTARR(3, (nX*nY))
vertices[0, *] = xVertices
vertices[1, *] = yVertices
PRINT, 'vertices:  '
PRINT, vertices, FORMAT = '(3F6.1)'

; Triangulate the mesh to establish connectivity.
TRIANGULATE, xVertices, yVertices, triangles
trianglesSize = SIZE(triangles, /DIMENSIONS)
polygons = LONARR(4, trianglesSize[1])
polygons[0, *] = 3
polygons[1, 0] = triangles
PRINT, 'polygons:  '
PRINT, polygons, FORMAT = '(4I6)'

; Derive connectivity from the resulting triangulation.
connectivity = REFORM(polygons, N_ELEMENTS(polygons))

; Initialize a model for the display.
oModel = OBJ_NEW('IDLgrModel')

; Initialize a polygon object to contain the mesh.
oPolygon = OBJ_NEW('IDLgrPolygon', vertices, $
   POLYGONS = connectivity, COLOR = [0, 128, 0], $
   STYLE = 1)

; Add the polygon to the model.
oModel -> Add, oPolygon

; Display the model.
XOBJVIEW, oModel, /BLOCK, $
   TITLE = 'Original Mesh'

; Introduce an irregular vertex by drastically changing
; a single y coordinate.
vertices[1, 45] = 10.

; Update polygon with new vertices.
oPolygon -> SetProperty, DATA = vertices

; Display change.
XOBJVIEW, oModel, /BLOCK, $
   TITLE = 'Mesh with New Irregular Vertex'

; Smooth entire mesh to reduce the effect of the
; irregular vertex.
smoothedVertices = MESH_SMOOTH(vertices, connectivity)
```

```
; Update polygon and display results.
oPolygon -> SetProperty, DATA = smoothedVertices
XOBJVIEW, oModel, /BLOCK, $
   TITLE = 'Smoothing with No Fixed Vertices'

; Determine which vertices should be fixed.  Basically,
; all of the vertices should be fixed except for the
; irregular vertex.
fixed = LINDGEN((nX*nY) - 1)
fixed[45] = fixed[45:*] + 1

; Smooth mesh with resulting fixed vertices.
smoothedVertices = MESH_SMOOTH(vertices, connectivity, $
   FIXED_VERTICES = fixed)

; Update polygon and display results.
oPolygon -> SetProperty, DATA = smoothedVertices
XOBJVIEW, oModel, /BLOCK, $
   TITLE = 'Smoothing with Almost All Vertices Fixed'

; Cleanup object references.
OBJ_DESTROY, [oModel]

END
```

The results for this example are shown in the following figure: the spiked mesh (left), and the two smoothed meshes (right).

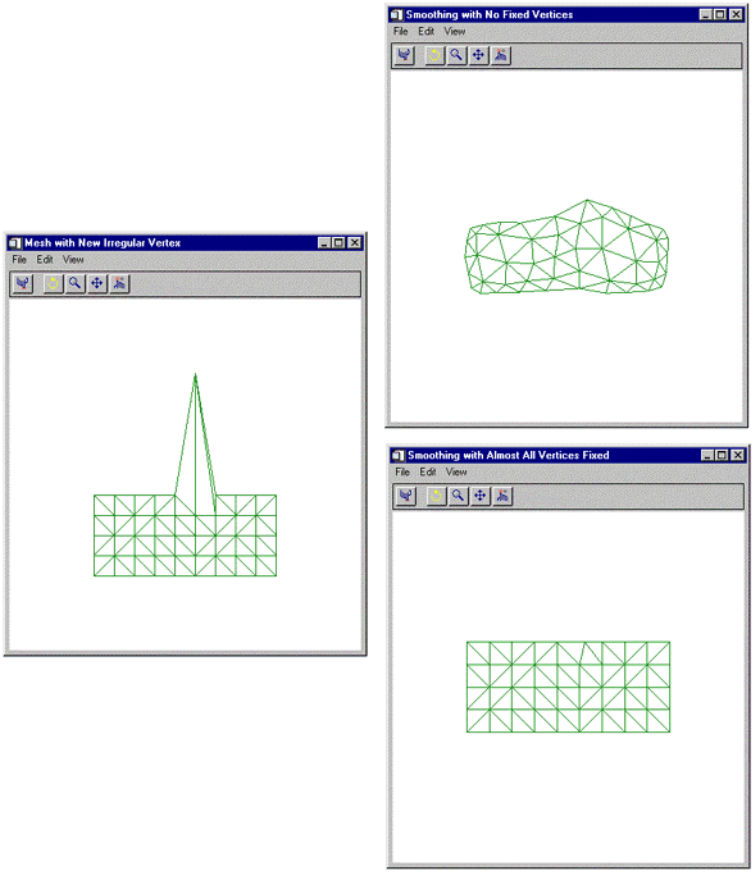



*Figure 15: The Spiked Mesh (left) and the Two Smoothed Meshes (right)*

## Version History

Introduced: 5.5

## See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SURFACEAREA, MESH_VALIDATE, MESH_VOLUME

# MESH_SURFACEAREA

The MESH_SURFACEAREA function computes various mesh properties to determine the mesh surface area, including integration of other properties interpolated on the surface of the mesh.

## Syntax

*Result* = MESH_SURFACEAREA ( *Verts*, *Conn* [, AUXDATA=*array*] [, MOMENT=*variable*] )

## Return Value

Returns the cumulative (weighted) surface area of the polygons in the mesh.

**Note**

The input polygonal mesh is assumed to contain only planar, convex polygons.

## Arguments

### Verts

Array of polygonal vertices [3, *n*].

### Conn

Polygonal mesh connectivity array.

## Keywords

### AUXDATA

Array of input auxiliary data (one value per vertex). If present, these values are used to weight a vertex for the purpose of the area computation. The surface area integral will linearly interpolate these values over the surface of each triangle. The default weight is 1.0 which results in the basic polygon area.

### MOMENT

If this keyword is present, it will return a three element float vector which corresponds to the first order moments computed with respect to the X, Y and Z axis. The computation is:

$$\vec{m} = \sum_{ntris} a_i \hat{c}_i$$

where *a* is the (weighted) area of the triangle and *c* is the centroid of the triangle, thus

$$\vec{m} / sarea$$

yields the (weighted) centroid of the polygon mesh.

## Version History

Introduced: 5.5

## See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_VALIDATE, MESH_VOLUME

# MESH_VALIDATE

The MESH_VALIDATE function checks for NaN values in vertices, removes unused vertices, and combines close vertices.

## Syntax

*Result* = MESH_VALIDATE ( *Verts*, *Conn* [, /REMOVE_NAN] [, /PACK_VERTICES] [, /COMBINE_VERTICES] [, TOLERANCE=*value*] )

## Return Value

The function return value is the number of triangles in the modified polygonal mesh connectivity array.

## Arguments

### Verts

Input/Output array of polygonal vertices [3, *n*]. These are potentially modified and returned to the user.

### Conn

Input/Output polygonal mesh connectivity array. This array is modified and returned to the user.

## Keywords

### COMBINE_VERTICES

If this keyword is set, the routine will attempt to collapse vertices which are at the same location in space into single vertices. If the expression

$$\max(|x_i - x_{i+1}|, |y_i - y_{i+1}|, |z_i - z_{i+1}|) < tolerance$$

is true, the points (*i*) and (*i*+1) can be collapsed into a single vertex. The result is returned as a modification of the *Verts* argument.

### PACK_VERTICES

If this keyword is set, the Verts input array will be packed to exclude any non-referenced vertices. The result is returned in the Verts argument.

### REMOVE_NAN

If this keyword is set, the function will remove any polygons from CONN which reference vertices containing NaN values.

### TOLERANCE

This keyword is used to specify the tolerance value used with the COMBINE_VERTS keyword. The default value is 0.0.

## Version History

Introduced: 5.5

## See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VOLUME

# MESH_VOLUME

The MESH_VOLUME function computes the volume that the mesh encloses. A region that a mesh encloses has a positive value for its volume when it is enclosed by mesh polygons that face outward from the enclosed region. Outward-facing polygons follow the convention of their vertices being ordered in a counter-clockwise direction while observing the polygon from the outside of the enclosed region. Likewise, a region has a negative value for its volume when it is enclosed by polygons that face inward to the enclosed region.

A single mesh may contain regions that have positive and negative volume values. This function adds these signed values together to produce a single volume value that takes into account the total of all positive regions minus any "holes" or subtractions specified by the negative regions.

If the SIGNED keyword is not specified, IDL returns the absolute value of the volume, which may be useful in situations where the polygon vertex ordering convention is unknown or opposite of the convention described above.

## Syntax

*Result* = MESH_VOLUME ( *Verts*, *Conn* [, /SIGNED] )

## Return Value

Returns the volume that the mesh encloses. If the mesh does not enclose space (i.e. MESH_ISSOLID( ) would return 0), this function returns 0.0.

**Note**

The input polygonal mesh is assumed to contain only planar, convex polygons.

## Arguments

### Verts

Array of polygonal vertices [3, *n*].

### Conn

Polygonal mesh connectivity array.

# Keywords

## SIGNED

Set this keyword to compute the signed volume. The sign will be negative for a mesh consisting of inward facing polygons.

# Version History

Introduced: 5.5

# See Also

MESH_CLIP, MESH_DECIMATE, MESH_ISSOLID, MESH_MERGE, MESH_NUMTRIANGLES, MESH_OBJ, MESH_SMOOTH, MESH_SURFACEAREA, MESH_VALIDATE

# MESSAGE

The MESSAGE procedure issues error and informational messages using the same mechanism employed by built-in IDL routines. By default, the message is issued as an error, the message is output, and IDL performs the required error-handling actions (which can be controlled via the CATCH, ON_ERROR, and ON_IOERROR procedures). As a side-effect of issuing the error, the system variable !ERROR_STATE is set and the text of the error message is placed in !ERROR_STATE.MSG. (If there is an operating system component to the error message, !ERROR_STATE.SYS_MSG is updated as well).

The MESSAGE procedure supports the following uses:

1. To issue a simple error message containing user-specified text.
2. To issue a specific error from a *message block* by name, with optional arguments. The NAME keyword is required in this case; if the error is not defined in the default IDL message block, the BLOCK keyword is also required. See DEFINE_MSGBLK and DEFINE_MSGBLK_FROM_FILE for examples of this usage.
3. To reissue the most recent error encountered by IDL. If the CATCH procedure is used to trap errors, the REISSUE_LAST keyword to MESSAGE can be used within the CATCH block to pass the error up to its caller.

If the call to the MESSAGE procedure causes execution to halt, traceback information is displayed automatically.

## Syntax

*To issue a simple error message:*

MESSAGE, [*Text*] [, /CONTINUE] [, LEVEL=*CallLevel*] [, /INFORMATIONAL] [, /IOERROR] [, /NONAME] [, /NOPREFIX] [, /NOPRINT] [, /RESET]

*To issue a named message from a message block:*

MESSAGE, [$Arg_1$, ... $Arg_N$,] NAME=*ErrorName* [, BLOCK=*BlockName*] [, /CONTINUE] [, LEVEL=*CallLevel*] [, /INFORMATIONAL] [, /IOERROR] [, /NONAME] [, /NOPREFIX] [, /NOPRINT] [, /RESET]

*To reissue the most recent error:*

MESSAGE, /REISSUE_LAST

# Arguments

## Text

A string value specifying the text to be displayed in a simple error message.

**Note**

The *Text* argument is only used when MESSAGE is issuing a simple error message; that is, if neither the NAME keyword nor the REISSUE_LAST keyword is present. If *none* of the *Text* argument, the NAME keyword, or the REISSUE_LAST keyword are present, MESSAGE returns quietly.

## $Arg_i$

When issuing a named error using the NAME (and possibly BLOCK) keyword, the $Arg_i$ arguments are substituted into the error format string, as described in the documentation for DEFINE_MSGBLK and DEFINE_MSGBLK_FROM_FILE.

# Keywords

## BLOCK

Set this keyword to a string containing the name of the IDL message block to use. This keyword is ignored unless the NAME keyword is also present to specify a message name.

By default, MESSAGE throws the IDL_M_USER_ERR message from the IDL_MBLK_CORE message block. If you wish to provide something other than the default error message, you can define your own message blocks and error messages. See the DEFINE_MSGBLK and DEFINE_MSGBLK_FROM_FILE procedures for details. You can use the HELP, /MESSAGES command to see the currently defined message blocks.

## CONTINUE

Set this keyword to return after issuing the error instead of taking the action specified by ON_ERROR. Use this option when it is desirable to report an error and then continue processing.

## INFORMATIONAL

Set this keyword to issue informational text instead of an error. In this case, !ERROR_STATE is not set. The !QUIET system variable controls the printing of informational messages.

## IOERROR

Set this keyword to indicate that the error occurred while performing I/O. The action specified by the ON_IOERROR procedure is executed instead of ON_ERROR.

## LEVEL

Many messages include the name of the routine that called MESSAGE at the beginning of the message text. Use the LEVEL keyword to an integer value to specify that the name of a routine further up in the current call chain should be used instead. Specify the value of LEVEL as described in the following table:

| LEVEL value | Meaning |
|---|---|
| 0 | The currently active routine. |
| > 0 | The absolute index of the routine to indicate. A value of 1 specifies the main level ($MAIN$), 2 indicates the routine called by $MAIN$, and so forth. |
| < 0 | Negative values indicate the relative index of the desired routine moving backwards from the current one. Hence, -1 indicates the caller of the current routine. |

*Table 71: LEVEL Keyword Values*

The LEVEL keyword can be used to hide error handling helper routines from user view. The following procedure will issue an error on behalf of its caller. The calling routine's name will appear in the resulting message, and not that of the error routine:

```
pro THROW_ERROR, text
   on_error, 2   ; Stop in caller
   MESSAGE, LEVEL=-1, text
end
```

## NAME

Set this keyword to a string containing the name of the message throw. By default, MESSAGE throws the IDL_M_USER_ERR message from the IDL_MBLK_CORE

message block. NAME is often used in conjunction with the BLOCK keyword to throw a non-default message from a non-default message block.

## NONAME

Set this keyword to suppress printing of the issuing routine's name at the beginning of the error message.

## NOPREFIX

Usually, the message includes the message prefix string (as specified by the MSG_PREFIX field of the !ERROR_STATE system variable) at the beginning. Set this keyword to omit the prefix.

## NOPRINT

Set this keyword to prevent the message from printing to the screen and cause the other actions to proceed quietly. The error system variables are updated as usual.

## REISSUE_LAST

Set this keyword to reissue the last error issued by IDL. By using this keyword in conjunction with the CATCH procedure, your code can catch an error caused by called code, perform recovery actions, and issue the error normally. See the Examples below for a demonstration of this approach.

**Note**

If this keyword is specified, no plain arguments or other keywords may be specified.

## RESET

Set this keyword to set the !ERROR_STATE system variable back to the "success" state and clear any internal traceback information being saved for use by the LAST_ERROR keyword to the HELP procedure.

## TRACEBACK

This keyword is obsolete and is included for compatibility with existing code only. Traceback information is provided by default.

# Examples

## Example 1

As an example, assume the statement:

```
message, 'Unexpected value encountered.'
```

is executed in a procedure named CALC. If an error occurs, the following message would be printed:

```
% CALC: Unexpected value encountered.
```

and execution would halt.

## Example 2

This example demonstrates the use of the CATCH procedure and the REISSUE_LAST keyword to the MESSAGE procedure to control errors. In this example, we write a procedure named GET_TWO_POINTERS, which creates and returns two image variables of identical size via pointer heap variables. One possible problem with such an operation is that the system may not have enough memory to allocate both images. We want this operation to be all or nothing, so if we fail to get both variables we need to free the variable we did get before allowing our caller to see the error:

```
PRO GET_TWO_POINTERS, D1, D2, P1, P2
  ; [D1, D2] - Input dimensions
  ; P1, P2 - Variables to receive pointers to images

  ON_ERROR, 2                  ; When we reissue error, have
                               ; control returned to caller.

  nullPtr = PTR_NEW()          ; Create a NULL pointer.
  P1 = (P2 = nullPtr)          ; Set both pointers to NULL.

  CATCH, error                 ; Establish catch block.
  IF (error NE 0) THEN BEGIN   ; An error occurs.
     CATCH, /CANCEL            ; Cancel catch block so an error
                               ; here will not cause looping.
     PTR_FREE, P1, P2          ; If P1 or P2 are non-NULL, free
     P1 = (P2 = nullPtr)       ; them so caller sees NULL pointers.
     MESSAGE, /REISSUE_LAST    ; Reissue the error. The caller
                               ; will get control.
     ; This line is never reached, because MESSAGE causes an
     ; implicit return to the calling routine.
   ENDIF
```

```
    P1 = PTR_NEW(BYTARR(D1, D2))  ; Get first image.
    P2 = PTR_NEW(BYTARR(D1, D2))  ; Get second image.

    ; We now have both images and can safely return.
END
```

## Version History

Introduced: Pre 4.0

REISSUE_LAST keyword: 6.0

## See Also

CATCH, DEFINE_MSGBLK, DEFINE_MSGBLK_FROM_FILE, ON_ERROR, ON_IOERROR, STRMESSAGE

# MIN

The MIN function returns the value of the smallest element of *Array*. The type of the result is the same as that of *Array*.

## Syntax

*Result* = MIN( *Array* [, *Min_Subscript*] [, DIMENSION=*value*] [, MAX=*variable*] [, /NAN] [, SUBSCRIPT_MAX=*variable*])

## Return Value

Returns the smallest array element value.

## Arguments

### Array

The array to be searched.

### Min_Subscript

A named variable that, if supplied, is converted to a long integer containing the one-dimensional subscript of the minimum element. Otherwise, the system variable !C is set to the one-dimensional subscript of the minimum element.

## Keywords

### DIMENSION

Set this keyword to the dimension over which to find the minimum values of an array. If this keyword is not present or is zero, the minimum is found over the entire array and is returned as a scalar value. If this keyword is present and nonzero, the result is the "slice" of the input array that contains the minimum value element, and the return values for *Result*, *Min_Subscript*, MAX, and SUBSCRIPT_MAX will all be arrays of one dimension less than the input array. That is, if the dimensions of *Array* are *N1*, *N2*, *N3*, and DIMENSION=2, the dimensions of the result are (*N1*, *N3*), and element (*i*,*j*) of the result contains the minimum value of *Array*[*i*, *, *j*].

For example:

```
arr = FINDGEN(2,3,2)
PRINT, arr
```

IDL prints:

```
0.00000     1.00000
2.00000     3.00000
4.00000     5.00000

6.00000     7.00000
8.00000     9.00000
10.0000     11.0000

PRINT, MIN(arr, DIMENSION=2)
```

IDL prints:

```
0.00000     1.00000
6.00000     7.00000

PRINT, MIN(arr, DIMENSION=1)
```

IDL prints:

```
0.00000     2.00000     4.00000
6.00000     8.00000     10.0000
```

## MAX

The name of a variable to receive the value of the maximum array element. If you need to find both the minimum and maximum array values, use this keyword to avoid scanning the array twice with separate calls to MAX and MIN.

## NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

**Note**

If the MIN function is run on an array containing NaN values and the NAN keyword is not set, an invalid result will occur.

## SUBSCRIPT_MAX

Set this keyword equal to a named variable that will contain the one-dimensional subscript of the maximum element, the value of which is available via the MAX keyword.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

```
; Create a simple two-dimensional array:
D = DIST(100)
; Find the minimum value in array D and print the result:
PRINT, MIN(D)
```

## Version History

Introduced: Original

## See Also

ARRAY_INDICES, MAX, WHERE

# MIN_CURVE_SURF

The MIN_CURVE_SURF function interpolates a regularly- or irregularly-gridded set of points, over either a plane or a sphere, with either a minimum curvature surface or a thin-plate-spline surface.

**Note**

The accuracy of this function is limited by the single-precision floating-point accuracy of the machine.

## Theory

A minimum curvature spline surface is fitted to the data points described by *x*, *y*, and *z*. The basis function is:

$$C(x_0, x_1, y_0, y_1) = d^2 \log(d^k)$$

where *d* is the distance between $(x_0, y_0)$, $(x_1, y_1)$ and $k = 1$ for minimum curvature surface or $k = 2$ for Thin Plate Splines. For *n* data points, a system of $n+3$ simultaneous equations are solved for the coefficients of the surface. For any interpolation point, the interpolated value is:

$$f(x, y) = b_0 + b_1 \cdot x + b_2 \cdot y + \sum a_i \cdot C(x_i, x, y_i, y)$$

For a sphere the value is:

$$f(l, t) = b_0 + b_1 \cdot x + b_2 \cdot y + b_3 \cdot z + \sum a_i \cdot C(L_i, l, T_i, t)$$

On the sphere, l and t are longitude and latitude. $C(L_i,l, T_i,t)$ is the basis function above, with distance between the two points, $(L_i,T_i)$, and (l , t), measured in radians of arc length. x, y, and z are the 3D cartesian coordinates of the point (l,t) on the unit sphere.

For a sphere with the CONST keyword set, the value is:

$$f(l, t) = b_0 + \sum a_i \cdot CL_i, l, T_i, t$$

The results obtained with the thin plate spline (TPS) and the minimum curvature surface (MCS) methods are very similar. The only difference is in the basis functions: TPS uses $d^2$*alog($d^2$), and MCS uses $d^2$*alog(d), where d is the distance from point $(x_i,y_i)$.

This routine is written in the IDL language. Its source code can be found in the file `min_curve_surf.pro` in the `lib` subdirectory of the IDL distribution.

# Syntax

*Result* = MIN_CURVE_SURF(*Z* [, *X*, *Y*] [, /DOUBLE] [, /TPS] [, /REGULAR] [, /SPHERE [, /CONST]] [, XGRID=*[xstart, xspacing]* | , XVALUES=*array*] [, YGRID=*[ystart, yspacing]* | , YVALUES=*array*] [, GS=*[xspace,yspace]*] [, BOUNDS=*[xmin, ymin, xmax, ymax]*] [, NX=*value*] [, NY=*value*] [, XOUT=*vector*] [, YOUT=*vector*] [, XPOUT=*array,* YPOUT=*array*])

# Return Value

This function returns a two-dimensional floating-point array containing the interpolated surface, sampled at the grid points.

# Arguments

## Z, X, Y

Arrays containing the *Z*, *X*, and *Y* coordinates of the data points on the surface. Points need not be regularly gridded. For regularly gridded input data, *X* and *Y* are not used: the grid spacing is specified via the XGRID and YGRID (or XVALUES and YVALUES) keywords, and *Z* must be a two-dimensional array. For irregular grids, all three parameters must be present and have the same number of elements. If Z is specified as a double-precision value, the computation will be performed in double-precision arithmetic. If the SPHERE keyword is set, X and Y are given in degrees of longitude and latitude, respectively.

# Keywords

## CONST

Set this keyword to fit data on the sphere with a constant baseline, otherwise, data on the sphere is fit with a baseline that contains a constant term plus linear X, Y, and Z terms. This keyword has an effect only if SPHERE is set. See Theory above for the formulae.

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic. If Z is double precision, the computations will also be done in double precision.

### SPHERE

Set this keyword to perform interpolation on the surface of a sphere. The inputs X and Y should be given in degrees of longitude and latitude, respectively.

### TPS

Set this keyword to use the thin-plate-spline method. The default is to use the minimum curvature surface method.

## Input Grid Description Keywords:

### REGULAR

If set, the *Z* parameter is a two-dimensional array of dimensions (*n*,*m*), containing measurements over a regular grid. If any of XGRID, YGRID, XVALUES, or YVALUES are specified, REGULAR is implied. REGULAR is also implied if there is only one parameter, *Z*. If REGULAR is set, and no grid specifications are present, the grid is set to (0, 1, 2, ...).

### XGRID

A two-element array, [*xstart*, *xspacing*], defining the input grid in the *x* direction. Do not specify both XGRID and XVALUES.

### XVALUES

An *n*-element array defining the *x* locations of Z[*i*,*j*]. Do not specify both XGRID and XVALUES.

### YGRID

A two-element array, [*ystart*, *yspacing*], defining the input grid in the *y* direction. Do not specify both YGRID and YVALUES.

### YVALUES

An *n*-element array defining the *y* locations of Z[*i*,*j*]. Do not specify both YGRID and YVALUES.

## Output Grid Description Keywords:

### GS

The output grid spacing. If present, GS must be a two-element vector [*xs*, *ys*], where *xs* is the horizontal spacing between grid points and *ys* is the vertical spacing. The default is based on the extents of *x* and *y*. If the grid starts at *x* value *xmin* and ends at *xmax*, then the default horizontal spacing is (*xmax* - *xmin*)/(NX-1). *ys* is computed in the same way. The default grid size, if neither NX or NY are specified, is 26 by 26.

### BOUNDS

If present, BOUNDS must be a four-element array containing the grid limits in *x* and *y* of the output grid: [*xmin*, *ymin*, *xmax*, *ymax*]. If not specified, the grid limits are set to the extent of *x* and *y*.

### NX

The output grid size in the *x* direction. NX need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

### NY

The output grid size in the *y* direction. NY need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

### XOUT

Use the XOUT keyword to specify a vector containing the output grid *x* values. If this parameter is supplied, GS, BOUNDS, and NX are ignored for the *x* output grid. XOUT allows you to specify irregularly-spaced output grids.

### YOUT

Use the YOUT keyword to specify a vector containing the output grid *y* values. If this parameter is supplied, GS, BOUNDS, and NY are ignored for the *y* output grid. YOUT allows you to specify irregularly-spaced output grids.

### XPOUT, YPOUT

Use the XPOUT and YPOUT keywords to specify arrays that contain the *x* and *y* values for the output points. If these keywords are used, the output grid need not be regular, and all other output grid parameters are ignored. XPOUT and YPOUT must have the same number of points, which is also the number of points returned in the result.

# Examples

### Example 1: Irregularly gridded cases

```
; Make a random set of points that lie on a Gaussian:
N = 15
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; The Gaussian:
Z = EXP(-2 * ((X-.5)^2 + (Y-.5)^2))
```

Use a 26 by 26 grid over the rectangle bounding x and y:

```
;Get the surface.
R = MIN_CURVE_SURF(Z, X, Y)
```

Alternatively, get a surface over the unit square, with spacing of 0.05:

```
R = MIN_CURVE_SURF(Z, X, Y, GS=[0.05, 0.05], BOUNDS=[0,0,1,1])
```

Alternatively, get a 10 by 10 surface over the rectangle bounding x and y:

```
R = MIN_CURVE_SURF(Z, X, Y, NX=10, NY=10)
```

### Example 2: Regularly gridded cases

```
; Make some random data:
z = RANDOMU(seed, 5, 6)

; Interpolate to a 26 x 26 grid:
CONTOUR, MIN_CURVE_SURF(z, /REGULAR)
```

# Version History

Introduced: Pre 4.0

# See Also

CONTOUR, GRID_TPS, TRI_SURF

# MK_HTML_HELP

The MK_HTML_HELP procedure, given a list of IDL procedure filenames (`.pro` files) or the names of directories containing such files, generates a file in HTML (HyperText Markup Language) format that contains documentation for those routines that contain standard IDL documentation headers. The resulting file can then be viewed with a web browser such as Microsoft Internet Explorer or Netscape Navigator.

MK_HTML_HELP procedure makes a single HTML file that starts with a list of the routines documented in the file. The names of routines in that list are hypertext links to the documentation for those routines. The documentation for each routine is simply the text of the documentation header copied from the corresponding `.pro` file—no reformatting is performed.

The documentation headers of the `.pro` files in question must have the following format:

- The first line of the documentation block contains only the characters `;+`, starting in column 1.
- The last line of the documentation block contains only the characters `;-`, starting in column 1.
- All other lines in the documentation block contain a `;` in column 1.
- If a line containing the string “NAME:” exists in the documentation block, the contents of the following line are used as the name of the routine being described. If the NAME: field is not present, the name of the source file is used as the routine name.

The file `template.pro` in the `examples` subdirectory of the IDL distribution contains a template for creating your own documentation headers.

This routine is supplied to allow users to make online documentation from their own IDL programs. Although it could be used to create an HTML documentation file from the `lib` subdirectory of the IDL distribution, we do not recommend doing so. The documentation headers on the files in the `lib` directory are used for historical purposes—most do not contain the most current or accurate documentation for those routines. The most current documentation for IDL’s built-in and library routines is found in IDL’s online help system (enter `?` at the IDL prompt).

This routine is written in the IDL language. Its source code can be found in the file `mk_html_help.pro` in the `lib` subdirectory of the IDL distribution.

# Syntax

MK_HTML_HELP, *Sources*, *Filename* [, /STRICT] [, TITLE=*string*] [, /VERBOSE]

# Arguments

## Sources

A string array containing the names of IDL procedure files (`.pro` files) or directories containing such files. The *Sources* array may contain both individual file and directory names. Each IDL procedure file must have the file extension `.pro`. Elements of the *Sources* array that do not have either of these extensions are assumed to be directories.

All `.pro` files found in *Sources* are searched for documentation headers. The documentation headers are extracted and saved in HTML format in the file specified by *Filename*.

**Note**

More than one documentation block may exist in a single input file.

## Filename

A string containing the name of the output file to be generated. HTML files are usually saved in files named with a `.html` or `.htm` extension.

# Keywords

## STRICT

Set this keyword to force MK_HTML_HELP to adhere strictly to the HTML format by scanning the documentation blocks for HTML reserved characters and replacing them in the output file with the appropriate HTML syntax. HTML reserved characters include < , > , & , and ". By default, this keyword is set to zero to allow for faster processing of the input files.

## TITLE

A string that supples the name to be used as the title of the HTML document. The default is “Extended IDL Help”.

### VERBOSE

Set this keyword to display informational messages as MK_HTML_HELP generates the HTML file. Normally, MK_HTML_HELP works silently.

## Examples

To generate an HTML help file named `myhelp.html` from the `.pro` files in the directory `/usr/home/dave/myroutines`, use the command:

```
MK_HTML_HELP, '/usr/home/dave/myroutines', 'myhelp.html'
```

To generate an HTML help file for all routines in a given directory whose file names contain the word “plot”, use the following commands:

```
plotfiles=FILE_SEARCH('/usr/home/dave/myroutines/*plot*.pro')
MK_HTML_HELP, plotfiles, 'myplot.html'
```

## Version History

Introduced: 4.0.1

## See Also

DOC_LIBRARY

# MODIFYCT

The MODIFYCT procedure updates the distribution color table file `colors1.tbl`, located in the `\resource\colors` subdirectory of the main IDL directory, or a user-designated file with a new, or modified, colortable.

This routine is written in the IDL language. Its source code can be found in the file `modifyct.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

MODIFYCT, *Itab*, *Name*, *R*, *G*, *B* [, FILE=*filename*]

## Arguments

### Itab

The index of the table to be updated, numbered from 0 to 255. If the specified entry is greater than the next available location in the table, the entry will be added to the table in the available location rather than the index specified by *Itab.* On return, *Itab* contains the index for the location that was modified or extended. The modified table can be then be loaded with the IDL command: LOADCT, *Itab.*

### Name

A string, up to 32 characters long, that contains the name for the new color table.

### R

A 256-element vector that contains the values for the red colortable.

### G

A 256-element vector that contains the values for the green colortable.

### B

A 256-element vector that contains the values for the blue colortable.

## Keywords

### FILE

Set this keyword to the name of a colortable file to be modified instead of the file `colors1.tbl`.

## Version History

Introduced: Original

## See Also

LOADCT, XLOADCT

# MOMENT

The MOMENT function computes the mean, variance, skewness, and kurtosis of a sample population contained in an *n*-element vector *X*. When $x = (x_0, x_1, x_2, ..., xn_{-1})$, the various moments are defined as follows:

$$\text{Mean} = \bar{x} = \frac{1}{N}\sum_{j=0}^{N-1} x_j$$

$$\text{Variance} = \frac{1}{N-1}\sum_{j=0}^{N-1} (x_j - \bar{x})^2$$

$$\text{Skewness} = \frac{1}{N}\sum_{j=0}^{N-1} \left(\frac{x_j - \bar{x}}{\sqrt{\text{Variance}}}\right)^3$$

$$\text{Kurtosis} = \frac{1}{N}\sum_{j=0}^{N-1} \left(\frac{x_j - \bar{x}}{\sqrt{\text{Variance}}}\right)^4 - 3$$

$$\text{Mean Absolute Deviation} = \frac{1}{N}\sum_{j=0}^{N-1} \left|x_j - \bar{x}\right|$$

$$\text{Standard Deviation} = \sqrt{\text{Variance}}$$

This routine is written in the IDL language. Its source code can be found in the file `moment.pro` in the `lib` subdirectory of the IDL distribution.

## Return Value

If the vector contains *n* identical elements, MOMENT computes the mean and variance, and returns the IEEE value NaN for the skewness and kurtosis, which are

not defined. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual.)

# Syntax

*Result* = MOMENT( *X* [, /DOUBLE] [, MDEV=*variable*] [, /NAN] [, SDEV=*variable*] )

# Arguments

## X

An *n*-element integer, single-, or double-precision floating-point vector.

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## MDEV

Set this keyword to a named variable that will contain the mean absolute deviation of *X*.

## NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## SDEV

Set this keyword to a named variable that will contain the standard deviation of *X*.

# Examples

```
; Define an n-element sample population:
X = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]
; Compute the mean, variance, skewness and kurtosis:
result = MOMENT(X)
PRINT, 'Mean: ', result[0] & PRINT, 'Variance: ', result[1] & $
   PRINT, 'Skewness: ', result[2] & PRINT, 'Kurtosis: ', result[3]
```

IDL prints:

```
Mean:       66.7333
Variance:    7.06667
Skewness:   -0.0942851
Kurtosis:   -1.18258
```

## Version History

Introduced: 4.0

## See Also

KURTOSIS, HISTOGRAM, MAX, MEAN, MEANABSDEV, MEDIAN, MIN, MOMENT, STDDEV, SKEWNESS, VARIANCE

# MORPH_CLOSE

The MORPH_CLOSE function applies the closing operator to a binary or grayscale image. MORPH_CLOSE is simply a dilation operation followed by an erosion operation.The closing operation is an idempotent operator—applying it more than once produces no further effect.

Both the opening and the closing operators have the effect of smoothing the image, with the opening operation removing pixels, and the closing operation adding pixels.

## Syntax

*Result* = MORPH_CLOSE (*Image*, *Structure* [, /GRAY]
[, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*] )

## Return Value

The result of a closing operation is that small holes and gaps within the image (smaller than the size of *Structure*) are filled, yet the original sizes of the primary foreground features are maintained.

## Arguments

### Image

A one-, two-, or three-dimensional array upon which the closing operation is to be performed. If neither of the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

### Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values - either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

## Keywords

### GRAY

Set this keyword to perform a grayscale, rather than binary, operation. Nonzero elements of the *Structure* parameter determine the shape of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

### PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of UINT and ULONG.

### UINT

Set this keyword to return an unsigned integer array. This keyword only applies for grayscale operations, and is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

### ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies for grayscale operations, and is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

### VALUES

An array of the same dimensions as *Structure* providing the values of the structuring element. The presence of this keyword implies a grayscale operation.

## Examples

The following code reads a data file in the IDL Demo data directory containing a magnified image of grains of pollen. It then applies a threshold and a morphological closing operator with a 3 by 3 square kernel to the original image. Notice that most of the holes in the pollen grains have been filled by the closing operator.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

;Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

;Show original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TVSCL, img, 20, 280

;Apply the threshold creating a binary image
thresh = img GE 140B
```

```
;Load a simple color table
TEK_COLOR

;Display Edges
XYOUTS, 520, 525, 'Edges', ALIGNMENT=.5, /DEVICE
TV, thresh, 360, 280

;Apply closing operator
closing = MORPH_CLOSE(thresh, REPLICATE(1,3,3))

;Show the result
XYOUTS, 180, 265, 'Closing Operator', ALIGNMENT=.5, /DEVICE
TV, closing, 20, 20

;Show added pixels in white
XYOUTS, 520, 265, 'Added Pixels in White', ALIGNMENT=.5, /DEVICE
TV, closing + thresh, 360, 20
```

## Version History

Introduced: 5.3

## See Also

DILATE, ERODE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

# MORPH_DISTANCE

The MORPH_DISTANCE function estimates *N*-dimensional distance maps, which contain for each foreground pixel the distance to the nearest background pixel, using a given norm. Available norms include: Euclidean, which is exact and is also known as the Euclidean Distance Map (EDM), and two more efficient approximations, chessboard and city block.

The distance map is useful for a variety of morphological operations: thinning, erosion and dilation by discs of radius “r”, and granulometry.

## Syntax

*Result* = MORPH_DISTANCE (*Data* [, /BACKGROUND] [, NEIGHBOR_SAMPLING={1 | 2 | 3 }] [, /NO_COPY] )

## Return Value

The returned variable is an array of the same dimension as the input array.

## Arguments

### Data

An input binary array. Zero-valued pixels are considered to be part of the background.

## Keywords

### BACKGROUND

By default, the EDM is computed for the foreground (non-zero) features in the *Data* argument. Set this keyword to compute the EDM of the background features instead of the foreground features. If the keyword is set, elements of *Result* that are on an edge are set to 0.

### NEIGHBOR_SAMPLING

Set this keyword to indicate how the distance of each neighbor from a given pixel is determined. Valid values include:

- 0 = default. No diagonal neighbors. Each neighbor is assigned a distance of 1.

- 1 = chessboard. Each neighbor is assigned a distance of 1.
- 2 = city block. Each neighbor is assigned a distance corresponding to the number of pixels to be visited when travelling from the current pixel to the neighbor. (The path can only take 90 degree turns; no diagonal paths are allowed.)
- 3 = actual distance. Each neighbor is assigned its actual distance from the current pixel (within the limitations of floating point representations).

#### Default Two Dimensional Example

```
     1
1    X    1
     1
```

#### Chessboard Two-Dimensional Example

```
1    1    1
1    X    1
1    1    1
```

#### City Block Two-Dimensional Example:

```
2    1    2
1    X    1
2    1    2
```

#### Actual Distance Two-Dimensional Example

```
sqrt(2)  1  sqrt(2)
   1     X     1
sqrt(2)  1  sqrt(2)
```

### NO_COPY

Set this keyword to request that the input array be reused, if possible. If this keyword is set, the input argument is undefined upon return.

## Examples

The following code reads a data file in the IDL Demo data directory containing a magnified image of grains of pollen. It then applies a threshold and the morphological distance operator. Thresholding the result distance operator with a value of “n” produces the equivalent of eroding the thresholded image with a disc of radius “n”.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0
```

```
;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

; Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

; Display the original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TV, img, 20, 280

; Apply the threshold:
thresh = img GE 140B

; Display the thresholded image
XYOUTS, 520, 525, 'Thresholded Image', ALIGNMENT=.5, /DEVICE
TVSCL, thresh, 360, 280

;Create Euclidean distance function
edist = MORPH_DISTANCE(thresh, NEIGHBOR_SAMPLING = 3)

; Display the distance function
XYOUTS, 180, 265, 'Distance Function', ALIGNMENT=.5, /DEVICE
TVSCL, edist, 20, 20

; Display image after erosion with a disc of radius 5:
XYOUTS, 520, 265, 'After erosion with disc of radius 5',
ALIGNMENT=.5, /DEVICE
TVSCL, edist GT 5, 360, 20
```

## Version History

Introduced: 5.3

## See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

# MORPH_GRADIENT

The MORPH_GRADIENT function applies the morphological gradient operator to a grayscale image. MORPH_GRADIENT is the subtraction of an eroded version of the original image from a dilated version of the original image.

## Syntax

*Result* = MORPH_GRADIENT (*Image*, *Structure* [, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*] )

## Return Value

The practical result of a morphological gradient operation is that the boundaries of features are highlighted.

## Arguments

### Image

A one-, two-, or three-dimensional array upon which the morphological gradient operation is to be performed.

### Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values - either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

## Keywords

### PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of the UINT and ULONG keywords.

### UINT

Set this keyword to return an unsigned integer array. This keyword is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

### ULONG

Set this keyword to return an unsigned longword integer array. This keyword is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

### VALUES

An array of the same dimensions as the *Structure* argument providing the values of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

## Examples

The following code reads a data file in the IDL Demo data directory containing a magnified image of grains of pollen. It then creates disc of radius 2, in a 5 by 5 array, with all elements within a radius of 2 from the center set to 1. This disc is used as the structuring element for the morphological gradient which is then displayed as both a gray scale image, and as a thresholded image.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

; Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

;Show original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TVSCL, img, 20, 280

;Define disc radius
r = 2

;Create a binary disc of given radius.
disc = SHIFT(DIST(2*r+1), r, r) LE r

bdisc = MORPH_GRADIENT(img, disc)

;Show edges
XYOUTS, 520, 525, 'Edges', ALIGNMENT=.5, /DEVICE
TVSCL, bdisc, 360, 280

;Show thresholded edges
XYOUTS, 180, 265, 'Threshold Edges', ALIGNMENT=.5, /DEVICE
```

```
TVSCL, bdisc ge 100, 20, 20
```

## Version History

Introduced: 5.3

## See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

# MORPH_HITORMISS

The MORPH_HITORMISS function applies the hit-or-miss operator to a binary image. The hit-or-miss operator is implemented by first applying an erosion operator with a *hit* structuring element to the original image. Then an erosion operator is applied to the complement of the original image with a secondary *miss* structuring element. The result is the intersection of the two results.

## Syntax

*Result* = MORPH_HITORMISS (*Image, HitStructure, MissStructure*)

## Return Value

The resulting image corresponds to the positions where the hit structuring element lies within the image, and the miss structure lies completely outside the image. The two structures must not overlap.

## Arguments

### Image

A one-, two-, or three-dimensional array upon which the morphological operation is to be performed. The image is treated as a binary image with all nonzero pixels considered as 1.

### HitStructure

A one-, two-, or three-dimensional array to be used as the hit structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

### MissStructure

A one-, two-, or three-dimensional array to be used as the miss structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

**Note**

It is assumed that the HitStructure and the MissStructure arguments are disjoint.

## Keywords

None.

## Example

The following code snippet identifies blobs with a radius of at least 2, but less than 4 in the pollen image. These regions totally enclose a disc of radius 2, contained in the 5 x 5 kernel named “hit”, and in turn, fit within a hole of radius 4, contained in the 9 x 9 array named “miss”. Executing this specific example identifies four blobs in the image with these attributes.

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

WINDOW, 0, XSIZE=700, YSIZE=540

; Display the original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TV, img, 20, 280

rh = 2 ;Radius of hit disc
rm = 4 ;Radius of miss disc

;Create a binary disc of given radius.
hit = SHIFT(DIST(2*rh+1), rh, rh) LE rh

;Complement of disc for miss
miss = SHIFT(DIST(2*rm+1), rm, rm) GT rm

;Load discrete color table
TEK_COLOR

;Apply the threshold
thresh = img GE 140B

; Display the thresholded image
XYOUTS, 520, 525, 'Thresholded Image', ALIGNMENT=.5, /DEVICE
TV, thresh, 360, 280

;Compute matches
matches = MORPH_HITORMISS(thresh, hit, miss)
```

```
;Expand matches to size of hit disc
matches = DILATE(matches, hit)

;Show matches.
XYOUTS, 180, 265, 'Matches', ALIGNMENT=.5, /DEVICE
TV, matches, 20, 20

;Superimpose, showing hit regions in blue.
;(Blue = color index 4 for tek_color.)
XYOUTS, 520, 265, 'Superimposed, hit regions in blue',$
   ALIGNMENT=.5, /DEVICE
TV, thresh + 3*matches, 360, 20
```

## Version History

Introduced: 5.3

## See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_OPEN, MORPH_THIN, MORPH_TOPHAT

# MORPH_OPEN

The MORPH_OPEN function applies the opening operator to a binary or grayscale image. MORPH_OPEN is simply an erosion operation followed by a dilation operation. The opening operation is an idempotent operator, applying it more than once produces no further effect.

An alternative definition of the opening, is that it is the union of all sets containing the structuring element in the original image. Both the opening and the closing operators have the effect of smoothing the image, with the opening operation removing pixels, and the closing operation adding pixels.

## Syntax

*Result* = MORPH_OPEN (*Image*, *Structure* [, /GRAY]
[, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*] )

## Return Value

The result of an opening operation is that small features (e.g., noise) within the image are removed, yet the original sizes of the primary foreground features are maintained.

## Arguments

### Image

A one-, two-, or three-dimensional array upon which the opening operation is to be performed. If neither of the keywords GRAY or VALUES is present, the image is treated as a binary image with all nonzero pixels considered as 1.

### Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values — either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

# Keywords

## GRAY

Set this keyword to perform a grayscale, rather than binary, operation. Nonzero elements of the *Structure* parameter determine the shape of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

## PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of the UINT and ULONG keywords.

## UINT

Set this keyword to return an unsigned integer array. This keyword only applies for grayscale operations, and is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

## ULONG

Set this keyword to return an unsigned longword integer array. This keyword only applies for grayscale operations and is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

## VALUES

An array of the same dimensions as *Structure* providing the values of the structuring element. The presence of this keyword implies a grayscale operation.

# Examples

The following code reads a data file in the IDL Demo data directory containing an magnified image of grains of pollen. It then applies a threshold and a morphological opening operator with a 3 by 3 square kernel to the original image. Notice that much of the irregular borders of the grains have been smoothed by the opening operator.

```
; Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img
```

```
; Create window:
WINDOW, 0, XSIZE=700, YSIZE=540

;Show original image
XYOUTS, 180, 525, 'Original Image', ALIGNMENT=.5, /DEVICE
TV, img, 20, 280

;Apply the threshold
thresh = img GE 140B

;Load a simple color table
TEK_COLOR

;Display edges
XYOUTS, 520, 525, 'Edges', ALIGNMENT=.5, /DEVICE
TV, thresh, 360, 280

;Apply opening operator
open = MORPH_OPEN(thresh, REPLICATE(1,3,3))

;Show the result
XYOUTS, 180, 265, 'Opening Operator', ALIGNMENT=.5, /DEVICE
TV, open, 20, 20

;Show pixels that have been removed in white
XYOUTS, 520, 265, 'Removed Pixels in White', ALIGNMENT=.5, /DEVICE
TV, open + thresh, 360, 20
```

## Version History

Introduced: 5.3

## See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_THIN, MORPH_TOPHAT

# MORPH_THIN

The MORPH_THIN function performs a thinning operation on binary images. The thinning operator is implemented by first applying a hit or miss operator to the original image with a pair of structuring elements, and then subtracting the result from the original image.

## Syntax

*Result* = MORPH_THIN ( *Image, HitStructure, MissStructure* )

## Return Value

In typical applications, this operator is repeatedly applied with the two structuring elements, rotating them after each application, until the result remains unchanged.

## Arguments

### Image

A one-, two-, or three-dimensional array upon which the thinning operation is to be performed. The image is treated as a binary image with all nonzero pixels considered as 1.

### HitStructure

A one-, two-, or three-dimensional array to be used as the hit structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

### MissStructure

A one-, two-, or three-dimensional array to be used as the miss structuring element. The elements are interpreted as binary values — either zero or nonzero. This structuring element must have the same number of dimensions as the *Image* argument.

**Note**

It is assumed that the *HitStructure* and the *MissStructure* arguments are disjoint.

## Keywords

None.

## Version History

Introduced: 5.3

## See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_TOPHAT

# MORPH_TOPHAT

The MORPH_TOPHAT function applies the top-hat operator to a grayscale image. The top-hat operator is implemented by first applying the opening operator to the original image, then subtracting the result from the original image. Applying the top-hat operator provides a result that shows the bright peaks within the image.

## Syntax

*Result* = MORPH_TOPHAT ( *Image, Structure* [, PRESERVE_TYPE=*bytearray* | /UINT | /ULONG] [, VALUES=*array*] )

## Return Value

Returns the resulting one-, two-, or three-dimensional array.

## Arguments

### Image

A one-, two-, or three-dimensional array upon which the top-hat operation is to be performed.

### Structure

A one-, two-, or three-dimensional array to be used as the structuring element. The elements are interpreted as binary values — either zero or nonzero. The structuring element must have the same number of dimensions as the *Image* argument.

## Keywords

### PRESERVE_TYPE

Set this keyword to return the same type as the input array. The input array must be of type BYTE, UINT, or ULONG. This keyword only applies for grayscale erosion/dilation, and is mutually exclusive of the UINT and ULONG keywords.

### UINT

Set this keyword to return an unsigned integer array. This keyword is mutually exclusive of the ULONG and PRESERVE_TYPE keywords.

### ULONG

Set this keyword to return an unsigned longword integer array. This keyword is mutually exclusive of the UINT and PRESERVE_TYPE keywords.

### VALUES

An array of the same dimensions as the *Structure* argument providing the values of the structuring element. If the VALUES keyword is not present, all elements of the structuring element are 0.

## Examples

The following example illustrates an application of the top-hat operator to an image in the `examples/demo/demodata` directory:

```
; Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Read the image
path=FILEPATH('pollens.jpg',SUBDIR=['examples','demo','demodata'])
READ_JPEG, path, img

; Create window:
WINDOW, 0, XSIZE=700, YSIZE=280

;Show original
XYOUTS, 180, 265, 'Original Image', ALIGNMENT=.5, /DEVICE
TVSCL, img, 20, 20

;Radius of disc
r = 2

;Create a binary disc of given radius.
disc = SHIFT(DIST(2*r+1), r, r) LE r

;Apply top-hat operator
tophat = MORPH_TOPHAT(img, disc)

;Display stretched result.
XYOUTS, 520, 265, 'Stretched Result', ALIGNMENT=.5, /DEVICE
TVSCL, tophat < 50, 360, 20
```

## Version History

Introduced: 5.3

## See Also

DILATE, ERODE, MORPH_CLOSE, MORPH_DISTANCE, MORPH_GRADIENT, MORPH_HITORMISS, MORPH_OPEN, MORPH_THIN

# MPEG_CLOSE

The MPEG_CLOSE procedure closes an MPEG sequence opened with the MPEG_OPEN routine. Note that MPEG_CLOSE does not save the MPEG file associated with the MPEG sequence; use MPEG_SAVE to save the file. The specified MPEG sequence identifier will no longer be valid after calling MPEG_CLOSE.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_close.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

MPEG_CLOSE, *mpegID*

## Arguments

### mpegID

The unique identifier of the MPEG sequence to be freed. (MPEG sequence identifiers are returned by the MPEG_OPEN routine.)

## Keywords

None.

## Examples

See MPEG_OPEN for an example using this routine.

## Version History

Introduced: 5.1

## See Also

MPEG_OPEN, MPEG_PUT, MPEG_SAVE, XINTERANIMATE

# MPEG_OPEN

The MPEG_OPEN function initializes an IDLgrMPEG object for MPEG encoding and returns the object reference. The MPEG routines provide a wrapper around the IDL Object Graphics IDLgrMPEG object, eliminating the need to use the Object Graphics interface to create MPEG files.

**Note**

The MPEG standard does not allow movies with odd numbers of pixels to be created.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_open.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

MPEG support in IDL requires a special license. For more information, contact your RSI sales representative or technical support.

## Syntax

*mpegID* = MPEG_OPEN( *Dimensions* [, BITRATE=value] [, FILENAME=*string*] [, IFRAME_GAP=*integer value*] [, MOTION_VEC_LENGTH={1 | 2 | 3}] [ QUALITY=*value*{0 to 100}] )

## Return Value

Returns the reference to the IDLgrMPEG object.

## Arguments

### Dimensions

A two-element vector of the form [*xsize*, *ysize*] indicating the dimensions of the images to be used as frames in the MPEG movie file. All images in the MPEG file must have the same dimensions.

**Note**

When creating MPEG files, you must be aware of the capabilities of the MPEG decoder you will be using to view it. Some decoders only support a limited set of sampling and bitrate parameters to normalize computational complexity, buffer size, and memory bandwidth. For example, the Windows Media Player supports a

limited set of sampling and bitrate parameters. In this case, it is best to use 352 x 240 x 30 fps or 352 x 288 x 25 fps when determining the dimensions and frame rate for your MPEG file. When opening a file in Windows Media Player that does not use these dimensions, you will receive a “Bad Movie File” error message. The file is not “bad”, this decoder just doesn’t support the dimensions of the MPEG.

# Keywords

## BITRATE

Set this keyword to a double-precision value to specify the MPEG movie bit rate. Higher bit rates will create higher quality MPEGs but will increase file size. The following table describes the valid values:

| MPEG Version | Range |
|---|---|
| MPEG 1 | 0.1 to 104857200.0 |
| MPEG 2 | 0.1 to 429496729200.0 |

*Table 72: BITRATE Value Range*

If you do not set this keyword, IDL computes the BITRATE value based upon the value you have specified for the QUALITY keyword.

**Note**

Only use the BITRATE keyword if changing the QUALITY keyword value does not produce the desired results. It is highly recommended to set the BITRATE to at least several times the frame rate to avoid unusable MPEG files or file generation errors.

## FILENAME

Set this keyword equal to a string representing the name of the file in which the encoded MPEG sequence is to be saved. The default file name is `idl.mpg`.

## IFRAME_GAP

Set this keyword to a positive integer value that specifies the number of frames between I frames to be created in the MPEG file. I frames are full-quality image frames that may have a number of predicted or interpolated frames between them.

If you do not specify this keyword, IDL computes the IFRAME_GAP value based upon the value you have specified for the QUALITY keyword.

**Note**

Only use the IFRAME_GAP keyword if changing the QUALITY keyword value does not produce the desired results.

### MOTION_VEC_LENGTH

Set this keyword to an integer value specifying the length of the motion vectors to be used to generate predictive frames. Valid values include:

- 1 = Small motion vectors.
- 2 = Medium motion vectors.
- 3 = Large motion vectors.

If you do not set this keyword, IDL computes the MOTION_VEC_LENGTH value based upon the value you have specified for the QUALITY keyword.

**Note**

Only use the MOTION_VEC_LENGTH keyword if changing the QUALITY value does not produce the desired results.

### QUALITY

Set this keyword to an integer value between 0 (low quality) and 100 (high quality) inclusive to specify the quality at which the MPEG stream is to be stored. Higher quality values result in lower rates of time compression and less motion prediction which provide higher quality MPEGs but with substantially larger file size. Lower quality factors may result in longer MPEG generation times. The default is 50.

**Note**

Since MPEG uses JPEG (lossy) compression, the original picture quality can’t be reproduced even when setting QUALITY to its highest setting.

## Examples

The following sequence of IDL commands illustrates the steps needed to create an MPEG movie file from a series of image arrays named image0, image1, .., image*N*, where *n* is the zero-based index of the last image in the movie:

```
; Open an MPEG sequence:
```

```
mpegID = MPEG_OPEN()

; Add the first frame:
MPEG_PUT, mpegID, IMAGE=image0, FRAME=0
MPEG_PUT, mpegID, IMAGE=image1, FRAME=1

; Subsequent frames:
...

; Last frame:
MPEG_PUT, mpegID, IMAGE=imagen, FRAME=n

; Save the MPEG sequence in the file myMovie.mpg:
MPEG_SAVE, mpegID, FILENAME='myMovie.mpg'

; Close the MPEG sequence:
MPEG_CLOSE, mpegID
```

## Version History

Introduced: 5.1

## See Also

MPEG_CLOSE, MPEG_PUT, MPEG_SAVE, XINTERANIMATE

# MPEG_PUT

The MPEG_PUT procedure stores the specified image array at the specified frame index in an MPEG sequence.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_put.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

MPEG_PUT, *mpegID* [, /COLOR] [, FRAME=*frame_number*] [, IMAGE=*array* | , WINDOW=*index*] [, /ORDER]

## Arguments

### mpegID

The unique identifier of the MPEG sequence into which the image will be inserted. (MPEG sequence identifiers are returned by the MPEG_OPEN routine.)

## Keywords

### COLOR

Set this keyword to read off an 8-bit display and pass the information through the current color table to create a 24-bit image.

### FRAME

Set this keyword equal to an integer specifying the frame at which the image is to be loaded. If the frame number matches a previously loaded frame, the previous frame is overwritten. The default is 0.

### IMAGE

Set this keyword equal to an *m* x *n* image array or a 3 x *m* x *n* True Color image array representing the image to be loaded at the specified frame. This keyword is ignored if the WINDOW keyword is specified.

### ORDER

Set this keyword to indicate that the rows of the image should be drawn from top to bottom. By default, the rows are drawn from bottom to top.

### WINDOW

Set this keyword to the index of a Direct Graphics Window (or to an object reference to an IDLgrWindow or IDLgrBuffer object) to indicate that the image to be loaded is to be read from the given window or buffer. If this keyword is specified, it overrides the value of the IMAGE keyword.

## Examples

See MPEG_OPEN for an example using this routine.

## Version History

Introduced: 5.1

## See Also

MPEG_CLOSE, MPEG_OPEN, MPEG_SAVE, XINTERANIMATE

# MPEG_SAVE

The MPEG_SAVE procedure encodes and saves an open MPEG sequence.

This routine is written in the IDL language. Its source code can be found in the file `mpeg_save.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

MPEG support in IDL requires a special license. For more information, contact your RSI sales representative or technical support.

## Syntax

MPEG_SAVE, *mpegID* [, FILENAME=*string*]

## Arguments

### mpegID

The unique identifier of the MPEG sequence to be saved to a file. (MPEG sequence identifiers are returned by the MPEG_OPEN routine.)

## Keywords

### FILENAME

Set this keyword to a string representing the name of the file to which the encoded MPEG sequence is to be saved. The default is `idl.mpg`.

## Examples

See MPEG_OPEN for an example using this routine.

## Version History

Introduced: 5.1

## See Also

MPEG_CLOSE, MPEG_OPEN, MPEG_PUT, XINTERANIMATE

# MSG_CAT_CLOSE

The MSG_CAT_CLOSE procedure closes a catalog file from the stored cache.

## Syntax

MSG_CAT_CLOSE, *object*

## Arguments

### object

The object reference returned from MSG_CAT_OPEN.

## Keywords

None

## Version History

Introduced: 5.2.1

## See Also

MSG_CAT_COMPILE, MSG_CAT_OPEN, IDLffLanguageCat

# MSG_CAT_COMPILE

The MSG_CAT_COMPILE procedure creates an IDL language catalog file.

**Note**

The locale is determined from the system locale in effect when compilation takes place.

## Syntax

MSG_CAT_COMPILE, *input*[, *output*] [, LOCALE_ALIAS=*string*] [, /MBCS]

## Arguments

### input

The input file with which to create the catalog. The file is a text representation of the key/MBCS association. Each line in the file must have a key. The language string must then be surrounded by double quotes, then an optional comment.

For example:

```
VERSION     "Version 1.0"     My revision number of the file
```

There are 2 special tags, one of which must be included when creating the file:

APPLICATION (required)

SUB_QUERY (optional)

### output

The optional output file name (including path if necessary) of the IDL language catalog file.

The naming convention for IDL language catalog files is as follows:

```
idl_ + "Application name" + _ + "Locale" + .cat
```

For example:

```
idl_envi_usa_eng.cat
```

If not set, a default filename is used based on the locale:

```
idl_[locale].cat
```

# Keywords

## LOCALE_ALIAS

Set this keyword to a scalar string containing any locale aliases for the locale on which the catalog is being compiled. A semi-colon is used to separate locales.

For example:

```
MSG_CAT_COMPILE,'input.txt', 'idl_envi_usa_eng.cat',$
LOCALE_ALIAS='C'
```

## MBCS

If set, this procedure assumes language strings to be in MBCS format. The default is 8-bit ASCII.

# Version History

Introduced: 5.2.1

# See Also

MSG_CAT_CLOSE, MSG_CAT_OPEN, IDLffLanguageCat

# MSG_CAT_OPEN

The MSG_CAT_OPEN function opens a specified catalog object file.

## Syntax

*Result* = MSG_CAT_OPEN( *application* [, DEFAULT_FILENAME=*filename*] [, FILENAME=*string*] [, FOUND=*variable*] [, LOCALE=*string*] [, PATH=*string*] [, SUB_QUERY=*value*] )

## Return Value

Returns a catalog object for the given parameters if found. If a match is not found, an unset catalog object is returned. If unset, the IDLffLanguageCat::Query method will always return the empty string unless a default catalog is provided.

## Arguments

### application

A scalar string representing the name of the desired application's catalog file.

## Keywords

### DEFAULT_FILENAME

Set this keyword to a scalar string containing the full path and filename of the catalog file to open if the initial request was not found.

### FILENAME

Set this keyword to a scalar string containing the full path and filename of the catalog file to open. If this keyword is set, *application*, PATH and LOCALE are ignored.

### FOUND

Set this keyword to a named variable that will contain 1 if a catalog file was found, 0 otherwise.

### LOCALE

Set this keyword to the desired locale for the catalog file. If not set, the current locale is used.

### PATH

Set this keyword to a scalar string containing the path to search for language catalog files. The default is the current directory.

### SUB_QUERY

Set this keyword equal to the value of the SUB_QUERY key to search against. If a match is found, it is used to further sub-set the possible return catalog choices.

## Version History

Introduced: 5.2.1

## See Also

MSG_CAT_CLOSE, MSG_CAT_COMPILE, IDLffLanguageCat

# MULTI

The MULTI procedure expands the current color table to “wrap around” some number of times.

This routine is written in the IDL language. Its source code can be found in the file `multi.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

MULTI, *N*

## Arguments

### N

The number of times the color table will wrap. This parameter does not have to be an integer.

## Keywords

None.

## Examples

Display an image, load color table 1, and make that color table “wrap around” 3 times. Enter:

```
;Display a simple image.
TVSCL, DIST(256)

;Load color table 1.
LOADCT, 1

;See how the new color table affects the image.
MULTI, 3
```

## Version History

Introduced: Original

## See Also

STRETCH, XLOADCT

# N_ELEMENTS

The N_ELEMENTS function returns the number of elements contained in an expression or variable.

## Syntax

*Result* = N_ELEMENTS(*Expression*)

## Return Value

Returns the number of elements.

## Arguments

### Expression

The expression for which the number of elements is to be returned. Scalar expressions always have one element. The number of elements in an array is equal to the product of its dimensions. If *Expression* is an undefined variable, N_ELEMENTS returns zero.

## Keywords

None.

## Examples

### Example 1

This example finds the number of elements in an array:

```
; Create an integer array:
I = INTARR(4, 5, 3, 6)
; Find the number of elements in I and print the result:
PRINT, N_ELEMENTS(I)
```

### Example 2

A typical use of N_ELEMENTS is to check if an optional input is defined, and if not, set it to a default value:

```
IF (N_ELEMENTS(roo) EQ 0) THEN roo=rooDefault
```

The original value of `roo` may be altered by a called routine, passing a different value back to the caller. Unless you intend for the routine to behave in this manner, you should prevent it by differentiating N_ELEMENTS' parameter from your routine's variable:

```
IF (N_ELEMENTS(roo) EQ 0) THEN rooUse=rooDefault $
   ELSE rooUse=roo
```

## Version History

Introduced: Original

## See Also

N_TAGS

# N_PARAMS

The N_PARAMS function returns the number of parameters used in calling an IDL procedure or function. This function is only useful within IDL procedures or functions. User-written procedures and functions can use N_PARAMS to determine if they were called with optional parameters.

**Note**

*In the case of object method procedures and functions, the SELF argument is not counted by N_PARAMS.*

## Syntax

*Result* = N_PARAMS()

## Return Value

Returns the number of non-keyword parameters.

## Arguments

None. This function always returns the number of parameters that were used in calling the procedure or function from which N_PARAMS is called.

## Keywords

None.

## Version History

Introduced: Original

## See Also

KEYWORD_SET

# N_TAGS

The N_TAGS function returns the number of structure tags contained in a structure expression.

## Syntax

*Result* = N_TAGS( *Expression* [, /DATA_LENGTH] [, /LENGTH] )

## Return Value

Returns the number of structure tags and optionally returns the size, in bytes, of the structure.

## Arguments

### Expression

The expression for which the number of structure tags is to be returned. Expressions that are not of structure type are considered to have no tags. N_TAGS does not search for tags recursively, so if *Expression* is a structure containing nested structures, only the number of tags in the outermost structure are counted.

## Keywords

### DATA_LENGTH

Set this keyword to return the length of the data fields contained within the structure, in bytes. This differs from LENGTH in that it does not include any alignment padding required by the structure. The length of the data for a given structure will be the same on any system.

### LENGTH

Set this keyword to return the length of the structure, in bytes.

**Note**

The length of a structure is machine dependent. The length of a given structure will vary depending upon the host machine. IDL pads and aligns structures in a manner consistent with the host machine's C compiler.

## Examples

Find the number of tags in the system variable !P and print the result by entering:

```
PRINT, N_TAGS(!P)
```

Find the length of !P, in bytes:

```
PRINT, N_TAGS(!P, /LENGTH)
```

## Version History

Introduced: Original

## See Also

CREATE_STRUCT, N_ELEMENTS, TAG_NAMES, Chapter 7, “Structures” in the *Building IDL Applications* manual

# NCDF_* Routines

For information, see Chapter 6, “Network Common Data Format” in the *IDL Scientific Data Formats* manual.

# NEWTON

The NEWTON function solves a system of *n* non-linear equations in *n* dimensions using a globally-convergent Newton's method.

NEWTON is based on the routine `newt` described in section 9.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = NEWTON( *X*, *Vecfunc* [, CHECK=*variable*] [, /DOUBLE] [, ITMAX=*value*] [, STEPMAX=*value*] [, TOLF=*value*] [, TOLMIN=*value*] [, TOLX=*value*] )

## Return Value

The result is an *n*-element vector containing the solution.

## Arguments

### X

An *n*-element vector containing an initial guess at the solution of the system.

### Vecfunc

A scalar string specifying the name of a user-supplied IDL function that defines the system of non-linear equations. This function must accept an *n*-element vector argument *X* and return an *n*-element vector result.

For example, suppose the non-linear system is defined by the following equations:

$$y_0 = x_0 + x_1 - 3, \quad y_1 = x_0^2 + x_1^2 - 9$$

We write a function NEWTFUNC to express these relationships in the IDL language:

```
FUNCTION newtfunc, X
   RETURN, [X[0] + X[1] -3.0, X[0]^2 + X[1]^2 - 9.0]
END
```

# Keywords

## CHECK

NEWTON calls an internal function named `fmin()` to determine whether the routine has converged to a local minimum rather than to a global minimum (see *Numerical Recipes*, section 9.7). Use the CHECK keyword to specify a named variable which will be set to 1 if the routine has converged to a local minimum or to 0 if it has not. If the routine does converge to a local minimum, try restarting from a different initial guess to obtain the global minimum.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## ITMAX

The maximum allowed number of iterations. The default value is 200.

## STEPMAX

The scaled maximum step length allowed in line search. The default value is 100.0.

## TOLF

Set the convergence criterion on the function values. The default value is $1.0 \times 10^{-4}$.

## TOLMIN

Set the criterion for deciding whether spurious convergence to a minimum of the function `fmin()` has occurred. The default value is $1.0 \times 10^{-6}$.

## TOLX

Set the convergence criterion on *X*. The default value is $1.0 \times 10^{-7}$.

# Examples

Use NEWTON to solve an *n*-dimensional system of *n* non-linear equations. Systems of non-linear equations may have multiple solutions; starting the algorithms with different initial guesses enables detection of different solutions.

```
FUNCTION newtfunc, X
RETURN, [X[0] + X[1] - 3, X[0]^2 + X[1]^2 - 9]

END
```

```
PRO TEST_NEWTON

; Provide an initial guess as the algorithm's starting point:
X = [1d, 5d]

; Compute the solution:
result = NEWTON(X, 'newtfunc')

; Print the result:
PRINT, 'For X=[1.0, 5.0], result = ', result

;Try a different starting point.
X = [1d, -1d]

; Compute the solution:
result = NEWTON(X,'newtfunc')

;Print the result.
PRINT, 'For X=[1.0, -1.0], result = ', result

END
```

IDL prints:

```
For X=[1.0, 5.0], result =  -2.4871776e-006       3.0000025
For X=[1.0, -1.0], result =        3.0000000 -2.9985351e-008
```

## Version History

Introduced: 4.0

## See Also

BROYDEN, FX_ROOT, FZ_ROOTS

# NORM

The NORM function computes the norm of a vector or a two-dimensional array.

By default, NORM computes the $L_2$ (Euclidean) norm for vectors, and the $L_\infty$ norm for arrays. You may use the LNORM keyword to specify different norms.

This routine is written in the IDL language. Its source code can be found in the file `norm.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = NORM( *A* [, /DOUBLE] [, LNORM={0 | 1 | 2 | *n*}])

## Return Value

Returns the Euclidean or infinity norm of a vector or an array.

## Arguments

### A

A can be either a real or complex vector, or a real or complex two-dimensional array.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### LNORM

Set this keyword to indicate which norm to compute. If *A* is a vector, then the possible values of this keyword are:

| Value | Description |
|---|---|
| 0 | Compute the $L_\infty$ norm, defined as MAX(ABS(*A*)). |
| 1 | Compute the $L_1$ norm, defined as TOTAL(ABS(*A*)). |

*Table 73: LNORM Keyword Values (Vector)*

| Value | Description |
|---|---|
| 2 | Compute the $L_2$ norm, defined as SQRT(TOTAL(ABS(*A*)^2)). This is the default. |
| *n* | Compute the $L_n$ norm, defined as (TOTAL(ABS(*A*)^*n*))^(1/*n*) where *n* is any number, float-point or integer. |

*Table 73: LNORM Keyword Values (Vector)*

If *A* is a two-dimensional array, then the possible values of this keyword are:

| Value | Description |
|---|---|
| 0 | Compute the $L_\infty$ norm (the maximum absolute row sum norm), defined as MAX(TOTAL(ABS(*A*), 1)). This is the default. |
| 1 | Compute the $L_1$ norm (the maximum absolute column sum norm), defined as MAX(TOTAL(ABS(*A*), 2)). |
| 2 | Compute the $L_2$ norm (the spectral norm) defined as the largest singular value, computed from SVDC. For LNORM = 2, *A* cannot be complex. |

*Table 74: LNORM Keyword Values (Two-Dimensional Array)*

# Examples

```
; Define an n-element complex vector A:
A = [COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3,1)]

; Compute the Euclidean norm of A and print:
PRINT, 'Euclidian Norm of A =', NORM(A)

; Define an m by n complex array B:
B = [[COMPLEX(1, 0), COMPLEX(2,-2), COMPLEX(-3,1)], $
     [COMPLEX(1,-2), COMPLEX(2, 2), COMPLEX(1, 0)]]

;Compute the Infinity norm of B and print.
PRINT, 'Infinity Norm of B =', NORM(B, /DOUBLE)
```

IDL prints:

```
Euclidian Norm of A =    4.35890
Infinity Norm of B =    6.9907048
```

## Version History

Introduced: Pre 4.0

## See Also

COND, SVDC

# OBJ_CLASS

The OBJ_CLASS function identifies the name of the object class or superclass of the given argument.

## Syntax

*Result* = OBJ_CLASS( [*Arg*] [, COUNT=*variable*] [, /SUPERCLASS{must specify Arg}] )

## Return Value

Returns a string containing the name of the class or superclass. If the supplied argument is not an object, a null string is returned. If no argument is supplied, OBJ_CLASS returns an array containing the names of all known object classes in the current IDL session.

## Arguments

### Arg

A scalar object reference or string variable for which the object class name is desired. If *Arg* is an object reference, it's object class definition is used. If *Arg* is a string, it is taken to be the name of the class for which information is desired. Passing a string argument is primarily useful in conjunction with the SUPERCLASS keyword.

## Keywords

### COUNT

Set this keyword equal to a named variable that will contain the number of names returned by OBJ_CLASS. It can be used to determine how many superclasses a class has when the SUPERCLASS keyword is specified.

### SUPERCLASS

Set this keyword to cause OBJ_CLASS to return the names of the object's *direct* superclasses as a string array, one element per superclass. The superclasses are ordered in the order they appear in the class structure declaration. In the case where the class has no superclasses, a scalar null string is returned, and the COUNT

keyword (if specified) returns the value 0. If SUPERCLASS is specified, the Arg argument must also be supplied.

## Version History

Introduced: 5.0

# OBJ_DESTROY

The OBJ_DESTROY procedure is used to destroy an object. If the class (or one of its superclasses) supplies a procedure method named CLEANUP, the method is called and all arguments and keywords passed by the user are passed to it. This method should perform any required cleanup on the object and return. Whether a CLEANUP method actually exists or not, IDL will destroy the heap variable representing the object and return.

**Note**

OBJ_DESTROY does not recurse. That is, if `object1` contains a reference to `object2`, destroying `object1` will *not* destroy `object2`. Take care not to lose the only reference to an object by destroying an object that contains that reference. Recursive cleanup of object hierarchies is a good job for a CLEANUP method.

## Syntax

OBJ_DESTROY, *ObjRef* [, $Arg_1$, …, $Arg_n$]

## Arguments

### ObjRef

The object reference for the object to be destroyed. *ObjRef* can be an array, in which case all of the specified objects are destroyed in turn. If the NULL object reference is passed, OBJ_DESTROY ignores it quietly.

### $Arg_1$…$Arg_n$

Any arguments accepted by the CLEANUP method for the object being destroyed can be specified as additional arguments to OBJ_DESTROY.

## Keywords

Any keywords accepted by the CLEANUP method for the object being destroyed can be specified as keywords to OBJ_DESTROY.

## Version History

Introduced: 5.0

# OBJ_ISA

When one object class is subclassed (inherits) from another class, there is an “Is A” relationship between them. The OBJ_ISA function is used to determine if an object instance is subclassed from the specified class.

## Syntax

*Result* = OBJ_ISA(*ObjectInstance*, *ClassName*)

## Return Value

OBJ_ISA returns True (1) if the specified variable is an object and has the specified class in its inheritance graph, or False (0) otherwise.

## Arguments

### ObjectInstance

A scalar or array variable for which the OBJ_ISA test should be performed. The result is of type byte, and has the same size and organization as *ObjectInstance*.

### ClassName

A string giving the name of the class for which *ObjectInstance* is being tested.

## Keywords

None.

## Version History

Introduced: 5.0

# OBJ_NEW

Given the name of a structure that defines an object class, the OBJ_NEW function returns an object reference to a new instance of the specified object type by carrying out the following operations in order:

1. If the class structure has not been defined, IDL will attempt to find and call a procedure to define it automatically. (See Chapter 22, “Object Basics” in the *Building IDL Applications* manual for details.) If the structure is still not defined, OBJ_NEW fails and issues an error.
2. If the class structure has been defined, OBJ_NEW creates an object heap variable containing a zeroed instance of the class structure.
3. Once the new object heap variable has been created, OBJ_NEW looks for a *method* function named *Class*::INIT (where *Class* is the actual name of the class). If an INIT method exists, it is called with the new object as its implicit SELF argument, as well as any arguments and keywords specified in the call to OBJ_NEW. If the class has no INIT method, the usual method-searching rules are applied to find one from a superclass. For more information on methods and method-searching rules, see “Method Routines” in Chapter 22 of the *Building IDL Applications* manual.

   The INIT method is expected to initialize the object instance data as necessary to meet the needs of the class implementation. INIT should return a scalar TRUE value (such as 1) if the initialization is successful, and FALSE (such as 0) if the initialization fails.

   **Note**

   OBJ_NEW does not call all the INIT methods in an object’s class hierarchy. Instead, it simply calls the first one it finds. Therefore, the INIT method for a class should call the INIT methods of its direct superclasses as necessary.

4. If the INIT method returns true, or if no INIT method exists, OBJ_NEW returns an object reference to the heap variable. If INIT returns false, OBJ_NEW destroys the new object and returns the NULL object reference, indicating that the operation failed. Note that in this case the CLEANUP method is not called. See “Destruction” in Chapter 22 of the *Building IDL Applications* manual for more on CLEANUP methods.

If called without arguments, OBJ_NEW returns a NULL object reference. The NULL object reference is a special value that never refers to a value object. It is primarily used as a placeholder in structure definitions, and as the initial value for elements of

object arrays created via OBJARR. The null object reference is useful as an indicator that an object reference is currently not usable.

# Syntax

*Result* = OBJ_NEW( [*ObjectClassName* [, $Arg_1$…...$Arg_n$]] )

# Return Value

Returns a reference to a new instance of the specified object type. If called without arguments, OBJ_NEW returns a NULL object reference. The NULL object reference is a special value that never refers to a value object. It is primarily used as a placeholder in structure definitions, and as the initial value for elements of object arrays created via OBJARR. The null object reference is useful as an indicator that an object reference is currently not usable.

# Arguments

## ObjectClassName

String giving the name of the structure type that defines the object class for which a new object should be created.

If *ObjectClassName* is not provided, OBJ_NEW does not create a new heap variable, and returns the *Null Object*, which is a special object reference that is guaranteed to never point at a valid object heap variable. The null object is a convenient value to use when defining structure definitions for fields that are object references, since it avoids the need to have a pre-existing valid object reference.

## $Arg_1$…$Arg_n$

Any arguments accepted by the INIT method for the class of object being created can be specified when the object is created.

# Keywords

Any keywords accepted by the INIT method for the class of object being created can be specified when the object is created.

# Version History

Introduced: 5.0

# OBJ_VALID

The OBJ_VALID function verifies the validity of its argument object references, or alternatively returns a vector of references to all the existing valid objects.

## Syntax

*Result* = OBJ_VALID( [*Arg*] [, CAST=*integer*] [, COUNT=*variable*] )

## Return Value

If called with an argument, OBJ_VALID returns a byte array of the same size as the argument. Each element of the result is set to True (1) if the corresponding object reference in the argument refers to an existing object, and False (0) otherwise.

If called with an integer or array of integers as its argument and the CAST keyword is set, OBJ_VALID returns an array of object references. Each element of the result is a reference to the heap variable indexed by the integer value. Integers used to index heap variables are shown in the output of the HELP and PRINT commands. This is useful primarily in programming/debugging when the you have lost a reference but see it with HELP and need to get a reference to it interactively in order to determine what it is and take steps to fix the code. See the “Examples” section below for an example.

If no argument is specified, OBJ_VALID returns a vector of references to all existing valid objects. If no valid objects exist, a scalar null object reference is returned.

## Arguments

### Arg

Scalar or array argument of object reference type.

## Keywords

### CAST

Set this keyword equal to an integer that indexes a heap variable to create a new pointer to that heap variable. Integers used to index heap variables are shown in the output of the HELP and PRINT commands. This is useful primarily in programming/debugging when the you have lost a reference but see it with HELP and

need to get a reference to it interactively in order to determine what it is and take steps to fix the code. See the “Examples” section below for an example.

### COUNT

Set this keyword equal to a named variable that will contain the number of currently valid objects. This value is returned as a longword integer.

## Examples

To determine if a given object reference refers to a valid heap variable, use:

```
IF (OBJ_VALID(obj)) THEN …
```

To destroy all existing pointer heap variables:

```
OBJ_DESTROY, OBJ_VALID()
```

You can use the CAST keyword to “reclaim” lost object references. For example:

```
; Create a class structure:
junk = {junk, data1:0, data2:0.0}

; Create an object:
A = OBJ_NEW('junk')

; Find the integer index:
PRINT, A

; In this case, the integer index to the heap variable is 3. If we
; reassign the variable A, we will "lose" the object reference, but
; the heap variable will still exist.
; Lose the object reference:
A = 0
PRINT, A, OBJ_VALID()

; We can reclaim the lost heap variable using the CAST keyword:
A = OBJ_VALID(3, /CAST)
PRINT, A
```

IDL prints:

```
<ObjHeapVar3(JUNK)>
0 <ObjHeapVar3(JUNK)>
<ObjHeapVar3(JUNK)>
```

## Version History

Introduced: 5.0

# OBJARR

The OBJARR function returns an object reference vector or array. The individual elements of the array are set to the NULL object reference.

## Syntax

*Result* = OBJARR( $D_1$ *[*, ..., $D_8$*]* [, /NOZERO] )

## Return Value

Returns an object reference to an array of the specified dimensions.

## Arguments

### Di

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

OBJARR sets every element of the result to the null object reference. If NOZERO is nonzero, this initialization is not performed and OBJARR executes faster.

**Warning**

If you specify NOZERO, the resulting array will have whatever value happens to exist at the system memory location that the array is allocated from. You should be careful to initialize such an array to valid object reference values.

## Examples

Create a 3 element by 3 element object reference array with each element containing the null object reference:

```
A = OBJARR(3, 3)
```

## Version History

Introduced: 5.0

# ON_ERROR

The ON_ERROR procedure determines the action taken when an error is detected inside an IDL user procedure or function by setting state information applying to the current routine and all nested routines. If an override exists within the nested routine, it takes precedence over the ON_ERROR call.

## Syntax

ON_ERROR, *N*

## Arguments

### N

An integer that specifies the action to take. Valid values for *N* are:

- 0: Stop at the statement in the procedure that caused the error, the default action.
- 1: Return all the way back to the main program level.
- 2: Return to the caller of the program unit that established the ON_ERROR condition.
- 3: Return to the program unit that established the ON_ERROR condition.

## Keywords

None.

## Version History

Introduced: Original

## See Also

CATCH, MESSAGE, ON_IOERROR, and Chapter 18, “Controlling Errors” in the *Building IDL Applications* manual.

# ON_IOERROR

The ON_IOERROR procedure specifies a statement to be jumped to if an I/O error occurs in the current procedure. Normally, when an I/O error occurs, an error message is printed and program execution is stopped. If ON_IOERROR is called and an I/O related error later occurs in the same procedure activation, control is transferred to the designated statement with the error code stored in the system variable !ERROR_STATE. The text of the error message is contained in !ERROR_STATE.MSG.

The effect of ON_IOERROR can be canceled by using the label “NULL” in the call.

## Syntax

ON_IOERROR, *Label*

## Arguments

### Label

Statement to jump to when I/O error is encountered.

## Keywords

None.

## Examples

The following code segment reads an integer from the keyboard. If an invalid number is entered, the program re-prompts.

```
i = 0 ; Number to read:

valid = 0 ; Valid flag

WHILE valid EQ 0 DO BEGIN
   ON_IOERROR, bad_num
   READ, 'Enter Number: ', i
   ;If we get here, i is good.
   VALID = 1
bad_num: IF ~ valid THEN $
         PRINT, 'You entered an invalid number.'
ENDWHILE
END
```

## Version History

Introduced: Original

## See Also

CATCH, MESSAGE, ON_ERROR, and Chapter 18, “Controlling Errors” in the *Building IDL Applications* manual.

# ONLINE_HELP

The ONLINE_HELP procedure invokes IDL's online help system. If called with no arguments, it starts the help viewer with the default IDL help file displayed.

**Note**

This procedure is intended for use in user-written routines. The `?` command, which is a shorthand for the ONLINE_HELP procedure, is intended for use at the IDL command line.

The online help viewer used by ONLINE_HELP depends on the operating system in use and the type of help document specified:

**UNIX**: IDL online help documents are provided in Adobe Acrobat PDF format. To use ONLINE_HELP (or the `?` command), you must have version 4.0.5 or later of either the Acrobat Reader or the full Acrobat application installed on your system, and the corresponding `acroread` command must be available in a directory included in your UNIX `PATH` environment variable. See the *Installing and Licensing IDL* manual for details.

**Note**

The Acrobat Reader application is available free of charge from Adobe at `http://www.adobe.com`. In addition, the most current version of Acrobat Reader available for each platform supported by IDL at the time of IDL's release is included on the IDL CD-ROM.

In addition, if a web browser is installed on the system and available for use by IDL, HTML files can be displayed. See "Displaying HTML Files under UNIX" on page 1408 for details.

**Windows**: IDL online help is built around the standard Windows help facilities. Windows HTML Help files (`.chm`) as well as traditional Windows help files (`.hlp`) can be displayed. In addition, if Adobe Acrobat is available on the system, PDF files can be displayed. If a web browser is available on the system, HTML files can be displayed. ONLINE_HELP will automatically determine which help format to use based on the file name.

For a more complete description of the Unix and Windows help systems, see "Providing Online Help For Your Application" in Chapter 19 of the *Building IDL Applications* manual.

# Syntax

ONLINE_HELP [, *Value*] [, BOOK=‘*filename*’] [, /FULL_PATH] [, /QUIT]

**UNIX-Only Keywords:** [, /FOLD_CASE] [, PAGE=*pageno*]

**Windows-Only Keywords:** [, /CONTEXT] [, /TOPICS]

# Arguments

## Value

An optional string that contains the name of a topic to be displayed.

Under UNIX, *Value* is the name of a topic to be displayed. If *Value* is omitted, if the specified topic does not exist in the specified or default file, or if the IDL Acrobat plug-in is not present, IDL displays a default topic. (For more information on the IDL Acrobat plug-in, see “About IDL’s Online Help System” in Chapter 19 of the *Building IDL Applications* manual.)

Under Windows, *Value* is loaded into the help viewer’s Index dialog. If *Value* is omitted, the specified or default file is displayed at its beginning. If the CONTEXT keyword is set, *Value* should be an integer value (not a string) that represents the *context number* of the help topic to be displayed; the specified topic will be displayed immediately, bypassing the Index dialog. If the BOOK keyword specifies a PDF file, *Value* is ignored and the specified file is opened to the first page of the file.

# Keywords

## BOOK

Set this keyword to a string containing the name of the help file to be displayed. If the BOOK keyword is omitted, the default IDL help file is displayed.

- Under UNIX, if the *Value* parameter is specified, the default IDL help file is `reference.pdf`. If the *Value* parameter is not specified, the default IDL help file is `onlguide.pdf`. Both files are located in the `Help` subdirectory of the IDL distribution.
- Under Windows, the default IDL help file is `idl.chm`, located in the `Help` subdirectory of the IDL distribution.

If the FULL_PATH keyword is specified, BOOK must specify a complete file path, including the directory specification and file extension for the file. If FULL_PATH is not specified:

- The file extension is optional and may be omitted.
- ONLINE_HELP will search the directories given by the !HELP_PATH environment variable to locate the file.

Any file specified by this keyword must be in the appropriate format for the viewer being invoked:

- Under UNIX, the file must be either a PDF file (`.pdf`) or an HTML file (`.html` or `.htm`).
- Under Microsoft Windows, the file must be either an HTML Help file (`.chm`), a WinHelp file (`.hlp`), a PDF file (`.pdf`), or an HTML file (`.html` or `.htm`). If you specify the file extension, IDL will use the appropriate viewer for that type of file.

**Note**

If no file extension is included in the value of the BOOK keyword, IDL will search each directory in !HELP_PATH until it finds a matching file with one of the following file extensions, in this order: `.chm` (Windows only), `.hlp` (Windows only), `.pdf`, `.html`, `.htm`. You can override this behavior by explicitly specifying the desired file extension.

## CONTEXT (Windows Only)

Set this keyword to indicate that the *Value* argument is an integer value that represents the context number of the help topic to be displayed. This keyword is intended for use with user-compiled help files that contain topics that have been mapped to specific context numbers when they were compiled using the [MAP] section of the help project file. Specifying a non-existent context number causes an error dialog to be displayed. For more information on how to create Help files with context numbers, see the documentation for the Help system compiler that you are using.

## FOLD_CASE (UNIX Only)

Normally, the string given by the *Value* argument is folded to upper case before being handed to Acrobat for display. Explicitly set FOLD_CASE=0 to indicate that the string should be handed to Acrobat without modification.

## FULL_PATH

Set this keyword to indicate that value of the BOOK keyword is a full and complete path to the help file, including any necessary directory information, and a file extension. If FULL_PATH is not specified, ONLINE_HELP searches the !HELP_PATH system variable to locate the file, and the file extension is optional.

### PAGE (UNIX Only)

Set this keyword equal to a page number. Acrobat will open the specified page in the specified PDF file.

### QUIT

Set this keyword to close the Help viewer.

**Note**

The QUIT keyword will close the Windows help viewers. It will close the Adobe Acrobat Reader if the IDL-Acrobat plug-in is installed. For other applications launched by ONLINE_HELP, this keyword has no effect.

### TOPICS (Windows Only)

Set this keyword to display the Index dialog for the specified help file.

### Obsolete Keywords

The following keywords are obsolete:

- HTML_HELP

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Displaying HTML Files under UNIX

To display an HTML file on a Windows system, IDL simply instructs Windows to open the specified file and leaves it to the operating system to choose the correct application based on the file type. UNIX systems have no cross-platform standard facility for associating different types of files with specific applications, so the situation is slightly more complicated.

When the BOOK keyword specifies an HTML file (that is, when the file name ends with any of `.html`, `.HTML`, `.htm`, or `.HTM`), IDL calls a shell script located in the IDL distribution. The shell script then launches a web browser with the specified file as its argument. By default, IDL assumes that it should launch the Netscape web browser, and that the `netscape` command is found in one of the directories specified by the `PATH` environment variable. Individual users can override the default behavior by setting environment variables to specify either a different browser or an entirely different shell script.

See the comments in the `online_help_html` script located in the `bin` subdirectory of the IDL distribution for details on setting the relevant environment variables.

## Examples

The following example uses the ONLINE_HELP procedure to launch the help viewer to display information on the FFT function:

```
ONLINE_HELP, 'fft'
```

This example displays the *External Development Guide* in PDF format:

```
ONLINE_HELP, BOOK='edg'
```

This Windows-only example displays the topic corresponding to context number 100 in a traditional Windows help file.

```
ONLINE_HELP, 100, /CONTEXT, /FULL_PATH, $
   BOOK='C:\keith\myfile.hlp'
```

This cross-platform example displays an HTML file in the system's default web browser.

```
ONLINE_HELP, BOOK='myfile.html'
```

## Version History

Introduced: 4.0.1

## See Also

MK_HTML_HELP, Chapter 19, "Providing Online Help For Your Application" in the *Building IDL Applications* manual

# OPEN

The three OPEN procedures open a specified file for input and/or output.

- OPENR (OPEN Read) opens an existing file for input only.
- OPENW (OPEN Write) opens a new file for input and output. If the file exists, it is truncated and its old contents are destroyed.
- OPENU (OPEN Update) opens an existing file for input and output.

## Syntax

There are three forms of the OPEN procedure:

OPENR, *Unit*, *File*
OPENW, *Unit*, *File*
OPENU, *Unit*, *File*

**Keywords (all platforms):** [, /APPEND | , /COMPRESS] [, BUFSIZE={0 | 1 | *value*>512}] [, /DELETE] [, ERROR=*variable*] [, /F77_UNFORMATTED] [, /GET_LUN] [, /MORE] [, /NOEXPAND_PATH] [, /STDIO] [, /SWAP_ENDIAN] [, /SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN] [, /VAX_FLOAT] [, WIDTH=*value*] [, /XDR]

**UNIX-Only Keywords:** [, /RAWIO]

## Arguments

### Unit

The unit number to be associated with the opened file.

### File

A string containing the name of the file to be opened. Under UNIX, the filename can contain any wildcard characters recognized by the shell specified by the SHELL environment variable. However, it is faster not to use wildcards because IDL doesn't use the shell to expand file names unless it has to.

**Note**

The optional *Record_Length* argument is obsolete, and should not be used in new code. See Appendix I, "Obsolete Features" for details.

# Keywords

**Note**

Platform-specific keywords are listed at the end of this section.

## APPEND

Set this keyword to open the file with the file pointer at the end of the file, ready for data to be appended. Normally, the file is opened with the file pointer at the beginning of the file. Under UNIX, use of APPEND prevents OPENW from truncating existing file contents. The APPEND and COMPRESS keywords are mutually exclusive and cannot be specified together.

## BUFSIZE

Set this keyword to a value greater than 512 to specify the size of the I/O buffer (in bytes) used when reading and writing files. Setting BUFSIZE=1 (or any other value less than 512) sets the buffer to the default size, which is platform-specific. Set BUFSIZE=0 to disable I/O buffering.

Note that the buffer size is only changeable when reading and writing stream files. Under UNIX, the RAWIO keyword must not be set. Also note that the system stdio may choose to ignore the buffer size setting.

## COMPRESS

If COMPRESS is set, IDL reads and writes all data to the file in the standard GZIP format. IDL's GZIP support is based on the freely available ZLIB library by Mark Adler and Jean-loup Gailly (see www.zlib.org for details). This means that IDL's compressed files are 100% compatible with the widely available gzip and gunzip programs. COMPRESS cannot be used with the APPEND keyword.

## DELETE

Set this keyword to delete the file when it is closed.

**Warning**

Setting the DELETE keyword *causes the file to be deleted* even if it was opened for read-only access. In addition, once a file is opened with this keyword, there is no way to cancel its operation.

## ERROR

A named variable to place the error status in. If an error occurs in the attempt to open *File*, IDL normally takes the error handling action defined by the ON_ERROR and/or ON_IOERROR procedures. OPEN always returns to the caller without generating an error message when ERROR is present. A nonzero error status indicates that an error occurred. The error message can then be found in !ERROR_STATE.MSG.

For example, statements similar to the following can be used to detect errors:

```
; Try to open the file demo.dat:
OPENR, 1, 'demo.dat', ERROR = err

; If err is nonzero, something happened. Print the error message to
; the standard error file (logical unit -2):
IF (err NE 0) then PRINTF, -2, !ERROR_STATE.MSG
```

## F77_UNFORMATTED

Unformatted variable-length record files produced by UNIX FORTRAN programs contain extra information along with the data in order to allow the data to be properly recovered. This method is necessary because FORTRAN input/output is based on record-oriented files, while UNIX files are simple byte streams that do not impose any record structure. Set the F77_UNFORMATTED keyword to read and write this extra information in the same manner as `f77(1)`, so that data to be processed by both IDL and FORTRAN. See "UNIX-Specific Information" in Chapter 10 of the *Building IDL Applications* manual for further details.

## GET_LUN

Set this keyword to use the GET_LUN procedure to set the value of *Unit* before the file is opened. Instead of using the two statements:

```
GET_LUN, Unit
OPENR, Unit, 'data.dat'
```

you can use the single statement:

```
OPENR, Unit, 'data.dat', /GET_LUN
```

## MORE

If MORE is set, and the specified *File* is a terminal, then all output to this unit is formatted in a manner similar to the UNIX `more(1)` command and sent to the standard output stream. Output pauses at the bottom of each screen, at which point the user can press one of the following keys:

- Space: Display the next page of text.

- Return: Display the next line of text.
- ‘q’ or ‘Q’: Suppress all remaining output.
- ‘h’ or ‘H’: Display this list of options.

For example, the following statements show how to output a file named text.dat to the terminal:

```
; Open the text file:
OPENR, inunit, 'text.dat', /GET_LUN

; Open the terminal as a file:
OPENW, outunit, '/dev/tty', /GET_LUN, /MORE

; Read the first line:
line = '' & READF, inunit, line

; While there is text left, output it:
WHILE ~ EOF(inunit) DO BEGIN
   PRINTF, outunit, line
   READF, inunit, line
ENDWHILE

; Close the files and deallocate the units:
FREE_LUN, inunit & FREE_LUN, outunit
```

## NOEXPAND_PATH

Set this keyword to specify that the *File* argument be used exactly as supplied, without applying the usual file path expansion.

## RAWIO (UNIX Only)

Set this keyword to disable all use of the standard UNIX I/O for the file, in favor of direct calls to the operating system. This allows direct access to devices, such as tape drives, that are difficult or impossible to use effectively through the standard I/O. Using this keyword has the following implications:

- No formatted or associated (ASSOC) I/O is allowed on the file. Only READU and WRITEU are allowed.
- Normally, attempting to read more data than is available from a file causes the unfilled space to be set to zero and an error to be issued. This does not happen with files opened with RAWIO. When using RAWIO, the programmer must check the transfer count, either via the TRANSFER_COUNT keywords to READU and WRITEU, or the FSTAT function.

- The EOF and POINT_LUN functions cannot be used with a file opened with RAWIO.
- Each call to READU or WRITEU maps directly to UNIX read(2) and write(2) system calls. The programmer must read the UNIX system documentation for these calls and documentation on the target device to determine if there are any special rules for I/O to that device. For example, the size of data that can be transferred to many cartridge tape drives is often forced to be a multiple of 512 bytes.

## STDIO

Forces the file to be opened via the standard C I/O library (stdio) rather than any other more native OS API that might usually be used. This is primarily of interest to those who intend to access the file from external code, and is not necessary for most files.

**Note**

If you intend to use the opened file with the READ_JPEG or WRITE_JPEG procedures using their UNIT keyword, you must specify the STDIO keyword to OPEN to ensure that the file is compatible.

The only exception to this rule is if the filename ends in `.jpg` or `.jpeg` and the STDIO keyword is not present in the call to OPEN. In this case OPEN uses stdio by default, covering most uses of jpeg files without requiring you to take special steps.

## SWAP_ENDIAN

Set this keyword to swap byte ordering for multi-byte data when performing binary I/O on the specified file. This is useful when accessing files also used by another system with byte ordering different than that of the current host.

## SWAP_IF_BIG_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has big endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

## SWAP_IF_LITTLE_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has little endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

## VAX_FLOAT

The opened file contains VAX format floating point values. This keyword implies little endian byte ordering for all data contained in the file, and supersedes any setting of the SWAP_ENDIAN, SWAP_IF_BIG_ENDIAN, or SWAP_IF_LITTLE_ENDIAN keywords.

The default setting for this keyword is FALSE.

**Warning**

Please read "Note on Accessing Data in VAX Floating Point Format" on page 1416 before using this feature.

## WIDTH

The desired output width. If no output width is specified, IDL uses the following rules to determine where to break lines:

- If the output file is a terminal, the terminal width is used.
- Otherwise, a default of 80 columns is used.

## XDR

Set this keyword to open the file for unformatted XDR (eXternal Data Representation) I/O via the READU and WRITEU procedures. Use XDR to make binary data portable between different machine architectures by reading and writing all data in a standard format. When a file is open for XDR access, the only I/O data transfer procedures that can be used with it are READU and WRITEU. XDR is described in "Portable Unformatted Input/Output" in Chapter 10 of the *Building IDL Applications* manual.

## Obsolete Keywords

The following keywords are obsolete:

- BINARY
- BLOCK
- DEFAULT
- EXTENDSIZE
- FIXED
- FORTRAN
- INITIALSIZE
- KEYED
- LIST
- MACCREATOR
- MACTYPE
- NONE
- NOAUTOMODE
- NOSTDIO
- PRINT

- SEGMENTED
- SHARED
- STREAM
- SUBMIT
- SUPERSEDE
- TRUNCATE_ON_CLOSE
- UDF_BLOCK
- VARIABLE

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Note on Accessing Data in VAX Floating Point Format

The floating-point number format used by a program such as IDL is determined entirely by the computer hardware upon which it runs. In the early years of computing it was common for different machines to have incompatible floating-point formats. In the 1970s and 1980s, PDP-11 and VAX minicomputers were widely used for scientific computation, and their floating-point format (known as VAX F and D floating) became the *de facto* standard for science. Early versions of IDL used these formats.

In ensuing years, the computing industry has converged upon a floating-point standard known as IEEE 754, commonly referred to as “IEEE floating” or “IEEE arithmetic.” Other formats (including the VAX formats) have diminished in importance. Now, all common computing hardware uses the IEEE format, which has significant advantages over earlier formats:

- Binary data is portable to almost all current and foreseeable computing hardware and operating systems, requiring at most simple byte-swapping.
- Special *Infinity* and *Not A Number (NaN)* values for undefined computations allow exceptional computations to be carried out in a well-defined manner (and at full speed) by modern pipelined computer architectures.

This convergence gained momentum in the 1980s as workstations and personal computers came into prominence. As a result, almost all versions of IDL since 1987 have used IEEE floating point arithmetic, and all current versions of IDL use this format.

Despite the almost universal current use of the IEEE format, valuable older data stored in the VAX floating-point formats exists at various scientific institutions around the world. In order to allow access to this data, IDL is able to read and write data in these formats. The VAX_FLOAT keyword to the OPEN procedure is used to enable this feature.

When converting between VAX and IEEE formats, you should be aware of the following basic numerical issues in order to get the best results. Translation of

floating-point values from IDL's native IEEE format to the VAX format and back (that is, VAX to IEEE to VAX) is not a completely reversible operation, and should be avoided when possible. There are many cases where the recovered values will differ from the original values, including:

- The VAX floating-point format lacks support for the IEEE special values (*NaN* and *Infinity*). Hence, their special meaning is lost when they are converted to VAX format and cannot be recovered.
- The IEEE and VAX floating formats have intrinsic differences in precision and range, which can cause information to be lost in both directions. When converting from one format to another, IDL rounds the value to the nearest representable value in the target format.

As a practical matter, an initial conversion of existing VAX format data to IEEE cannot be avoided if the data is to be used on modern machines. However, each format conversion can add a small amount of error to the resulting values, so it is important to minimize the number of such conversions. RSI recommends using IEEE/VAX conversions only to read existing VAX format data, and strongly recommends that all new files be created using the native IEEE format. This introduces only a single unavoidable conversion, and minimizes the resulting conversion error.

## Examples

The following example opens the IDL distribution file `people.dat` and reads an image from that file:

```
; Open 'people.dat' on file unit number 1. The FILEPATH
; function is used to return the full path name to this
; distribution file.
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])

; Define a variable into which the image will be read:
image=BYTARR(192, 192, /NOZERO)

; Read the data:
READU, 1, image

; Display the image:
TV, image
```

## Version History

Introduced: Original

## See Also

CLOSE, GET_LUN, POINT_LUN, PRINT/PRINTF, READ/READF, READU, WRITEU

# OPLOT

The OPLOT procedure plots vector data over a previously-drawn plot. It differs from PLOT only in that it does not generate a new axis. Instead, it uses the scaling established by the most recent call to PLOT and simply overlays a plot of the data on the existing axis.

## Syntax

OPLOT, [*X*,] *Y* [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, NSUM=*value*] [, /POLAR] [, THICK=*value*]

**Graphics Keywords:** [, CLIP=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, COLOR=*value*] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, PSYM=*integer*{0 to 10}] [, SYMSIZE=*value*] [, /T3D] [, ZVALUE=*value*{0 to 1}]

## Arguments

### X

A vector argument. If X is not specified, *Y* is plotted as a function of point number (starting at zero). If both arguments are provided, *Y* is plotted as a function of *X*.

This argument is converted to double-precision floating-point before plotting. Plots created with OPLOT are limited to the range and precision of double precision floating-point values.

### Y

The ordinate data to be plotted. This argument is converted to double-precision floating-point before plotting.

## Keywords

### MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See “Special Floating-Point Values” in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

### MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

### NSUM

The presence of this keyword indicates the number of data points to average when plotting. If NSUM is larger than 1, every group of NSUM points is averaged to produce one plotted point. If there are *m* data points, then *m*/NSUM points are displayed. On logarithmic axes a geometric average is performed.

It is convenient to use NSUM when there is an extremely large number of data points to plot because it plots fewer points, the graph is less cluttered, and it is quicker.

### POLAR

Set this keyword to produce polar plots. The *X* and *Y* vector parameters, both of which must be present, are first converted from polar to Cartesian coordinates. The first parameter is the radius, and the second is expressed in radians.

For example, to make a polar plot, use the command:

```
OPLOT, /POLAR, R, THETA
```

### THICK

Controls the thickness of the lines connecting the points. A thickness of 1.0 is normal, 2.0 is double wide, etc.

### Graphics Keywords Accepted

See Appendix B, "Graphics Keywords" for the description of graphics and plotting keywords not listed above. CLIP, COLOR, LINESTYLE, NOCLIP, PSYM, SYMSIZE, T3D, ZVALUE.

## Examples

```
; Create a simple dataset:
D = SIN(FINDGEN(100)/EXP(FINDGEN(100)/50))

; Create an X-Y plot of vector D:
PLOT, D
```

```
; Overplot the sine of D as a thick, dashed line:
OPLOT, SIN(D), LINESTYLE = 5, THICK = 2
```

## Version History

Introduced: Original

## See Also

IPLOT, OPLOTERR, PLOT

# OPLOTERR

The OPLOTERR procedure plots error bars over a previously drawn plot. A plot of *X* versus *Y* with error bars drawn from *Y* - *Err* to *Y* + *Err* is written to the output device over any plot already there.

This routine is written in the IDL language. Its source code can be found in the file `oploterr.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

OPLOTERR, [ *X* ,] *Y* , *Err* [, *Psym* ]

## Arguments

### X

An optional array of X values. The procedure checks whether or not the third parameter passed is a vector to decide if *X* was passed. If *X* is not passed, then INDGEN(*Y*) is assumed for the X values.

### Y

The array of Y values. *Y* cannot be of type string.

### Err

The array of error bar values.

### Psym

The plotting symbol to use (default = +7).

## Keywords

None

## Version History

Introduced: Original

## See Also

ERRPLOT, IPLOT, OPLOT, PLOTERR

# P_CORRELATE

The P_CORRELATE function computes the partial correlation coefficient of a dependent variable and one particular independent variable when the effects of all other variables involved are removed.

To compute the partial correlation, the following method is used:

- Let *Y* and *X* be the variables of primary interest and let $C_1...C_p$ be the variables held fixed.
- First, calculate the residuals after regressing *Y* on $C_1...C_p$. (These are the parts of *Y* that cannot be predicted by $C_1...C_p$.)
- Then, calculate the residuals after regressing *X* on $C_1...C_p$. (These are the parts of *X* that cannot be predicted by $C_1...C_p$.)
- The partial correlation coefficient between *Y* and *X* adjusted for $C_1...C_p$ is the correlation between these two sets of residuals.

This routine is written in the IDL language. Its source code can be found in the file `p_correlate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = P_CORRELATE( *X*, *Y*, *C* [, /DOUBLE] )

## Return Value

Returns the correlation coefficient.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector that specifies the independent variable data.

### Y

An *n*-element integer, single-, or double-precision floating-point vector that specifies the dependent variable data.

### C

An integer, single-, or double-precision floating-point array that specifies the independent variable data whose effects are to be removed. *C* may either be an *n*-element vector containing the independent variable, or a *p*-by-*n* two-dimensional array in which each column corresponds to a separate independent variable.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

```
; Define three sample populations:
X0 = [64, 71, 53, 67, 55, 58, 77, 57, 56, 51, 76, 68]
X1 = [57, 59, 49, 62, 51, 50, 55, 48, 52, 42, 61, 57]
X2 = [ 8, 10, 6, 11, 8, 7, 10, 9, 10, 6, 12, 9]

; Compute the partial correlation of X0 and X1 with the effects
; of X2 removed.
result = P_CORRELATE(X0, X1, X2)

PRINT, result
```

IDL prints:

```
0.533469
```

## Version History

Introduced: 4.0

## See Also

A_CORRELATE, C_CORRELATE, CORRELATE, M_CORRELATE, R_CORRELATE

# PARTICLE_TRACE

The PARTICLE_TRACE procedure traces the path of a massless particle through a vector field. The function allows the user to specify a set of starting points and a vector field. The input seed points can come from any vertex-producing process. The points are tracked by treating the vector field as a velocity field and integrating. Each path is tracked until the path leaves the input volume or a maximum number of steps is reached. The vertices generated along the paths are returned packed into a single array along with a polyline connectivity array. The polyline connectivity array organizes the vertices into separate paths (one per seed). Each path has an orientation. The initial orientation may be set using the SEED_NORMAL keyword. As a path is tracked, the change in the normal is also computed and may be returned to the user as an optional argument. Path output can be passed directly to an IDLgrPolyline object or passed to the STREAMLINE procedure for generation of orientated ribbons. Control over aspects of the integration (e.g. method or stepsize) is also provided.

## Syntax

PARTICLE_TRACE, *Data*, *Seeds*, *Verts*, *Conn* [, *Normals*]
[, MAX_ITERATIONS=*value*] [, ANISOTROPY=*array*]
[, INTEGRATION={0 | 1}] [, SEED_NORMAL=*vector*] [, TOLERANCE=*value*]
[, MAX_STEPSIZE=*value*] [, /UNIFORM]

## Arguments

### Data

Input data array. This array can be of dimensions [2, *dx*, *dy*] for two-dimensional vector fields or [3, *dx*, *dy*, *dz*] for three-dimensional vector fields.

### Seeds

Input array of seed points ([3, *n*] or [2, *n*]).

### Verts

Array of output path vertices ([3, *n*] or [2, *n*] array of floats).

### Conn

Output path connectivity array in IDLgrPolyline POLYLINES keyword format. There is one set of line segments in this array for each input seed point.

### Normals

Output normal estimate at each output vertex ([3, *n*] array of floats).

## Keywords

### ANISOTROPY

Set this input keyword to a two- or three- element array describing the distance between grid points in each dimension. The default value is [1.0, 1.0, 1.0] for three-dimensional data and [1.0, 1.0] for two-dimensional data.

### INTEGRATION

Set this keyword to one of the following values to select the integration method:

- 0 = 2nd order Runge-Kutta (the default)
- 1 = 4th order Runge-Kutta

### SEED_NORMAL

Set this keyword to a three-element vector which selects the initial normal for the paths. The default value is [0.0, 0.0, 1.0]. This keyword is ignored for 2-D data.

### TOLERANCE

This keyword is used with adaptive step-size control in the 4th order Runge-Kutta integration scheme. It is ignored if the UNIFORM keyword is set or the 2nd order Runge-Kutta scheme is selected.

### MAX_ITERATIONS

This keyword specifies the maximum number of line segments to return for each path. The default value is 200.

### MAX_STEPSIZE

This keyword specifies the maximum path step size. The default value is 1.0.

### UNIFORM

If this keyword is set, the step size will be set to a fixed value, set via the MAX_STEPSIZE keyword. If this keyword is not specified, and TOLERANCE is either unspecified or inapplicable, then the step size is computed based on the velocity at the current point on the path according to the formula:

stepsize = MIN(MaxStepSize, MaxStepSize/MAX(ABS(U), ABS(V), ABS(W)))

where (U,V,W) is the local velocity vector.

## Version History

Introduced: 5.5

# PATH_CACHE

The PATH_CACHE procedure is used to control IDL's use of the *path cache*. By default, as IDL searches directories included in the !PATH system variable for `.pro` or `.sav` files to compile, it creates an in-memory list of *all* `.pro` and `.sav` files contained in each directory. When IDL later searches for a `.pro` or `.sav` file, before attempting to open the file in a given directory, IDL checks the path cache to determine whether the directory has already been cached. If the directory is included in the cache, IDL uses the cached information to determine whether the file will be found in that directory, and will only attempt to open the file there if the cache tells it that the file exists. By eliminating unnecessary attempts to open files, the path cache speeds the path searching process.

The path cache is enabled by default, and in almost all cases its operation is transparent to the IDL user, save for the boost in path searching speed it provides. Because the cache automatically adjusts to changes made to IDL's path, use of PATH_CACHE should not be necessary in typical IDL operation. It is provided to allow complete control over the details of how and when the caching operation is performed.

- For information on when the path cache is *not* used, see "Situations in which IDL will not use the Path Cache" on page 1431.
- For information on disabling the path cache, see "Disabling the Path Cache" on page 1432.

**Note**

Prior to IDL 6.0, IDL did not use a path cache. Aside from the improvement in performance, the behavior of IDL with the path cache is identical to that without in almost all cases. The rare cases in which it differs, and options for disabling its use, are discussed in "Options for Avoiding Use of the Path Cache" on page 1433.

## About the Path Cache

The first time an IDL session attempts to call a function or procedure written in the IDL language, it must locate and compile the file containing the code for that routine. The file containing the routine must have the same name as the routine, with either a `.pro` or a `.sav` extension. After trying to open the file in the user's current working directory, IDL will attempt to open the file in each of the directories listed in the !PATH system variable, in the order specified by !PATH. The search stops when a file with the desired name is found or no directories remain in !PATH.

By default, IDL maintains an in-memory cache of the locations of `.pro` and `.sav` files stored in directories included in the !PATH system variable. The path cache is built automatically during normal operation, as IDL searches the directories specified by !PATH. Once a directory is cached, IDL knows whether or not it contains a given file, without the need to actually attempt to open that file. This information allows IDL to bypass directories that do not contain the desired file, providing a significant boost in the speed of path searching. The path cache can significantly improve the startup speed of large, object-oriented applications, because method resolution requires extensive path searching.

The path cache operates on a per-directory basis; if IDL searches a directory for a `.pro` or `.sav` file, the locations of *all* `.pro` and `.sav` files in that directory are added to the cache, and the directory is not searched again until the cache is cleared and rebuilt.

**Note**

The current contents of the path cache can be viewed using the PATH_CACHE keyword to the HELP procedure.

# Syntax

PATH_CACHE[, /CLEAR] [, /ENABLE] [, /REBUILD]

# Arguments

None.

# Keywords

## CLEAR

Set this keyword to clear the entire contents of the path cache, leaving it completely empty. If path caching is enabled, IDL will begin rebuilding the cache the next time it needs to locate a `.pro` or `.sav` file. If you wish to prevent the rebuilding of the cache, set the ENABLE keyword equal to zero as well.

**Note**

The .RESET_SESSION executive command clears the entire path cache as part of resetting the IDL session.

### ENABLE

Set this keyword to a non-zero value to specify that IDL should use the path cache when searching for files and also add new directories to the cache as they are opened. Set this keyword to zero to disable use of the cache when searching for files, and to discontinue adding new directories.

**Note**

Disabling the cache does not cause the current contents of the cache to be discarded. To discard the cache information, specify the CLEAR keyword.

### REBUILD

Set this keyword to discard the current contents of the path cache (as if the CLEAR keyword had been specified), and then immediately rebuild the cache by searching the directories specified by the current value of the !PATH system variable for `.pro` and `.sav` files.

**Note**

If !PATH contains many directories, or if access to those directories is slow, rebuilding the cache using this method may also be slow. In many cases, the CLEAR keyword is sufficient, since IDL will rebuild the empty cache as program execution requires it to search for `.pro` and `.sav` files.

## Situations in which IDL will not use the Path Cache

By default, IDL uses the path cache whenever it tries to locate `.pro` or `.sav` files. However, IDL will never use the path cache in the following situations:

### Current Working Directory

The path cache is neither checked nor added to if the file being searched for exists in the current working directory. Before IDL searches !PATH for a file to compile, it always looks in the current working directory without checking the cache.

### Relative Paths

The path cache does not cache directories specified relative to the current directory, even though relative paths are allowed in the specification of !PATH.

An absolute (or *fully qualified*) path is a path that completely specifies the location of a file. Under UNIX, an absolute path is specified relative to the root of the filesystem, and therefore starts with a slash (`/`) character. Under Microsoft Windows, an absolute

path starts with a drive letter (`C:`, for example) or a double backslash (`\\`) (if the file is specified using the Universal Naming Convention format). In contrast, a relative path is incomplete, and must be interpreted relative to the current working directory of the IDL process. IDL only caches absolute paths.

### Executive Commands

The path cache is neither checked nor added to when a `.COMPILE` or `.RUN` executive command is issued. In such cases, IDL performs a standard directory-by-directory search of the directories included in !PATH.

### IDL_NOCACHE File Present

IDL will not cache the contents of any directory that contains a file named `IDL_NOCACHE`. See “Marking Specific Directories as Uncacheable” on page 1433 for additional information on this feature.

### Path Cache Disabled

IDL will neither check nor add files to the path cache if it has been disabled. See “Disabling the Path Cache”, below, for additional information.

## Disabling the Path Cache

By default, IDL caches the locations of `.pro` and `.sav` files in all directories specified by the !PATH system variable. Use of the path cache can be fully disabled in the following ways:

1. By issuing the PATH_CACHE command with the ENABLE keyword set equal to zero. This will disable the path cache until you manually re-enable it, or for the duration of the current IDL session. See the description of the ENABLE keyword, above, for details.
2. By unchecking the “Enable Path Caching” checkbox on the Path tab of the IDLDE Preferences dialog. See “Path Preferences” in Chapter 5 of the *Using IDL* manual for details.
3. By defining an environment variable named IDL_PATH_CACHE_DISABLE before starting IDL. See “Environment Variables Used by IDL” in Chapter 1 of the *Using IDL* manual for details.

In addition, you can selectively disable use of the path cache for specific directories by creating a file named `IDL_NOCACHE` in the directory. See “Marking Specific Directories as Uncacheable”, below, for details.

## Marking Specific Directories as Uncacheable

You can mark specific directories as being uncacheable even though the directory is included in !PATH. To do so, create a file named `IDL_NOCACHE` in that directory.

**Note**

IDL does not inspect the contents of an `IDL_NOCACHE` file; it can contain anything you wish, or nothing at all. Under Unix operating systems, the `IDL_NOCACHE` file must be named exactly as shown, using all uppercase characters in the name. Under Microsoft Windows, the characters can have any case, but RSI suggests you use upper case for consistency.

When IDL encounters a directory containing an `IDL_NOCACHE` file during normal path searching, it makes a special entry in the path cache telling it that the directory must not be cached. Once this is done, all future attempts to locate files in that directory will be done without using cached information.

**Note**

If the directory to which you add an `IDL_NOCACHE` file has already been added to the path cache for the current IDL session, you must clear the existing cache (using the CLEAR keyword to the PATH_CACHE procedure) before the no-cache setting will take effect.

To re-enable path caching for a directory that has been marked as uncacheable, remove the `IDL_NOCACHE` file, and then reset IDL's path cache in one of the following ways:

- Specify the CLEAR keyword to the PATH_CACHE procedure.
- Issue the .RESET_SESSION executive command.
- Exit and restart the IDL session.

## Options for Avoiding Use of the Path Cache

In most cases, the files contained in directories included in !PATH do not change during an IDL session. In such cases the path cache is completely transparent to the IDL user, and serves only to speed compilation of IDL routines. As a result, there is rarely a reason to globally disable the path cache.

If files are created or deleted in a directory included in !PATH during an IDL session, the path cache can become confused and provide bad information to IDL about the contents of that directory. There are several ways to handle this situation. The

following list of alternatives is given in rough order of preference, with the easiest and lowest-impact options given first:

1. Leave the path cache enabled, and change your current working directory to the directory in which files are created or deleted. Since IDL checks the current working directory before checking the directories in !PATH, use of the path cache does not affect IDL's ability to find these files.
2. If the addition or deletion of files in a directory included in !PATH is a rare occurrence, leave the path cache enabled and clear it in one of the following ways after the contents of the directory have changed:
   - Specify the CLEAR keyword to the PATH_CACHE procedure.
   - Issue the .RESET_SESSION executive command.
   - Exit and restart the IDL session.
3. Leave the path cache enabled and use the .COMPILE or .RUN executive commands to force the compilation of any file, regardless of the contents of the path cache.
4. If you have a directory (other than your current working directory) in which files are regularly added or deleted during the execution of IDL sessions, you can leave path caching enabled but explicitly disable caching of that specific directory by creating an `IDL_NOCACHE` file, as described in "Marking Specific Directories as Uncacheable" on page 1433. This approach works for all IDL sessions that access the directory, and is therefore convenient in long-term or multi-user situations.
5. You can completely disable operation of the path cache using one of the methods described under "Disabling the Path Cache" on page 1432. This is not recommended, because most directories are not dynamic, and completely disabling path caching sacrifices the performance advantages of caching directories whose contents *are* static.

## Note on Behavior at Startup

Depending on the value of your !PATH system variable, you may notice that some directories are being cached immediately when IDL starts up. This will occur if your path definition string includes the `<IDL_DEFAULT>` token, or if one or more entries include the "+" symbol. In these cases, in order for IDL to build the !PATH system variable, it must inspect subdirectories of the specified directories for the presence of `.pro` and `.sav` files, with the side effect of adding these directories to the path cache. See EXPAND_PATH for a discussion of IDL's path expansion behavior.

# Examples

The following statement disables path caching for the current session:

```
PATH_CACHE, ENABLE = 0
```

The following statement disables path caching for the current session and throws away the current contents of the cache:

```
PATH_CACHE, ENABLE = 0, /CLEAR
```

Suppose you want to remove a directory included in !PATH from the cache without resetting your IDL session. The following statements cause the specified directory not to be included in future caching by creating a file named `IDL_NOCACHE` in that directory:

```
OPENW, UNIT = u, '/home/idluser/idl_dev_dir/IDL_NOCACHE', /GET_LUN
FREE_LUN, u
```

The OPENW and FREE_LUN statements create an empty file with the desired name in the target directory. Executing the following statement clears the cache so as to reflect the change in the current IDL session:

```
PATH_CACHE, /CLEAR
```

The next time IDL encounters this directory in a path search, it will see the presence of the `IDL_NOCACHE` and make a note in the path cache that the directory is not cacheable.

**Note**

You can also create the `IDL_NOCACHE` file outside IDL using any convenient command (text editor, Unix `touch` command, *etc*.). If the file is created outside IDL, only the `PATH_CACHE, /CLEAR` statement is necessary.

# Version History

Introduced: 6.0

# See Also

.FULL_RESET_SESSION, .RESET_SESSION, "!PATH" in Appendix D, "Environment Variables Used by IDL" in Chapter 1 of the *Using IDL* manual, "Path Preferences" in Chapter 5 of the *Using IDL* manual

# PATH_SEP

The PATH_SEP function returns the proper file path segment separator character for the current operating system. This is the character used by the host operating system for delimiting subdirectory names in a path specification. Use this function instead of hard-coding separators to make code more portable.

This routine is written in the IDL language. Its source code can be found in the file `path_sep.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = PATH_SEP( [ /PARENT_DIRECTORY ] [, /SEARCH_PATH ] )

## Return Value

Returns a string containing the specified separator character.

## Arguments

None.

## Keywords

Specify at most one of the following keywords:

### PARENT_DIRECTORY

If set, PATH_SEP returns the standard directory notation used by the host operating system to indicate the parent of a directory.

### SEARCH_PATH

If set, PATH_SEP returns the character used to separate entries in a search path.

## Version History

Introduced: 5.5

## See Also

FILE_BASENAME, FILE_DIRNAME, FILE_SEARCH, FILEPATH

# PCOMP

The PCOMP function computes the principal components of an *m*-column, *n*-row array, where *m* is the number of variables and *n* is the number of observations or samples. The principal components of a multivariate data set may be used to restate the data in terms of derived variables or may be used to reduce the dimensionality of the data by reducing the number of variables (columns).

This routine is written in the IDL language. Its source code can be found in the file `pcomp.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = PCOMP( *A* [, COEFFICIENTS=*variable*] [, /COVARIANCE] [, /DOUBLE] [, EIGENVALUES=*variable*] [, NVARIABLES=*value*] [, /STANDARDIZE] [, VARIANCES=*variable*] )

## Return Value

The result is an *nvariables*-column (*nvariables* ≤ *m*), *n*-row array of derived variables.

## Arguments

### A

An *m*-column, *n*-row, single- or double-precision floating-point array.

## Keywords

### COEFFICIENTS

Use this keyword to specify a named variable that will contain the principal components used to compute the derived variables. The principal components are the coefficients of the derived variables and are returned in an *m*-column, *m*-row array. The rows of this array correspond to the coefficients of the derived variables. The coefficients are scaled so that the sums of their squares are equal to the eigenvalue from which they are computed.

### COVARIANCE

Set this keyword to compute the principal components using the covariances of the original data. The default is to use the correlations of the original data to compute the principal components.

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision result. Set DOUBLE=0 to use single-precision for computations and to return a single-precision result. The default is /DOUBLE if *Array* is double precision, otherwise the default is DOUBLE=0.

### EIGENVALUES

Use this keyword to specify a named variable that will contain a one-column, *m*-row array of eigenvalues that correspond to the principal components. The eigenvalues are listed in descending order.

### NVARIABLES

Use this keyword to specify the number of derived variables. A value of zero, negative values, and values in excess of the input array's column dimension result in a complete set (*m*-columns and *n*-rows) of derived variables.

### STANDARDIZE

Set this keyword to convert the variables (the columns) of the input array to standardized variables (variables with a mean of zero and variance of one).

### VARIANCES

Use this keyword to specify a named variable that will contain a one-column, *m*-row array of variances. The variances correspond to the percentage of the total variance for each derived variable.

## Examples

```
PRO ex_pcomp

   ;Define an array with 4 variables and 20 observations.
   array = [[19.5, 43.1, 29.1, 11.9], $
            [24.7, 49.8, 28.2, 22.8], $
            [30.7, 51.9, 37.0, 18.7], $
            [29.8, 54.3, 31.1, 20.1], $
```

```
                  [19.1, 42.2, 30.9, 12.9], $
                  [25.6, 53.9, 23.7, 21.7], $
                  [31.4, 58.5, 27.6, 27.1], $
                  [27.9, 52.1, 30.6, 25.4], $
                  [22.1, 49.9, 23.2, 21.3], $
                  [25.5, 53.5, 24.8, 19.3], $
                  [31.1, 56.6, 30.0, 25.4], $
                  [30.4, 56.7, 28.3, 27.2], $
                  [18.7, 46.5, 23.0, 11.7], $
                  [19.7, 44.2, 28.6, 17.8], $
                  [14.6, 42.7, 21.3, 12.8], $
                  [29.5, 54.4, 30.1, 23.9], $
                  [27.7, 55.3, 25.7, 22.6], $
                  [30.2, 58.6, 24.6, 25.4], $
                  [22.7, 48.2, 27.1, 14.8], $
                  [25.2, 51.0, 27.5, 21.1]]

   ;Remove the mean from each variable.
   m = 4    ; number of variables
   n = 20   ; number of observations
   means = TOTAL(array, 2)/n
   array = array - REBIN(means, m, n)

   ;Compute derived variables based upon the principal components.
   result = PCOMP(array, COEFFICIENTS = coefficients, $
      EIGENVALUES=eigenvalues, VARIANCES=variances, /COVARIANCE)
   PRINT, 'Result: '
   PRINT, result, FORMAT = '(4(F8.2))'
   PRINT
   PRINT, 'Coefficients: '
   FOR mode=0,3 DO PRINT, $
      mode+1, coefficients[*,mode], $
      FORMAT='("Mode#",I1,4(F10.4))'
   eigenvectors = coefficients/REBIN(eigenvalues, m, m)
   PRINT
   PRINT, 'Eigenvectors: '
   FOR mode=0,3 DO PRINT, $
      mode+1, eigenvectors[*,mode],$
      FORMAT='("Mode#",I1,4(F10.4))'
   array_reconstruct = result ## eigenvectors
   PRINT
   PRINT, 'Reconstruction error: ', $
      TOTAL((array_reconstruct - array)^2)
   PRINT
   PRINT, 'Energy conservation: ', TOTAL(array^2),
TOTAL(eigenvalues)*(n-1)
   PRINT
   PRINT, '     Mode   Eigenvalue  PercentVariance'
   FOR mode=0,3 DO PRINT, $
```

```
      mode+1, eigenvalues[mode], variances[mode]*100

END
```

When the above program is compiled and executed, the following output is produced:

```
Result:
 -107.38   13.40   -1.41   -0.03
    3.20    0.70    5.95   -0.02
   32.50   38.66   -3.87    0.01
   40.89   13.79   -4.98   -0.01
 -107.24   19.36    1.77    0.02
   18.43  -17.15   -1.47   -0.00
   99.89   -6.23    0.13    0.02
   45.38    8.11    6.53   -0.01
  -21.31  -18.31    3.75   -0.01
    5.54  -11.17   -4.52    0.02
   83.14    4.97    0.09    0.01
   87.11   -3.16    2.81    0.00
 -101.32  -11.78   -6.12    0.01
  -73.07    6.24    6.61    0.02
 -137.02  -19.10    1.33    0.01
   57.11    6.96    0.84   -0.01
   42.13  -10.07   -2.14    0.01
   83.30  -16.69   -2.72   -0.01
  -54.13    2.56   -4.21   -0.03
    2.84   -1.06    1.62   -0.01

Coefficients:
Mode#1    4.8799    5.0568    1.0282    4.7936
Mode#2    1.0147   -0.9545    3.4885   -0.7743
Mode#3   -0.6183   -0.9554    0.2690    1.5796
Mode#4   -0.0900    0.0752    0.0472    0.0022

Eigenvectors:
Mode#1    0.0665    0.0689    0.0140    0.0653
Mode#2    0.0690   -0.0649    0.2372   -0.0526
Mode#3   -0.1601   -0.2473    0.0697    0.4089
Mode#4   -5.6290    4.7013    2.9540    0.1372

Reconstruction error:  1.44876e-010

Energy conservation:       1748.17      1748.17

     Mode   Eigenvalue  PercentVariance
       1      73.4205      79.7970
       2      14.7099      15.9875
       3      3.86271      4.19818
       4    0.0159915    0.0173803
```

The first two derived variables account for 96% of the total variance of the original data.

## Version History

Introduced: 5.0

## See Also

CORRELATE, EIGENQL

# PLOT

The PLOT procedure draws graphs of vector arguments. If one parameter is used, the vector parameter is plotted on the ordinate versus the point number on the abscissa. To plot one vector as a function of another, use two parameters. PLOT can also be used to create polar plots by setting the POLAR keyword.

## Syntax

PLOT, [*X*,] *Y* [, /ISOTROPIC] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, NSUM=*value*] [, /POLAR] [, THICK=*value*] [, /XLOG] [, /YLOG] [, /YNOZERO]

**Graphics Keywords:** [, BACKGROUND=*color_index*] [, CHARSIZE=*value*] [, CHARTHICK=*integer*] [, CLIP=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, /NODATA] [, /NOERASE] [, POSITION=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, PSYM=*integer*{0 to 10}] [, SUBTITLE=*string*] [, SYMSIZE=*value*] [, /T3D] [, THICK=*value*] [, TICKLEN=*value*] [, TITLE=*string*]
[, {X | Y | Z}CHARSIZE=*value*]
[, {X | Y | Z}GRIDSTYLE=*integer*{0 to 5}]
[, {X | Y | Z}MARGIN=*[left, right]*]
[, {X | Y | Z}MINOR=*integer*]
[, {X | Y | Z}RANGE=*[min, max]*]
[, {X | Y | Z}STYLE=*value*]
[, {X | Y | Z}THICK=*value*]
[, {X | Y | Z}TICK_GET=*variable*]
[, {X | Y | Z}TICKFORMAT=*string*]
[, {X | Y | Z}TICKINTERVAL= *value*]
[, {X | Y | Z}TICKLAYOUT=*scalar*]
[, {X | Y | Z}TICKLEN=*value*]
[, {X | Y | Z}TICKNAME=*string_array*]
[, {X | Y | Z}TICKS=*integer*]
[, {X | Y | Z}TICKUNITS=*string*]
[, {X | Y | Z}TICKV=*array*]
[, {X | Y | Z}TITLE=*string*]
[, ZVALUE=*value*{0 to 1}]

# Arguments

## X

A vector argument. If X is not specified, *Y* is plotted as a function of point number (starting at zero). If both arguments are provided, *Y* is plotted as a function of *X*.

This argument is converted to double precision floating-point before plotting. Plots created with PLOT are limited to the range and precision of double-precision floating-point values.

## Y

The ordinate data to be plotted. This argument is converted to double-precision floating-point before plotting.

# Keywords

## ISOTROPIC

Set this keyword to force the scaling of the X and Y axes to be equal.

**Note**

The X and Y axes will be scaled isotropically and then fit within the rectangle defined by the POSITION keyword; one of the axes may be shortened. See "POSITION" on page 3877 for more information.

## MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## NSUM

The presence of this keyword indicates the number of data points to average when plotting. If NSUM is larger than 1, every group of NSUM points is averaged to produce one plotted point. If there are *m* data points, then *m*/NSUM points are displayed. On logarithmic axes a geometric average is performed.

It is convenient to use NSUM when there is an extremely large number of data points to plot because it plots fewer points, the graph is less cluttered, and it is quicker.

## POLAR

Set this keyword to produce polar plots. The *X* and *Y* vector parameters, both of which must be present, are first converted from polar to Cartesian coordinates. The first parameter is the radius, and the second is the angle (expressed in radians). For example, to make a polar plot, you would use a command such as:

```
PLOT, /POLAR, R, THETA
```

## THICK

Controls the thickness of the lines connecting the points. A thickness of 1.0 is normal, 2 is double wide, etc.

## XLOG

Set this keyword to specify a logarithmic X axis, producing a log-linear plot. Set both XLOG and YLOG to produce a log-log plot. Note that logarithmic axes that have ranges of less than a decade are not labeled.

## YNOZERO

Set this keyword to inhibit setting the minimum Y axis value to zero when the *Y* data are all positive and nonzero, and no explicit minimum Y value is specified (using YRANGE, or !Y.RANGE). By default, the Y axis spans the range of 0 to the maximum value of *Y*, in the case of positive Y data. Set bit 4 in !Y.STYLE to make this option the default.

## YLOG

Set this keyword to specify a logarithmic Y axis, producing a linear-log plot. Set both XLOG and YLOG to produce a log-log plot. Note that logarithmic axes that have ranges of less than a decade are not labeled.

### Graphics Keywords Accepted

See Appendix B, “Graphics Keywords”, for the description of graphics and plotting keywords not listed above. BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, FONT, LINESTYLE, NOCLIP, NODATA, NOERASE, NORMAL, POSITION, PSYM, SUBTITLE, SYMSIZE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

## Examples

The PLOT procedure has many keywords that allow you to create a vast variety of plots. Here are a few simple examples using the PLOT command.

```
; Create a simple dataset:
D = FINDGEN(100)

; Create a simple plot with the title "Simple Plot":
PLOT, D, TITLE = 'Simple Plot'

; Plot one argument versus another:
PLOT, SIN(D/3), COS(D/6)

; Create a polar plot:
PLOT, D, D, /POLAR, TITLE = 'Polar Plot'

; Use plotting symbols instead of connecting lines by including the
; PSYM keyword. Label the X and Y axes with XTITLE and YTITLE:
PLOT, SIN(D/10), PSYM=4, XTITLE='X Axis', YTITLE='Y Axis'
```

## Version History

Introduced: Original

## See Also

IPLOT, OPLOT, PLOTS

# PLOT_3DBOX

The PLOT_3DBOX procedure plots a function of two variables (e.g., *Z=f(X, Y)*) inside a 3-D box. Optionally, the data can be projected onto the “walls” surrounding the plot area.

This routine is written in the IDL language. Its source code can be found in the file `plot_3dbox.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PLOT_3DBOX, *X*, *Y*, *Z* [, GRIDSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, PSYM=*integer*{1 to 10}] [, /SOLID_WALLS] [, /XY_PLANE] [, XYSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /XZ_PLANE] [, XZSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /YZ_PLANE] [, YZSTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, AX=*degrees*] [, AZ=*degrees*] [, ZAXIS={1 | 2 | 3 | 4}]

**Graphics Keywords:** Accepts all graphics keywords accepted by PLOT except for: FONT, PSYM, SYMSIZE, {XYZ}TICK_GET, and ZVALUE.

## Arguments

### X

A vector (i.e., a one-dimensional array) of X coordinates.

### Y

A vector of Y coordinates.

### Z

A vector of Z coordinates. *Z[i]* is a function of *X[i]* and *Y[i]*.

# Keywords

## GRIDSTYLE

Set this keyword to the linestyle index for the type of line to be used when drawing the gridlines. Linestyles are described in the following table:

| Index | Linestyle |
|---|---|
| 0 | Solid |
| 1 | Dotted |
| 2 | Dashed |
| 3 | Dash Dot |
| 4 | Dash Dot Dot |
| 5 | Long Dashes |

*Table 75: IDL Linestyles*

## PSYM

Set this keyword to a plotting symbol index to be used in plotting the data. For more information, see “PSYM” on page 3878.

## SOLID_WALLS

Set this keyword to cause the boundary “walls” of the plot to be filled with the color index specified by the COLOR keyword.

## XY_PLANE

Set this keyword to plot the *X* and *Y* values on the Z=0 axis plane.

## XYSTYLE

Set this keyword to the linestyle used to draw the XY plane plot. See the table above for a list of linestyles.

## XZ_PLANE

Set this keyword to plot the *Y* and *Z* values on the Y=MAX(*Y*) axis plane.

### XZSTYLE

Set this keyword to the linestyle used to draw the XZ plane plot. See the table above for a list of linestyles.

### YZ_PLANE

Set this keyword to plot the *Y* and *Z* values on the X=MAX(*X*) axis plane.

### YZSTYLE

Set this keyword to the linestyle used to draw the YZ plane plot. See the table above for a list of linestyles.

### SURFACE Keywords

In addition to the keywords described above, the AX, AZ, and ZAXIS keywords to the SURFACE procedure are accepted by PLOT_3DBOX. See "SURFACE" on page 1934.

### Graphics Keywords Accepted

See Appendix B, "Graphics Keywords", for the description of graphics and plotting keywords not listed above. BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NOERASE, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKV, [XYZ]TITLE.

## Examples

```
; Create some data to be plotted:
X = REPLICATE(5., 10.)
X1 = COS(FINDGEN(36)*10.*!DTOR)*2.+5.
X = [X, X1, X]
Y = FINDGEN(56)
Z = REPLICATE(5., 10)
Z1 = SIN(FINDGEN(36)*10.*!DTOR)*2.+5.
Z = [Z, Z1, Z]

; Create the box plot with data projected on all of the walls. The
; PSYM value of -4 plots the data as diamonds connected by lines:
PLOT_3DBOX, X, Y, Z, /XY_PLANE, /YZ_PLANE, /XZ_PLANE, $
   /SOLID_WALLS, GRIDSTYLE=1, XYSTYLE=3, XZSTYLE=4, $
   YZSTYLE=5, AZ=40, TITLE='Example Plot Box', $
```

```
XTITLE='X Coordinate', YTITLE='Y Coodinate', $
ZTITLE='Z Coordinate', SUBTITLE='Sub Title', $
/YSTYLE, ZRANGE=[0,10], XRANGE=[0,10], $
PSYM=-4, CHARSIZE=1.6
```

## Version History

Introduced: Pre 4.0

## See Also

IPLOT, PLOTS, SURFACE

# PLOT_FIELD

The PLOT_FIELD procedure plots a 2-D field. *N* random points are picked, and from each point a path is traced along the field. The length of the path is proportional to the field vector magnitude.

This routine is written in the IDL language. Its source code can be found in the file `plot_field.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PLOT_FIELD, *U*, *V* [, ASPECT=*ratio*] [, LENGTH=*value*] [, N=*num_arrows*] [, TITLE=*string*]

## Arguments

### U

A 2-D array giving the field vector at each point in the U(X) direction.

### V

A 2-D array giving the field vector at each point in the V(Y) direction.

## Keywords

### ASPECT

Set this keyword to the aspect ratio of the plot (i.e., the ratio of the X size to Y size). The default is 1.0.

### LENGTH

Set this keyword to the length of the longest field vector expressed as a fraction of the plotting area. The default is 0.1.

### N

Set this keyword to the number of arrows to draw. The default is 200.

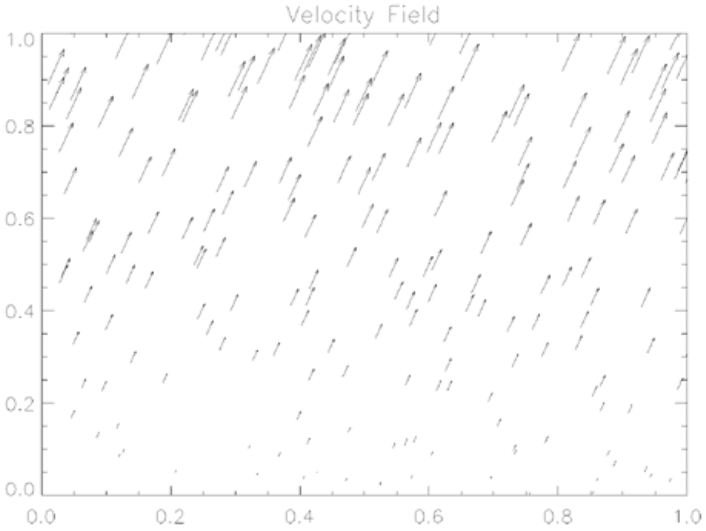
### TITLE

Set this keyword to the title of plot. The default is “Velocity Field”.

## Examples

```
; Create array X:
X = FINDGEN(20, 20)

; Create array Y:
Y = FINDGEN(20, 20)*3

; Plot X vs. Y:
PLOT_FIELD, X, Y
```

The above commands produce the following plot:




## Version History

Introduced: Original

## See Also

FLOW3, VEL, VELOVECT

# PLOTERR

The PLOTERR procedure plots individual data points with error bars.

This routine is written in the IDL language. Its source code can be found in the file `ploterr.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PLOTERR, [ *X* ,] *Y* , *Err* [, TYPE={1 | 2 | 3 | 4}] [, PSYM=*integer*{1 to 10}]

## Arguments

### X

An optional array of X values. The procedure checks the number of arguments passed to decide if X was passed. If X is not passed, INDGEN(Y) is assumed for X values.

### Y

The array of Y values. *Y* cannot be of type string.

### Err

The array of error-bar values.

## Keywords

### TYPE

The type of plot to be produced. The possible types are:

- 1 = X Linear - Y Linear (default)
- 2 = X Linear - Y Log
- 3 = X Log - Y Linear
- 4 = X Log - Y Log

### PSYM

The plotting symbol to use. The default is +7.

## Version History

Introduced: Original

## See Also

ERRPLOT, IPLOT, OPLOTERR, PLOT

# PLOTS

The PLOTS procedure plots vectors or points on the current graphics device in either two or three dimensions. The coordinates can be given in data, device, or normalized form using the DATA (the default), DEVICE, or NORMAL keywords.

The COLOR keyword can be set to a scalar or vector value. If it is set to a vector value, the line segment connecting $(X_i, Y_i)$ to $(X_{i+1}, Y_{i+1})$ is drawn with a color index of $COLOR_{i+1}$. In this case, COLOR must have the same number of elements as *X* and *Y*.

## Syntax

PLOTS, *X* [, *Y* [, *Z*]] [, /CONTINUE]

**Graphics Keywords:** [, CLIP=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, PSYM=*integer*{0 to 10}] [, SYMSIZE=*value*] [, /T3D] [, THICK=*value*] [, Z=*value*]

## Arguments

### X

A vector or scalar argument providing the X components of the points to be connected. If only one argument is specified, *X* must be an array of either two or three vectors (i.e., `(2,*)` or `(3,*)`). In this special case, `X[0,*]` are taken as the X values, `X[1,*]` are taken as the Y values, and `X[2,*]` are taken as the Z values.

### Y

An optional argument providing the Y coordinate(s) of the points to be connected.

### Z

An optional argument providing the Z coordinates of the points to be connected. If *Z* is not provided, X and Y are used to draw lines in two dimensions.

*Z* has no effect if the keyword T3D is not specified and the system variable !P.T3D= 0.

# Keywords

## CONTINUE

Set this keyword to continue drawing a line from the last point of the most recent call to PLOTS.

For example:

```
; Position at (0,0):
PLOTS, 0, 0

; Draws vector from (0,0) to (1,1):
PLOTS, 1, 1, /CONTINUE

; Draws two vectors from (1,1) to (2,2) to (3,3):
PLOTS, [2,3], [2,3], /CONTINUE
```

## Graphics Keywords Accepted

See Appendix B, “Graphics Keywords”, for the description of graphics and plotting keywords not listed above. CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NORMAL, PSYM, SYMSIZE, T3D, THICK, Z.

# Examples

```
; Draw a line from (100, 200) to (600, 700), in device coordinates,
; using color index 12:
PLOTS, [100,600], [200,700], COLOR=12, /DEVICE

; Draw a polyline where the line color is proportional to the
; ordinate that ends each line segment.
; First create datasets X and Y:
X = SIN(FINDGEN(100)) & Y = COS(FINDGEN(100))

; Now plot X and Y in normalized coordinates with colors as
; described above:
PLOTS, X, Y, COLOR = BYTSCL(Y, TOP=!D.N COLORS-1), /NORMAL

; Load a good colortable to better show the result:
LOADCT, 13

; Draw 3-D vectors over an established SURFACE plot.
; The SAVE keyword tells IDL to save the 3-D transformation
; established by SURFACE.
SURFACE, DIST(5), /SAVE
```

```
; Draw a line between (0,0,0) and (3,3,3). The T3D keyword makes
; PLOTS use the previously established 3-D transformation:
PLOTS, [0,3], [0,3], [0,3], /T3D

; Draw a line between (3,0,0) and (3,3,3):
PLOTS, [3,3], [0,3], [0,3], /T3D

; Draw a line between (0,3,0) and (3,3,3):
PLOTS, [0,3], [3,3], [0,3], /T3D
```

## Version History

Introduced: Original

## See Also

ANNOTATE, IPLOT, XYOUTS

# PNT_LINE

The PNT_LINE function computes the perpendicular distance between a point *P0* and a line between points *L0* and *L1*. This function is limited by the machine accuracy of single precision floating point.

This routine is written in the IDL language. Its source code can be found in the file `pnt_line.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = PNT_LINE( *P0*, *L0*, *L1* [, *Pl*] [, /INTERVAL] )

## Return Value

Returns the perpendicular distance.

## Arguments

### P0

The location of the point. *P0* may have 2 to *n* elements, for *n* dimensions.

### L0

One end-point of the line. *L0* must have same number of elements as *P0*.

### L1

The other end-point of the line. *L1* must have the same number of elements as *L0*.

### Pl

A named variable that will contain the location of the point on the line between *L0* and *L1* that is closest to *P0*. *Pl* is not necessarily in the interval (*L0*, *L1*).

## Keywords

### INTERVAL

If set, and if the point on the line between *L0* and *L1* that is closest to *P0* is not within the interval (*L0*, *L1*), PNT_LINE will return the distance from *P0* to the closer of the two endpoints *L0* and *L1*.

## Examples

To print the distance between the point (2,3) and the line from (-3,3) to (5,12), and also the location of the point on the line closest to (2,3), enter the following command:

```
PRINT, PNT_LINE([2,3], [-3,3], [5,12], Pl), Pl
```

IDL prints:

```
3.73705    -0.793104      5.48276
```

## Version History

Introduced: Pre 4.0

## See Also

CIR_3PNT, SPH_4PNT

# POINT_LUN

The POINT_LUN procedure sets or obtains the current position of the file pointer for the specified file.

**Note**

POINT_LUN cannot be used with files opened with the RAWIO keyword to the OPEN routines. Depending upon the device in question, the IOCTL function might be used instead for files of this type.

### Use Of POINT_LUN On Compressed Files

In general, it is not possible to arbitrarily move the file pointer within a compressed file (files opened with the COMPRESS keyword to OPEN) because the file compression code needs to maintain a compression state for the file that includes all the data that has already been passed in the stream. This limitation results in the following constraints on the use of POINT_LUN with compressed files:

- POINT_LUN is not allowed on compressed files open for output, except to positions beyond the current file position. The compression code emulates such motion by outputting enough zero bytes to move the pointer to the new position.
- POINT_LUN is allowed to arbitrary positions on compressed files opened for input. However, this feature is emulated by positioning the file to the beginning of the file and then reading and discarding enough data to move the file pointer to the desired position. This can be extremely slow.

For these reasons, use of POINT_LUN on compressed files, although possible under some circumstances, is best avoided.

## Syntax

POINT_LUN, *Unit*, *Position*

## Arguments

### Unit

The file unit for the file in question. If *Unit* is positive, POINT_LUN sets the file position to the position given by *Position*. If negative, POINT_LUN gets the current

file position and assigns it to the variable given by *Position*. Note that POINT_LUN cannot be used with the 3 standard file units (0, -1, and -2).

### Position

If *Unit* is positive, *Position* gives the byte offset into the file at which the file pointer should be set. For example, to rewind the file to the beginning, specify 0.

If *Unit* is negative, *Position* must be a named variable into which the current file position will be stored. The returned type will be a longword signed integer if the position is small enough to fit, and an unsigned 64-bit integer otherwise.

## Keywords

None.

## Examples

To move the file pointer 2048 bytes into the file associated with file unit number 1, enter:

```
POINT_LUN, 1, 2048
```

To return the file pointer for file unit number 2, enter:

```
POINT_LUN, -2, pos
```

## Version History

Introduced: Original

## See Also

GET_LUN, OPEN, TRUNCATE_LUN

# POLAR_CONTOUR

The POLAR_CONTOUR procedure draws a contour plot from data in polar coordinates. Data can be regularly- or irregularly-gridded. All of the keyword options supported by CONTOUR are available to POLAR_CONTOUR.

This routine is written in the IDL language. Its source code can be found in the file `polar_contour.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

POLAR_CONTOUR, *Z*, *Theta*, *R* [, C_ANNOTATION=*vector_of_strings*] [, C_CHARSIZE=*value*] [, C_CHARTHICK=*integer*] [, C_COLORS=*vector*] [, C_LINESTYLE=*vector*] [, /FILL | , CELL_FILL [, C_ORIENTATION=*degrees*] [, C_SPACING=*value*]] [, C_THICK=*vector*] [, /CLOSED] [, /IRREGULAR] [, LEVELS=*vector* | NLEVELS=*integer*{1 to 29}] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, /OVERPLOT] [, /PATH_DATA_COORDS | ,TRIANGULATION=*variable*] [, /XLOG] [, /YLOG] [, /ZAXIS] [, SHOW_TRIANGULATION=*color_index*]

## Arguments

### Z

The data values to be contoured. If the data is regularly gridded, *Z* must have the dimensions (N_ELEMENTS(*Theta*), N_ELEMENTS(*R*). Note that the ordering of the elements in the array *Z* is opposite that used by the POLAR_SURFACE routine.

### Theta

A vector of angles in radians. For regularly-gridded data, *Theta* must have the same number of elements as the first dimension of *Z*. For a scattered grid, *Theta* must have the same number of elements as *Z*.

### R

A vector of radius values. For regularly-gridded data, *R* must have the same number of elements as the second dimension of *Z*. For a scattered grid, *R* must have the same number of elements as *Z*.

# Keywords

POLAR_CONTOUR accepts all of the keywords accepted by the CONTOUR routine except C_LABELS, DOWNHILL, FOLLOW, PATH_FILENAME, PATH_INFO, and PATH_XY. See “CONTOUR” on page 292. In addition, there is one unique keyword:

## SHOW_TRIANGULATION

Set this keyword to a color index to be used in overplotting the triangulation between datapoints.

# Examples

This example uses POLAR_CONTOUR with regularly-gridded data:

```
;Handle TrueColor displays:
DEVICE, DECOMPOSED=0

;Load color table
TEK_COLOR

nr = 12 ; number of radii
nt = 18 ; number of Thetas

; Create a vector of radii:
r = FINDGEN(nr)/(nr-1)

; Create a vector of Thetas:
theta = 2*!PI * FINDGEN(nt)/(nt-1)

; Create some data values to be contoured:
z = COS(theta*3) # (r-0.5)^2

; Create the polar contour plot:
POLAR_CONTOUR, z, theta, r, /FILL, c_color=[2, 3, 4, 5]
```

# Version History

Introduced: 4.0

# See Also

CONTOUR

# POLAR_SURFACE

The POLAR_SURFACE function interpolates a surface from polar coordinates (R, Theta, Z) to rectangular coordinates (X, Y, Z).

This routine is written in the IDL language. Its source code can be found in the file `polar_surface.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = POLAR_SURFACE( *Z*, *R*, *Theta* [, /GRID] [, SPACING=*[xspacing*, *yspacing]*] [, BOUNDS=*[*$x_0$, $y_0$, $x_1$, $y_1$*]*] [, /QUINTIC] [, MISSING=*value*] )

## Return Value

The function returns a two-dimensional array of the same type as Z.

## Arguments

### Z

An array containing the surface value at each point. If the data are regularly gridded in *R* and *Theta*, *Z* is a two dimensional array, where *Zi,j* has a radius of *Ri* and an azimuth of *Thetaj*. If the data are irregularly-gridded, *Ri* and *Thetai* contain the radius and azimuth of each *Zi*. Note that the ordering of the elements in the array *Z* is opposite that used by the POLAR_CONTOUR routine.

### R

The radius. If the data are regularly gridded in *R* and *Theta*, *Zi,j* has a radius of *Ri*. If the data are irregularly-gridded, *R* must have the same number of elements as *Z*, and contains the radius of each point.

### Theta

The azimuth, in radians. If the data are regularly gridded in *R* and *Theta*, *Zi,j* has an azimuth of *Thetaj*. If the data are irregularly-gridded, *Theta* must have the same number of elements as *Z*, and contains the azimuth of each point.

# Keywords

## GRID

Set this keyword to indicate that *Z* is regularly gridded in *R* and *Theta*.

## SPACING

A two element vector containing the desired grid spacing of the resulting array in *x* and *y*. If omitted, the grid will be approximately 51 by 51.

## BOUNDS

A four element vector, $[x_0, y_0, x_1, y_1]$, containing the limits of the *xy* grid of the resulting array. If omitted, the extent of input data sets the limits of the grid.

## QUINTIC

Set this keyword to use quintic interpolation, which is slower but smoother than the default linear interpolation.

## MISSING

Use this keyword to specify a value to use for areas within the grid but not within the convex hull of the data points. The default is 0.0.

# Examples

```
; The radius:
R = FINDGEN(50) / 50.0

; Theta:
THETA = FINDGEN(50) * (2 * !PI / 50.0)

; Make a function (tilted circle):
Z = R # SIN(THETA)

; Show it:
SURFACE, POLAR_SURFACE(Z, R, THETA, /GRID)
```

# Version History

Introduced: Pre 4.0

## See Also

POLAR keyword to PLOT

# POLY

The POLY function evaluates a polynomial function of a variable.

This routine is written in the IDL language. Its source code can be found in the file `poly.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = POLY(*X*, *C*)

## Return Value

The result is equal to:

$$C_0 + C_1x + C_2x^2 + ...$$

## Arguments

### X

The variable. This value can be a scalar, vector or array.

### C

The vector of polynomial coefficients. The degree of the polynomial is N_ELEMENTS(*C*) - 1.

## Keywords

None.

## Version History

Introduced: Original

## See Also

FZ_ROOTS

# POLY_2D

The POLY_2D function performs polynomial warping of images. This function performs a geometrical transformation in which the resulting array is defined by:

$$g\,[x, y] = f\,[x', y'] = f\,[a\,[x, y], b\,[x, y]]$$

where $g[x, y]$ represents the pixel in the output image at coordinate $(x, y)$, and $f\,[x', y']$ is the pixel at $(x', y')$ in the input image that is used to derive $g[x, y]$. The functions $a\,(x, y)$ and $b\,(x, y)$ are polynomials in $x$ and $y$ of degree $N$, whose coefficients are given by $P$ and $Q$, and specify the spatial transformation:

$$x' = a(x, y) = \sum_{i=0}^{N} \sum_{j=0}^{N} P_{i,j} x^j y^i$$

$$y' = b(x, y) = \sum_{i=0}^{N} \sum_{j=0}^{N} Q_{i,j} x^j y^i$$

Either the nearest neighbor or bilinear interpolation methods can be selected.

## Syntax

*Result* = POLY_2D( *Array, P, Q* [, *Interp* [, $Dim_x$, $Dim_y$]] [, CUBIC={-1 to 0}] [, MISSING=*value*] )

## Arguments

### Array

A two-dimensional array of any basic type except string. The result has the same type as *Array.*

### P and Q

*P* and *Q* are arrays containing the polynomial coefficients. Each array must contain $(N+1)^2$ elements (where *N* is the degree of the polynomial). For example, for a linear transformation, *P* and *Q* contain four elements and can be a 2 x 2 array or a 4-element vector. $P_{i,j}$ contains the coefficient used to determine *x'*, and is the weight of the term $x^j y^i$. The POLYWARP procedure can be used to fit *(x', y')* as a function of *(x, y)* and determines the coefficient arrays *P* and *Q*.

### Interp

Set this argument to 1 to perform bilinear interpolation. Set this argument to 2 to perform cubic convolution interpolation (as described under the CUBIC keyword, below). Otherwise, the nearest neighbor method is used. For the linear case, (*N*=1), bilinear interpolation requires approximately twice as much time as does the nearest neighbor method.

### $Dim_x$

If present, $Dim_x$ specifies the number of columns in the output. If omitted, the output has the same number of columns as *Array.*

### $Dim_y$

If present, $Dim_y$ specifies the number of rows in the output. If omitted, the output has the same number of rows as *Array.*

## Keywords

### CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm. Note that cubic convolution interpolation works only with one- and two-dimensional arrays.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than $\omega_0$, and *f* is sampled with spacing less than or equal to $1/2\omega_0$,

then *f* can be reconstructed by convolving with a sinc function: sinc (*x*) = sin (π*x*) / (π*x*).

In the one-dimensional case, four neighboring points are used, while in the two-dimensional case 16 points are used. Note that cubic convolution interpolation is significantly slower than bilinear interpolation.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

### MISSING

Specifies the output value for points whose *x’*, *y’* is outside the bounds of *Array*. If MISSING is not specified, the resulting output value is extrapolated from the nearest pixel of *Array*.

### Thread Pool Keywords

This routine is written to make use of IDL’s *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords” for details.

## Examples

Some simple linear (degree one) transformations are:

| $P_{0,0}$ | $P_{1,0}$ | $P_{0,1}$ | $P_{1,1}$ | $Q_{0,0}$ | $Q_{1,0}$ | $Q_{0,1}$ | $Q_{1,1}$ | Effect |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | Identity |
| 0 | 0 | 0.5 | 0 | 0 | 1 | 0 | 0 | Stretch X by a factor of 2 |
| 0 | 0 | 1 | 0 | 0 | 2.0 | 0 | 0 | Shrink Y by a factor of 2 |

*Table 76: Simple Transformations for Use with POLY_2D*

| $P_{0,0}$ | $P_{1,0}$ | $P_{0,1}$ | $P_{1,1}$ | $Q_{0,0}$ | $Q_{1,0}$ | $Q_{0,1}$ | $Q_{1,1}$ | Effect |
|---|---|---|---|---|---|---|---|---|
| z | 0 | 1 | 0 | 0 | 1 | 0 | 0 | Shift left by z pixels |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | Transpose |

*Table 76: Simple Transformations for Use with POLY_2D*

POLY_2D is often used in conjunction with the POLYWARP procedure to warp images.

```
; Create and display a simple image:
A = BYTSCL(SIN(DIST(250)), TOP=!D.TABLE_SIZE) & TV, A

; Set up the arrays of original points to be warped:
XO = [61, 62, 143, 133]
YO = [89, 34, 38, 105]

; Set up the arrays of points to be fit:
XI = [24, 35, 102, 92]
YI = [81, 24, 25, 92]

; Use POLYWARP to generate the P and Q inputs to POLY_2D:
POLYWARP, XI, YI, XO, YO, 1, P, Q

; Perform an image warping based on P and Q:
B = POLY_2D(A, P, Q)

; Display the new image:
TV, B, 250, 250
```

Images can also be warped over irregularly gridded control points using the WARP_TRI procedure.

## Version History

Introduced: Original

## See Also

POLYWARP

# POLY_AREA

The POLY_AREA function returns the area of a polygon given the coordinates of its vertices.

It is assumed that the polygon has *n* vertices with *n* sides and the edges connect the vertices in the order:

[(x1,y1), (x2,y2), ... , (x*n*,y*n*), (x1,y1)]

such that the last vertex is connected to the first vertex.

This routine is written in the IDL language. Its source code can be found in the file `poly_area.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = POLY_AREA( *X*, *Y* [, /DOUBLE] [, /SIGNED] )

## Return Value

If either of the input arguments is double-precision or if the DOUBLE keyword is set, the result is a double-precision value, otherwise, the result is single-precision.

## Arguments

### X

An *n*-element vector of X coordinate locations for the vertices.

### Y

An *n*-element vector of Y coordinate locations for the vertices.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision result. Explicitly set DOUBLE=0 to use single-precision for computations and to return a single-precision result. By default, if either of the arguments to POLY_AREA is double-precision, computations are done in double-precision; if both arguments are single-precision, computations are done in single-precision.

### SIGNED

If set, returns a signed area. Polygons with edges traversed in counterclockwise order have a positive area; polygons traversed in the clockwise order have a negative area.

## Version History

Introduced: Original

## See Also

DEFROI, POLYFILLV

# POLY_FIT

The POLY_FIT function performs a least-square polynomial fit with optional weighting and returns a vector of coefficients.

The POLY_FIT routine uses matrix inversion to determine the coefficients. A different version of this routine, SVDFIT, uses singular value decomposition (SVD). The SVD technique is more flexible and robust, but may be slower.

This routine is written in the IDL language. Its source code can be found in the file `poly_fit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = POLY_FIT( *X*, *Y*, *Degree* [, CHISQ=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*] [, STATUS=*variable*] [, YBAND=*variable*] [, YERROR=*variable*] [, YFIT=*variable*] )

## Return Value

POLY_FIT returns a vector of coefficients of length *Degree*+1. If the DOUBLE keyword is set, or if *X* or *Y* are double precision, then the result will be double precision, otherwise the result will be single precision.

## Arguments

### X

An *n*-element vector of independent variables.

### Y

A vector of dependent variables, the same length as *X*.

### Degree

The degree of the polynomial to fit.

### Yfit, Yband, Sigma, Corrm

*The Yfit, Yband, Sigma, and Corrm arguments are obsolete, and have been replaced by the YFIT, YBAND, YERROR, and COVAR keywords, respectively. Code using these*

*arguments will continue to work as before, but new code should use the keywords instead.*

# Keywords

## CHISQ

Set this keyword to a named variable that will contain the value of the chi-square goodness-of-fit.

## COVAR

Set this keyword to a named variable that will contain the Covariance matrix of the coefficients.

**Note**

The COVAR matrix depends only upon the independent variable X and (optionally) the MEASURE_ERRORS. The values do not depend upon Y. See section 15.4 of *Numerical Recipes in C* (Second Edition) for details.

## DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic. All computations are performed using double-precision arithmetic.

## MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

**Note**

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(*Y*).

## SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters.

**Note**

If MEASURE_ERRORS is omitted, then you are assuming that a polynomial is the correct model for your data, and therefore, no independent goodness-of-fit test is

possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

## STATUS

Set this keyword to a named variable to receive the status of the operation. Possible status values are:

- 0 = Successful completion.
- 1 = Singular array (which indicates that the inversion is invalid). *Result* is NaN.
- 2 = Warning that a small pivot element was used and that significant accuracy was probably lost.
- 3 = Undefined (NaN) error estimate was encountered.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

**Tip**

Status values of 2 or 3 can often be resolved by setting the DOUBLE keyword.

## YBAND

Set this keyword to a named variable that will contain the 1 standard deviation error estimate for each point.

## YERROR

Set this keyword to a named variable that will contain the standard error between YFIT and Y.

## YFIT

Set this keyword to a named variable that will contain the vector of calculated *Y* values. These values have an error of + or – YBAND.

## Examples

In this example, we use X and Y data corresponding to the known polynomial $f(x) = 0.25 - x + x^2$. Using POLY_FIT to compute a second degree polynomial fit returns the exact coefficients (to within machine accuracy).

```
; Define an 11-element vector of independent variable data:
X = [0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0]

; Define an 11-element vector of dependent variable data:
Y = [0.25, 0.16, 0.09, 0.04, 0.01, 0.00, 0.01, 0.04, 0.09, $
   0.16, 0.25]

; Define a vector of measurement errors:
measure_errors = REPLICATE(0.01, 11)

; Compute the second degree polynomial fit to the data:
result = POLY_FIT(X, Y, 2, MEASURE_ERRORS=measure_errors, $
   SIGMA=sigma)

; Print the coefficients:
PRINT, 'Coefficients: ', result
PRINT, 'Standard errors: ', sigma
```

IDL prints:

```
Coefficients:    0.250000    -1.00000    1.00000
Standard errors:    0.00761853    0.0354459    0.0341395
```

## Version History

Introduced: Original

## See Also

COMFIT, CURVEFIT, GAUSSFIT, LINFIT, REGRESS, SFIT, SVDFIT

# POLYFILL

The POLYFILL procedure fills the interior of a region of the display enclosed by an arbitrary two or three-dimensional polygon. The available filling methods are: solid fill, parallel lines, or a pattern contained in an array. Not all methods are available on every hardware output device. See “Fill Methods” below.

**Note**

POLYFILL uses the current graphics device’s own polygon filling methodology when possible. For some devices, polygon filling is designed to avoid filling a given pixel more than once when neighboring polygons (that is, polygons with shared edges) are drawn. If the resulting pixel fill from POLYFILL is unsatisfactory, consider using DRAW_ROI instead.

The polygon is defined by a list of connected vertices stored in X, Y, and Z. The coordinates can be given in data, device, or normalized form using the DATA, DEVICE, or NORMAL keywords.

## Fill Methods

Line-fill method: Filling using parallel lines is device-independent and works on all devices that can draw lines. Crosshatching can be simulated by performing multiple fills with different orientations. The spacing, linestyle, orientation, and thickness of the filling lines can be specified using the corresponding keyword parameters. The LINE_FILL keyword selects this filling style, but is not required if either the ORIENTATION or SPACING parameters are present.

Solid fill method: By default, POLYFILL fills the polygon with a solid color. For devices that do not directly support filling with a solid color, the solid fill is automatically emulated using the line-fill method.

Patterned fill: Some output devices support filling with a pattern. For these devices, the fill pattern array can be explicitly specified with the PATTERN keyword. Refer to the description of that keyword for a list of devices that support patterned fill.

# Syntax

POLYFILL, *X* [, *Y* [, *Z*]] [, IMAGE_COORD=*array*] [, /IMAGE_INTERP]
[, /LINE_FILL] [, PATTERN=*array*] [, SPACING=*centimeters*]
[, TRANSPARENT=*value*]

**Graphics Keywords:** [, CLIP=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, ORIENTATION=*ccw_degrees_from_horiz*] [, /T3D] [, THICK=*value*] [, Z=*value*]

# Arguments

## X

A vector argument providing the X coordinates of the points to be connected. The vector must contain at least three elements. If only one argument is specified, *X* must be an array of either two or three vectors (i.e., `(2,*)` or `(3,*)`). In this special case, the vector `X[0,*]` specifies the X values, `X[1,*]` specifies Y, and `X[2,*]` contain the Z values.

## Y

A vector argument providing the Y coordinates of the points to be connected. *Y* must contain at least three elements.

## Z

An optional vector argument providing the Z coordinates of the points to be connected. If Z is not provided, X and Y are used to draw lines in two dimensions. Z must contain at least three elements. Z has no effect if the keyword T3D is not specified and the system variable !P.T3D= 0.

# Keywords

## IMAGE_COORD (Z-Buffer Output Only)

A 2 x *n* array containing the fill pattern array subscripts of each of the *n* polygon vertices. Use this keyword in conjunction with the PATTERN keyword to warp images over 2-D and 3-D polygons.

## IMAGE_INTERP (Z-Buffer Output Only)

Specifies the method of sampling the PATTERN array when the IMAGE_COORD keyword is present. The default method is to use nearest-neighbor sampling. Bilinear interpolation sampling is performed if IMAGE_INTERP is set.

## LINE_FILL

Set this keyword to indicate that polygons are to be filled with parallel lines, rather than using solid or patterned filling methods.When using the line-drawing method of

filling, the thickness, linestyle, orientation, and spacing of the lines may be specified with keywords.

## PATTERN

A rectangular array of pixels giving the fill pattern. If this keyword parameter is omitted, POLYFILL fills the area with a solid color. The pattern array may be of any size; if it is smaller than the filled area the pattern array is cyclically repeated.

**Note**

This keyword is supported for the following devices:

METAFILE, PRINTER (Unix & Windows only), PS, WIN, X, and Z.

For the PostScript device, fill patterns are only supported with language level 2. Use the LANGUAGE_LEVEL keyword to DEVICE to set the PostScript language level to 2 if filled patterns are to be used. On Windows98, the pattern size is limited to 8x8.

For example, to fill the current plot window with a grid of dots, enter the following commands:

```
; Define pattern array as 10 by 10:
PAT = BYTARR(10,10)

; Set center pixel to bright:
PAT[5,5] = 255

; Fill the rectangle defined by the four corners of the window with
; the pattern:
POLYFILL, !X.WINDOW([0,1,1,0]), $
          !Y.WINDOW([0,0,1,1]), /NORM, PAT = PAT
```

## SPACING

The spacing, in centimeters, between the parallel lines used to fill polygons.

## TRANSPARENT (Z-Buffer output only)

Specifies the minimum pixel value to draw in conjunction with the PATTERN and IMAGE_COORD keywords. Pixels less than this value are not drawn and the Z-buffer is not updated.

### Graphics Keywords Accepted

See Appendix B, “Graphics Keywords”, for the description of graphics and plotting keywords not listed above. CLIP, COLOR, DATA, DEVICE, LINESTYLE, NOCLIP, NORMAL, ORIENTATION, T3D, THICK, Z.

### Z-Buffer-Specific Keywords

Certain keyword parameters are only active when the Z-buffer is the currently selected graphics device: IMAGE_COORD, IMAGE_INTERP, TRANSPARENT and COLOR. These parameters allow images to be warped over 2-D or 3-D polygons, and the output of shaded polygons. See “The Z-Buffer Device” in Appendix A.

For shaded polygons, the COLOR keyword can specify an array that contains the color index at each vertex. Color indices are linearly interpolated between vertices. If COLOR contains a scalar, the entire polygon is drawn with the given color index, just as with the other graphics output devices.

Images can be warped over polygons by passing in the image with the PATTERN parameter, and a (2, *n*) array containing the image space coordinates that correspond to each of the N vertices with the IMAGE_COORD keyword.

The IMAGE_INTERP keyword indicates that bilinear interpolation is to be used, rather than the default nearest-neighbor sampling. Pixels less than the value of TRANSPARENT are not drawn, simulating transparency.

## Examples

Fill a rectangular polygon that has the vertices (30,30), (100, 30), (100, 100), and (30, 100) in device coordinates:

```
; Create the vectors of X and Y values:
X = [30, 100, 100, 30] & Y = [30, 30, 100, 100]

; Fill the polygon with color index 175:
POLYFILL, X, Y, COLOR = 175, /DEVICE
```

## Version History

Introduced: Original

## See Also

POLYFILLV

# POLYFILLV

The POLYFILLV function returns a vector containing the subscripts of the array elements contained inside a polygon defined by vectors.

The *X* and *Y* parameters are vectors that contain the subscripts of the vertices that define the polygon in the coordinate system of the two-dimensional $S_x$ by $S_y$ array. The $S_x$ and $S_y$ parameters define the number of columns and rows in the array enclosing the polygon. At least three points must be specified, and all points should lie within the limits: $0 \le X_i < S_x$ and $0 \le Y_i < S_y$ for all *i*.

As with the POLYFILL procedure, the polygon is defined by connecting each point with its successor and the last point with the first. This function is useful for defining, analyzing, and displaying regions of interest within a two-dimensional array.

The scan line coordinate system defined by Rogers in *Procedural Elements for Computer Graphics*, McGraw-Hill, 1985, page 71, is used. In this system, the scan lines are considered to pass through the center of each row of pixels. Pixels are activated if the center of the pixel is to the right of the intersection of the scan line and the polygon edge within the interval.

## Syntax

*Result* = POLYFILLV( *X*, *Y*, $S_x$, $S_y$ [, *Run_Length*] )

## Return Value

Returns a vector containing the one-dimensional subscripts of the array elements contained inside a polygon defined by vectors *X* and *Y*. If no points are contained within the polygon, a -1 is returned and an informational message is printed.

## Arguments

### X

A vector containing the X subscripts of the vertices that define the polygon.

### Y

A vector containing the Y subscripts of the vertices that define the polygon.

### $S_x$

The number of columns in the array surrounding the polygon.

### $S_y$

The number of rows in the array surrounding the polygon.

### Run_Length

Set this optional parameter to a nonzero value to make POLYFILLV return a vector of run lengths, rather than subscripts. For large polygons, a considerable savings in space results. When run-length encoded, each element with an even subscript result contains the length of the run, and the following element contains the starting index of the run.

## Examples

To determine the mean and standard deviation of the elements within a triangular region defined by the vertices at pixel coordinates (100, 100), (200, 300), and (300, 100), inside a 512 x 512 array called DATA, enter the commands:

```
; Get the subscripts of the elements inside the triangle:
P = DATA[POLYFILLV([100,200,300], [100,300,100], 512, 512)]

; Use the STDEV function to obtain the mean and standard deviation
; of the selected elements:
STD = STDEV(P,MEAN)
```

## Version History

Introduced: Original

## See Also

POLYFILL

# POLYSHADE

The POLYSHADE function creates a shaded-surface representation of one or more solids described by a set of polygons. This function accepts, as arguments, an array of three-dimensional vertices and a list of the indices of the vertices that describe each polygon.

Shading values are determined from one of three sources: a light source model, a user-specified array containing vertex shade values, or a user-specified array containing polygon shade values.

The shaded surface is constructed using the scan line algorithm. The default shading model is a combination of diffuse reflection and depth cueing. With this shading model, polygons are shaded using either constant shading, in which each polygon is given a constant intensity, or with Gouraud shading where the intensity is computed at each vertex and then interpolated over the polygon. Use the SET_SHADING procedure to control the direction of the light source and other shading parameters.

User-specified shading arrays allow “4-dimensional” displays that consist of a surface defined by a set of polygons, shaded with values from another variable.

## Syntax

*Result* = POLYSHADE( *Vertices*, *Polygons*)

or

*Result* = POLYSHADE(*X*, *Y*, *Z*, *Polygons*)

**Keywords:** [, /DATA | , /NORMAL] [, POLY_SHADES=*array*] [, SHADES=*array*] [, /T3D] [, TOP=*value*] [, XSIZE=*columns*] [, YSIZE=*rows*]

## Return Value

Returns a shaded-surface representation. Output is a two-dimensional byte array containing the shaded image unless the current graphics output device is the Z-buffer. If the current output device is the Z-buffer, the results are merged with the Z-buffer’s contents and the function result contains a dummy value.

# Arguments

## Vertices

A (3, *n*) array containing the X, Y, and Z coordinates of each vertex. Coordinates can be in either data or normalized coordinates, depending on which keywords are present.

## X, Y, Z

The X, Y, and Z coordinates of each vertex can, alternatively, be specified as three array expressions of the same dimensions.

## Polygons

An integer or longword array containing the indices of the vertices for each polygon. The vertices of each polygon should be listed in counterclockwise order when observed from outside the surface. The vertex description of each polygon is a vector of the form: [*n*, $i_0$, $i_1$, ..., $i_{n-1}$] and the array *Polygons* is the concatenation of the lists of each polygon. For example, to render a pyramid consisting of four triangles, *Polygons* would contain 16 elements, made by concatenating four, four-element vectors of the form [3, $V_0$, $V_1$, $V_2$]. $V_0$, $V_1$, and $V_2$ are the indices of the vertices describing each triangle.

# Keywords

## DATA

Set this keyword to indicate that the vertex coordinates are in data units, the default coordinate system.

## NORMAL

Set this keyword to indicate that coordinates are in normalized units, within the three dimensional (0,1) cube.

## POLY_SHADES

An array expression, with the same number of elements as there are polygons defined in the *Polygons* array, containing the color index used to render each polygon. No interpolation is performed if all pixels within a given polygon have the same shade value. For most displays, this parameter should be scaled into the range of bytes.

### SHADES

An array expression, with the same number of elements as *Vertices*, containing the color index at each vertex. The shading of each pixel is interpolated from the surrounding SHADE values. For most displays, this parameter should be scaled into the range of bytes.

**Warning**

When using the SHADES keyword on TrueColor devices, we recommend that decomposed color support be turned off by setting DECOMPOSED=0 for DEVICE.

### T3D

Set this keyword to use the three-dimensional to two-dimensional transformation contained in the homogeneous 4 by 4 matrix !P.T. Note that if T3D is set, !P.T must contain a valid transformation matrix. The SURFACE, SCALE3, and T3D procedures (and others) can all be used to set up transformations.

### TOP

The maximum shading value when light source shading is in effect. The default value is one less than the number of colors available in the currently selected graphics device.

### XSIZE

The number of columns in the output image array. If this parameter is omitted, the number of columns is equal to the X size of the currently selected display device.

Warning: The size parameters should be explicitly specified when the current graphics device is PostScript or any other high-resolution device. Making the output image the default full device size is likely to cause an insufficient memory error.

### YSIZE

The number of rows in the output image array. If this parameter is omitted, the number of rows is equal to the Y resolution of the currently selected display device.

## Examples

POLYSHADE is often used in conjunction with SHADE_VOLUME for volume visualization. The following example creates a spherical volume dataset and renders an isosurface from that dataset:

```
; Create an empty, 3-D array:
SPHERE = FLTARR(20, 20, 20)

; Create the spherical dataset:
FOR X=0,19 DO FOR Y=0,19 DO FOR Z=0,19 DO $
   SPHERE(X, Y, Z) = SQRT((X-10)^2 + (Y-10)^2 + (Z-10)^2)

; Find the vertices and polygons for a density level of 8:
SHADE_VOLUME, SPHERE, 8, V, P

; Set up an appropriate 3-D transformation so we can see the
; sphere. This step is very important:
SCALE3, XRANGE=[0,20], YRANGE=[0,20], ZRANGE=[0,20]

; Render the image. Note that the T3D keyword has been set so that
; the previously-established 3-D transformation is used:
image = POLYSHADE(V, P, /T3D)

; Display the image:
TV, image
```

## Version History

Introduced: Original

## See Also

IVOLUME, PROJECT_VOL, RECON3, SET_SHADING, SHADE_SURF, SHADE_VOLUME, VOXEL_PROJ

# POLYWARP

The POLYWARP procedure performs polynomial spatial warping.

Using least squares estimation, POLYWARP determines the coefficients $Kx_{i,j}$ and $Ky_{(i,j)}$ of the polynomial functions:

$$X_i = \sum_{i,\,j} Kx_{i,\,j} \cdot Xo^j \cdot Yo^i$$

$$Y_i = \sum_{i,\,j} Ky_{i,\,j} \cdot Xo^j \cdot Yo^i$$

*Kx* and *Ky* can be used as inputs P and Q to the built-in function POLY_2D. This coordinate transformation may be then used to map from *Xo*, *Yo* coordinates into *Xi*, *Yi* coordinates.

This routine is written in the IDL language. Its source code can be found in the file `polywarp.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

POLYWARP, *Xi*, *Yi*, *Xo*, *Yo*, *Degree*, *Kx*, *Ky* [, /DOUBLE] [, STATUS=*variable*]

## Arguments

### Xi, Yi

Vectors of X and Y coordinates to be fit as a function of Xo and Yo.

### Xo, Yo

Vectors of X and Y independent coordinates. These vectors must have the same number of elements as *Xi* and *Yi*.

### Degree

The degree of the fit. The number of coordinate pairs must be greater than or equal to $(Degree+1)^2$.

### Kx

A named variable that will contain the array of coefficients for *Xi* as a function of (*Xo*, *Yo*). This parameter is returned as a (*Degree*+1) by (*Degree*+1) element array.

### Ky

A named variable that will contain the array of coefficients for *Yi*. This parameter is returned as a (*Degree*+1) by (*Degree*+1) element array.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision result. Explicitly set DOUBLE=0 to ensure the use of single-precision for computations and to return a single-precision result. By default, POLYWARP performs computations in double precision and returns a double-precision result if any of the inputs are double-precision; computations are performed in single precision and the result returned as single-precision if all of the inputs are single-precision.

### STATUS

Set this keyword to a named variable to receive the status of the operation. Possible status values are:

| Value | Description |
|---|---|
| 0 | Successful completion. |
| 1 | Singular array (which indicates that the inversion is invalid). |
| 2 | Warning that a small pivot element was used and that significant accuracy was probably lost. |

*Table 77: STATUS Keyword Values*

**Note**

If STATUS is not specified, any warning messages will be output to the screen.

## Examples

The following example shows how to display an image and warp it using the POLYWARP and POLY_2D routines.

```
; Create and display the original image:
A = BYTSCL(SIN(DIST(250)))
TVSCL, A

; Now set up the Xi’s and Yi’s:
XI = [24, 35, 102, 92]
YI = [81, 24, 25, 92]

; Enter the Xo’s and Yo’s:
XO = [61, 62, 143, 133]
YO = [89, 34, 38, 105]

; Run POLYWARP to obtain a Kx and Ky:
POLYWARP, XI, YI, XO, YO, 1, KX, KY

; Create a warped image based on Kx and Ky with POLY_2D:
B = POLY_2D(A, KX, KY)

; Display the new image:
TV, B
```

## Version History

Introduced: Original

## See Also

POLY_2D, WARP_TRI

# POPD

The POPD procedure changes the current working directory to the directory saved on the top of the directory stack maintained by the PUSHD and POPD procedures. This top entry is then removed from the stack.

Attempting to pop a directory when the stack is empty causes a warning message to be printed. The current directory is not changed in this case. The common block DIR_STACK is used to store the directory stack.

This routine is written in the IDL language. Its source code can be found in the file `popd.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

POPD

## Arguments

None.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

CD, PRINTD, PUSHD

# POWELL

The POWELL procedure minimizes a user-written function *Func* of two or more independent variables using the Powell method. POWELL does not require a user-supplied analytic gradient.

POWELL is based on the routine `powell` described in section 10.5 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

POWELL, *P*, *Xi*, *Ftol*, *Fmin*, *Func* [, /DOUBLE] [, ITER=*variable*] [, ITMAX=*value*]

## Arguments

### P

On input, *P* is an *n*-element vector specifying the starting point. On output, it is replaced with the location of the minimum.

### Xi

On input, *Xi* is an initial *n* by *n* element array whose columns contain the initial set of directions (usually the *n* unit vectors). On output, it is replaced with the then-current directions.

### Ftol

An input value specifying the fractional tolerance in the function value. Failure to decrease by more than *Ftol* in one iteration signals completeness. For single-precision computations, a value of $1.0 \times 10^{-4}$ is recommended; for double-precision computations, a value of $1.0 \times 10^{-8}$ is recommended.

### Fmin

On output, *Fmin* contains the value at the minimum-point *P* of the user-supplied function specified by *Func*.

### Func

A scalar string specifying the name of a user-supplied IDL function of two or more independent variables to be minimized. This function must accept a vector argument *X* and return a scalar result.

For example, suppose we wish to minimize the function

$$f(x, y) = (x + 2y)e^{-x^2 - y^2}$$

To evaluate this expression, we define an IDL function named POWFUNC:

```
FUNCTION powfunc, X
   RETURN, (X[0] + 2.0*X[1]) * EXP(-X[0]^2 -X[1]^2)
END
```

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### ITER

Use this keyword to specify an output variable that will be set to the number of iterations performed.

### ITMAX

Use this keyword to specify the maximum allowed number of iterations. The default is 200.

**Warning**

POWELL halts once the value specified with ITMAX has been reached.

## Examples

We can use POWELL to minimize the function POWFUNC given above.

```
PRO TEST_POWELL

   ; Define the fractional tolerance:
   ftol = 1.0e-4

   ; Define the starting point:
   P = [.5d, -.25d]
```

```
   ; Define the starting directional vectors in column format:
   xi = TRANSPOSE([[1.0, 0.0],[0.0, 1.0]])

   ; Minimize the function:
   POWELL, P, xi, ftol, fmin, 'powfunc'

   ; Print the solution point:
   PRINT, 'Solution point: ', P

   ; Print the value at the solution point:
   PRINT, 'Value at solution point: ', fmin

END

FUNCTION powfunc, X
   RETURN, (X[0] + 2.0*X[1]) * EXP(-X[0]^2 -X[1]^2)
END
```

IDL prints:

```
Solution point:    -0.31622777     -0.63245552
Value at solution point:    -0.95900918
```

The exact solution point is [-0.31622777, -0.63245553].

The exact minimum function value is -0.95900918.

## Version History

Introduced: 4.0

## See Also

AMOEBA, DFPMIN, SIMPLEX

# PRIMES

The PRIMES function computes the first *K* prime numbers.

This routine is written in the IDL language. Its source code can be found in the file `primes.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = PRIMES(*K*)

## Return Value

The result is a *K*-element long integer vector.

## Arguments

### K

An integer or long integer scalar that specifies the number of primes to be computed.

## Examples

To compute the first 25 prime numbers:

```
PRINT, PRIMES(25)
```

IDL prints:

```
 2     3     5     7    11    13
17    19    23    29    31    37
41    43    47    53    59    61
67    71    73    79    83    89
97
```

## Version History

Introduced: 4.0

# PRINT/PRINTF

The two PRINT procedures perform formatted output. PRINT performs output to the standard output stream (IDL file unit -1), while PRINTF requires a file unit to be explicitly specified.

### Format Compatibility

If the FORMAT keyword is not present and PRINT is called with more than one argument, and the first argument is a scalar string starting with the characters "$(", this initial argument is taken to be the format specification, just as if it had been specified via the FORMAT keyword. This feature is maintained for compatibility with version 1 of VMS IDL.

## Syntax

PRINT [, $Expr_1$, ..., $Expr_n$]

PRINTF [, *Unit*, $Expr_1$, ..., $Expr_n$]

**Keywords:** [, AM_PM=*[string, string]*] [, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*] [, MONTHS=*string_array*{12 names}] [, /STDIO_NON_FINITE]

## Arguments

### Unit

For PRINTF, *Unit* specifies the file unit to which the output is sent.

### $Expr_i$

The expressions to be output.

## Keywords

### AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

## DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

## FORMAT

If FORMAT is not specified, IDL uses its default rules for formatting the output. FORMAT allows the format of the output to be specified in precise detail, using a FORTRAN-style specification. See “Using Explicitly Formatted Input/Output” in Chapter 10 of the *Building IDL Applications* manual.

## MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

## STDIO_NON_FINITE

Set this keyword to allow the writing of data files readable by C or FORTRAN programs on a given platform; it is otherwise unnecessary.The various systems supported by IDL differ widely in the representation used for non-finite floating point values (i.e., NaN and Infinity). Consider that the following are all possible representations for NaN on at least one IDL platform:

```
NaN, NanQ, ?.0000, nan0x2, nan0x7, 1.#QNAN, -1.#IND0.
```

And the following are considered to be Infinity:

```
Inf, Infinity, ++.0000, ----.0000, 1.#INF
```

On input, IDL can recognize any of these, but on output, it uses the same standard representation on all platforms. This promotes cross-platform consistency. To cause IDL to use the system C library `sprintf()` function to format such values, yielding the native representation for that platform, set the STDIO_NON_FINITE keyword.

## Obsolete Keywords

The following keywords are obsolete:

- REWRITE

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Examples

To print the string “IDL is fun.” enter the command:

```
PRINT, 'IDL is fun.'
```

To print the same message to the open file associated with file unit number 2, use the command:

```
PRINTF, 2, 'IDL is fun.'
```

## Version History

Introduced: Original

## See Also

ANNOTATE, MESSAGE, WRITEU, XYOUTS

# PRINTD

The PRINTD procedure prints the contents of the directory stack maintained by the PUSHD and POPD procedures. The contents of the directory stack are listed on the default output device. The common block DIR_STACK is used to store the directory stack.

This routine is written in the IDL language. Its source code can be found in the file `printd.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PRINTD

## Arguments

None.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

CD, POPD, PUSHD

# PRO

The PRO statement defines an IDL procedure.

**Note**

For information on using the PRO statement, see Chapter 4, "Procedures and Functions" in the *Building IDL Applications* manual.

## Syntax

PRO *Procedure_Name*, $argument_1$, ..., $argument_n$
  …
END

## Arguments

### $argument_n$

A parameter that is passed to the procedure.

## Keywords

None.

## Examples

The following example demonstrates the use of arguments in a PRO statement:

```
PRO MYPROCEDURE
   X = 5
   ; Call the ADD procedure:
   ADD, 3, X
END

PRO ADD, A, B
   PRINT, 'A = ', A
   PRINT, 'B = ', B
   A = A + B
   PRINT, 'A = ', A
END
```

After running `myprocedure.pro`, IDL returns:

```
A =    3
B =    5
A =    8
```

## Version History

Introduced: Original

# PRODUCT

The PRODUCT function returns the product of elements within an array. The product of the array elements over a given dimension is returned if the *Dimension* argument is present. Because the product can easily overflow, the product is computed using double-precision arithmetic and the *Result* is double precision.

**Tip**

If your array has a mix of very large and very small values, the product may underflow or overflow during the computation, even though the final result would be within double-precision limits. In this case, you should not use PRODUCT, but instead compute the product by taking the logarithm, using the TOTAL function, and then taking the exponential: *Result* = EXP(TOTAL(ALOG(*Array*))).

## Syntax

*Result* = PRODUCT(*Array* [, *Dimension*] [, /CUMULATIVE] [, /NAN] )

## Return Value

Returns the product of the elements of *Array.*

## Arguments

### Array

The array for which to compute the product. This array can be of any basic type except string.

### Dimension

An optional argument specifying the dimension over which to compute the product, starting at one. If this argument is not present or zero, the product of all the array elements is returned. If this argument is present, the result is an array with one less dimension than *Array.* For example, if the dimensions of *Array* are N1, N2, N3, and *Dimension* is 2, the dimensions of the result are (N1, N3), and element (i,j) of the result contains the product:

$$R_{i,j} = \prod_{k=0}^{N_2 - 1} A_{i,k,j}$$

# Keywords

## CUMULATIVE

If this keyword is set, the result is an array of the same size as the input, with each element, *i*, containing the product of the input array elements 0 to *i*. This keyword also works with the *Dimension* parameter, in which case the cumulative product is performed over the given dimension.

## NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data with the value 1.

## Thread Pool Keywords

This routine is written to make use of IDL's thread pool, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, “Thread Pool Keywords”.

# Examples

To find the product of all elements in a one-dimensional array:

```
; Define a one-dimensional array:
array = [20, 10, 5, 5, 3]

; Find the product of the array elements:
prod = PRODUCT(array)

; Print the results:
PRINT, 'Product of Array = ', prod
```

IDL prints:

```
Product of Array =        15000.000
```

Now find the product of elements in a two-dimensional array:

```
; Define a two-dimensional array:
array = FINDGEN(4,4) + 1

; Find the product of all array elements:
prodAll = PRODUCT(array)

; Find the product along the first dimension:
prod1 = PRODUCT(array, 1)

; Find the product along the second dimension:
prod2 = PRODUCT(array, 2)

; Print the results:
PRINT, 'Product of all elements = ', prodAll
PRINT, 'Product along first dimension: '
PRINT, prod1
PRINT, 'Product along second dimension: '
PRINT, prod2
```

IDL prints:

```
Product of all elements   2.0922790e+013
Product along first dimension:
 24.000000       1680.0000       11880.000       43680.000
Product along second dimension:
 585.00000       1680.0000       3465.0000       6144.0000
```

## Version History

Introduced: 5.6

## See Also

FACTORIAL, TOTAL

# PROFILE

The PROFILE function extracts a profile from an image and returns the values of the image along the profile line marked by the user.

This routine is written in the IDL language. Its source code can be found in the file `profile.pro` in the `lib` subdirectory of the IDL distribution.

### Using PROFILE

To mark a profile line after calling PROFILE, click in the image with the left mouse button to mark the beginning and ending points. The pixel coordinates of the selected points are displayed in the IDL command log.

## Syntax

*Result* = PROFILE( *Image* [, *XX*, *YY*] [, /NOMARK] [, XSTART=*value*] [, YSTART=*value*] )

## Return Value

Returns a floating-point vector containing the values along the profile line.

## Arguments

### Image

The data array representing the image. This array can be of any type except complex.

### XX

A named variable that will contain the X coordinates of the points along the selected profile.

### YY

A named variable that will contain the Y coordinates of the points along the selected profile.

# Keywords

## NOMARK

Set this keyword to inhibit marking the image with the profile line.

## XSTART

The starting X location of the lower-left corner of *Image*. If this keyword is not specified, 0 is assumed.

## YSTART

The starting Y location of the lower-left corner of *Image*. If this keyword is not specified, 0 is assumed.

# Examples

This example displays an image, selects a profile, and plots that profile in a new window:

```
; Create an image:
A = BYTSCL(DIST(256))

; Display the image:
TV, A

; Extract a profile from the image:
R = PROFILE(A)
```

Mark two points on the image with the mouse.

```
; Create a new plotting window:
WINDOW, /FREE

; Plot the profile:
PLOT, R
```

**Note**

The PROFILES procedure is an interactive version of this routine.

# Version History

Introduced: Original

## See Also

PROFILES

# PROFILER

The PROFILER procedure allows you to access the IDL Code Profiler. The IDL Code Profiler helps you analyze the performance of your applications. You can easily monitor the calling frequency and execution time for procedures and functions.

## Syntax

PROFILER [, *Module*] [, /CLEAR] [, DATA=*variable*] [, OUTPUT=*variable*] [, /REPORT] [, /RESET] [, /SYSTEM]

## Arguments

### Module

The program to which changes in profiling will be applied. If *Module* is not specified, profiling changes will be applied to all currently-compiled programs.

**Note**

The *Module* is often named with respect to the file in which it is stored. For example, the file `build_it.pro` may contain the module, `build_it`. If you specify the file name, you will incur a syntax error.

## Keywords

### CLEAR

Set this keyword to disable profiling of *Module* or of all compiled modules if *Module* is not specified.

### DATA

Set this keyword to a specified variable containing output of the report as an unnamed structure with the following tags and data types:

```
{NAME:char, COUNT:long, ONLY_TIME:double, TIME:double,
SYSTEM:byte}
```

### OUTPUT

Set this keyword to a specified variable in which to store the results of the REPORT keyword.

### REPORT

Set this keyword to report the results of profiling. If you enter a program at the command line, the PROFILER procedure will report the status of all the specified modules used either since the beginning of the IDL session, or since the PROFILER was reset.

### RESET

Set this keyword to clear the results of profiling.

### SYSTEM

Set this keyword to profile IDL system procedures and functions. By default, only user-written or library files, which have been compiled, are profiled.

## Examples

```
; Include IDL system procedures and functions when profiling:
PROFILER, /SYSTEM

; Create a dataset using the library function DIST. Note that DIST
; is immediately compiled:
A= DIST(500)

; Display the image:
TV, A

; Retrieve the profiling results:
PROFILER, /REPORT
```

IDL prints:

```
Module       Type  Count     Only(s)   Avg.(s)     Time(s)   Avg.(s)
FINDGEN      (S)       1    0.000239  0.000239    0.000239  0.000239
FLTARR       (S)       1    0.010171  0.010171    0.010171  0.010171
N_ELEMENTS   (S)       1    0.000104  0.000104    0.000104  0.000104
ON_ERROR     (S)       1    0.000178  0.000178    0.000178  0.000178
SQRT         (S)     251    0.099001  0.000394    0.099001  0.000394
TV           (S)       1    2.030000  2.030000    2.030000  2.030000
```

## Version History

Introduced: 5.1

## See Also

Chapter 17, “Debugging an IDL Program” in the *Building IDL Applications* manual.

# PROFILES

The PROFILES procedure interactively draws row or column profiles of an image in a separate window. A new window is created and the mouse location in the original window is used to plot profiles in the new window.

This routine is written in the IDL language. Its source code can be found in the file `profiles.pro` in the `lib` subdirectory of the IDL distribution.

### Using PROFILES

Moving the mouse within the original image interactively creates profile plots in the newly-created profile window. Pressing the left mouse button toggles between row and column profiles. The right mouse button exits.

## Syntax

PROFILES, *Image* [, /ORDER] [, SX=*value*] [, SY=*value*] [, WSIZE=*value*]

## Arguments

### Image

The variable that represents the image displayed in the current window. This data need not be scaled into bytes. The profile graphs are made from this array, even if it is not currently displayed.

## Keywords

### ORDER

Set this keyword to 1 for images written top down or 0 for bottom up. Default is the current value of !ORDER.

### SX

Starting X position of the image in the window. If this keyword is omitted, 0 is assumed.

### SY

Starting Y position of the image in the window. If this keyword is omitted, 0 is assumed.

### WSIZE

The size of the PROFILES window as a fraction or multiple of 640 by 512.

## Examples

Create and display an image and use the PROFILES routine on it.

```
; Create an image:
A = BYTSCL(DIST(256))

; Display the image:
TV, A

; Run the PROFILES routine:
PROFILES, A, WSIZE = .5
```

A 320 x 256 pixel PROFILES window should appear. Move the cursor over the original image to see the profile at the cursor position. Press the left mouse button to toggle between row and column profiles. Press the right mouse button (with the cursor over the original image) to exit the routine.

## Version History

Introduced: Pre 4.0

## See Also

PROFILE

# PROJECT_VOL

The PROJECT_VOL function returns a two-dimensional image that is the projection of a 3-D volume of data onto a plane (similar to an X-ray). The returned image is a translucent rendering of the volume (the highest data values within the volume show up as the brightest regions in the returned image). Depth queuing and opacity may be used to affect the image. The volume is projected using a 4x4 matrix, so any type of projection may be used including perspective. Typically the system viewing matrix (!P.T) is used as the 4x4 matrix.

**Note**

The VOXEL_PROJ procedure performs many of the same functions as this routine, and is faster.

This routine is written in the IDL language. Its source code can be found in the file `project_vol.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = PROJECT_VOL( *Vol*, *X_Sample*, *Y_Sample*, *Z_Sample*
[, /AVG_INTENSITY] [, /CUBIC] [, DEPTH_Q=*value*] [, OPAQUE=*3D_array*]
[, TRANS=*array*] [, XSIZE=*longword integer*] [, YSIZE=*longword integer*]
[, /Z_BUFFER] )

## Return Value

Returns a projection of the volumetric data.

## Arguments

### Vol

A 3-D array of any type except string or structure containing the three-dimensional volume of data to project.

### X_Sample

A long integer specifying the number of rays to project along the X dimension of the image. The returned image will have the dimensions *X_sample* by *Y_sample*.

### Y_Sample

A long integer specifying the number of rays to project along the Y dimension of the image. To preserve the correct aspect ratio of the data, *Y_sample* should equal *X_sample*.

### Z_Sample

A long integer specifying the number of samples to take along each ray. Higher values for *X_sample*, *Y_sample*, and *Z_sample* increase the image resolution as well as execution time.

## Keywords

### AVG_INTENSITY

If this keyword is set, the average intensity method of projection is used. The default is a maximum intensity projection. This keyword is ignored if the Z_BUFFER keyword is set.

### CUBIC

If this keyword is set, the cubic method of interpolation is used. The default is bilinear interpolation.

### DEPTH_Q

Set this keyword to indicate that the image should be created using depth queuing. The depth queuing should be a single floating-point value between 0.0 and 1.0. This value specifies the brightness of the farthest regions of the volume relative to the closest regions of the volume. A value of 0.0 will cause the back side of the volume to be completely blacked out, while a value of 1.0 indicates that the back side will show up just as bright as the front side. The default is 1.0 (indicating no depth queuing).

### OPAQUE

A 3-D array of any type except string or structure, with the same size and dimensions as *Vol*. This array specifies the opacity of each cell in the volume. OPAQUE values of 0 allow all light to pass through. OPAQUE values are cumulative. For example, if a ray emanates from a data value of 50, and then passes through 10 opaque cells (each with a data value of 0 and an opacity value of 5) then that ray would be completely blocked out (the cell with the data value of 50 would be invisible on the returned image). The default is no opacity.

### TRANS

A 4x4 floating-point array to use as the transformation matrix when projecting the volume. The default is to use the system viewing matrix (!P.T).

### XSIZE

The *x* size of the returned image to return. CONGRID is used to resize the final image to be XSIZE by YSIZE. The default is the *x* size of the current window (or the *x* size of the Z-buffer). If no current window exists, then the default is *X_sample*.

### YSIZE

The *y* size of the returned image. CONGRID is used to resize the final image to be XSIZE by YSIZE. The default is the *y* size of the current window (or the *y* size of the Z-buffer). If no current window exists, then the default is *Y_sample*.

### Z_BUFFER

If this keyword is set, the projection is combined with the contents of the Z-buffer. The default is to not use the Z-buffer contents.

## Examples

Use the T3D routine to set up a viewing projection and render a volume of data using PROJECT_VOL.

```
; First, create some data:
vol = RANDOMU(S, 40, 40, 40)
FOR I=0, 10 DO vol = SMOOTH(vol, 3)
vol = BYTSCL(vol(3:37, 3:37, 3:37))
opaque = RANDOMU(S, 40, 40, 40)
FOR I=0, 10 DO opaque = SMOOTH(opaque, 3)
opaque = BYTSCL(opaque(3:37, 3:37, 3:37), TOP=25B)

; Set up the view:
xmin = 0 & ymin = 0 & zmin = 0
xmax = 34 & ymax = 34 & zmax = 34
!X.S = [-xmin, 1.0] / (xmax - xmin)
!Y.S = [-ymin, 1.0] / (ymax - ymin)
!Z.S = [-zmin, 1.0] / (zmax - zmin)
T3D, /RESET
T3D, TRANSLATE=[-0.5, -0.5, -0.5]
T3D, SCALE=[0.7, 0.7, 0.7]
T3D, ROTATE=[30, -30, 60]
T3D, TRANSLATE=[0.5, 0.5, 0.5]
WINDOW, 0, XSIZE=512, YSIZE=512
```

```
; Generate and display the image:
img = PROJECT_VOL(vol, 64, 64, 64, DEPTH_Q=0.7, $
  OPAQUE=opaque, TRANS=(!P.T))
TVSCL, img
```

## Version History

Introduced: Pre 4.0

## See Also

POLYSHADE, VOXEL_PROJ

# PS_SHOW_FONTS

The PS_SHOW_FONTS procedure displays all the PostScript fonts that IDL knows about, with both the StandardAdobe and ISOLatin1 encodings. Each display takes a separate page, and each character in each font is shown with its character index.

A PostScript file is produced, one page per font/mapping combination. The output file contains almost 70 pages of output. A PostScript previewer is recommended rather than sending it to a printer.

This routine is written in the IDL language. Its source code can be found in the file `ps_show_fonts.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PS_SHOW_FONTS [, /NOLATIN]

## Arguments

None.

## Keywords

### NOLATIN

Set this keyword to prevent output of ISOLatin1 encodings.

## Version History

Introduced: Pre 4.0

## See Also

PSAFM

# PSAFM

The PSAFM procedure takes an Adobe Font Metrics file as input and generates a new AFM file in the format that IDL likes. This new file differs from the original in the following ways:

- Information not used by IDL is removed.
- AFM files with the AdobeStandardEncoding are supplemented with an ISOLatin1Encoding.

This routine is written in the IDL language. Its source code can be found in the file `psafm.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PSAFM, *Input_Filename*, *Output_Filename*

## Arguments

### Input_Filename

A string that contains the name of existing AFM file from Adobe.

### Output_Filename

A string that specifies the name of new IDL-format AFM file to be created.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

PS_SHOW_FONTS

# PSEUDO

The PSEUDO procedure creates a pseudo-color table based on the LHB (Lightness, Hue, and Brightness) system and loads it.

The pseudo-color mapping used is generated by first translating from the LHB coordinate system to the LAB coordinate system, finding *N* colors spread out along a helix that spans this LAB space (supposedly a near maximal entropy mapping for the eye, given a particular *N*) and remapping back into the RGB (Red, Green, and Blue) colorspace. The result is loaded as the current colortable.

This routine is written in the IDL language. Its source code can be found in the file `pseudo.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PSEUDO, *Litlo*, *Lithi*, *Satlo*, *Sathi*, *Hue*, *Loops* [, *Colr*]

## Arguments

### Litlo

Starting lightness, from 0 to 100%.

### Lithi

Ending lightness, from 0 to 100%.

### Satlo

Starting saturation, from 0 to 100%.

### Sathi

Ending saturation, from 0 to 100%.

### Hue

Starting hue, in degrees, from 0 to 360.

### Loops

The number of loops of hue to make in the color helix. This value can range from 0 to around 3 to 5 and need not be an integer.

### Colr

An optional (256,3) integer array in which the new R, G, and B values are returned. Red = *Colr*[*,0], green = *Colr*[*,1], blue = *Colr*[*,2].

## Keywords

None.

## Version History

Introduced: Original

## See Also

COLOR_CONVERT, COLOR_QUAN

# PTR_FREE

The PTR_FREE procedure destroys the heap variables pointed at by its pointer arguments. Any memory used by the heap variable is released, and the variable ceases to exist. No change is made to the arguments themselves and all pointers to the destroyed variables continue to exist. Such pointers are known as *dangling references*. PTR_FREE is the only way that pointer heap variables can be destroyed. If PTR_FREE is not called on a heap variable, it continues to exist until the IDL session ends, even if no pointers remain that can be used to reference it.

**Note**

PTR_FREE is not recursive. That is, if the heap variable pointed at by `pointer1` contains `pointer2`, destroying `pointer1` will *not* destroy the heap variable pointed at by `pointer2`. Take care not to lose the only pointer to a heap variable by destroying a pointer to a heap variable that contains that pointer.

## Syntax

PTR_FREE, $P_1$, ... …, $P_n$

## Arguments

### $P_i$

Scalar or array arguments of pointer type. If the NULL pointer is passed, PTR_FREE ignores it quietly.

## Keywords

None.

## Version History

Introduced: 5.0

# PTR_NEW

The PTR_NEW function provides the primary mechanism for creating heap variables.

## Syntax

*Result* = PTR_NEW( [*InitExpr*] [, /ALLOCATE_HEAP] [, /NO_COPY] )

## Return Value

It returns a pointer to the created variable.

## Arguments

### InitExpr

If *InitExpr* is provided, PTR_NEW uses it to initialize the newly created heap variable. Note that the new heap variable does not point at the *InitExpr* variable in any sense—the new heap variable simply contains a copy of its value.

If *InitExpr* is not provided, PTR_NEW does not create a new heap variable, and returns the *Null Pointer*, a special pointer with a fixed known value that can never point at a heap variable. The null pointer is useful as a terminator in dynamic data structures, or as a placeholder in structure definitions.

## Keywords

### ALLOCATE_HEAP

Set this keyword to cause PTR_NEW to allocate an undefined heap variable rather than return a null pointer when *InitExpr* is not specified.

### NO_COPY

Usually, when the *InitExpr* argument is provided, PTR_NEW allocates additional memory to make a copy. If the NO_COPY keyword is set, the value data is taken away from the *InitExpr* variable and attached directly to the heap variable. This feature can be used to move data very efficiently. However, it has the side effect of causing the *InitExpr* variable to become undefined. Using the NO_COPY keyword is completely equivalent to the statement:

```
Result = PTR_NEW(TEMPORARY(InitExpr))
```

and is provided as a syntactic convenience.

## Version History

Introduced: 5.0

# PTR_VALID

The PTR_VALID function verifies the validity of its pointer arguments, or alternatively returns a vector of pointers to all the existing valid pointer heap variables.

## Syntax

*Result* = PTR_VALID( [*Arg*] [, /CAST] [, COUNT=*variable*] )

## Return Value

If called with an pointer or array of pointers as its argument, PTR_VALID returns a byte array of the same size as the argument. Each element of the result is set to True (1) if the corresponding pointer in the argument refers to an existing valid heap variable, or to False (0) otherwise.

If called with an integer or array of integers as its argument and the CAST keyword is set, PTR_VALID returns an array of pointers. Each element of the result is a pointer to the heap variable indexed by the integer value. Integers used to index heap variables are shown in the output of the HELP and PRINT commands. This is useful primarily in programming/debugging when you have lost a reference but see it with HELP and need to get a reference to it interactively in order to determine what it is and take steps to fix the code. See the “Examples” section below for an example.

If no argument is specified, PTR_VALID returns a vector of pointers to all existing valid pointer heap variables—*even if there are currently no pointers to the heap variable*. This usage allows you to “reclaim” pointer heap variables to which all pointers have been lost. If no valid pointer heap variables exist, a scalar null pointer is returned.

## Arguments

### Arg

*Arg* can be one of the following:

1. A scalar or array argument of pointer type.
2. If the CAST keyword is set, an integer index or array of integer indices to heap variables. Integers used to index heap variables are shown in the output of the HELP and PRINT commands.

# Keywords

## CAST

Set this keyword to create a new pointer to each heap variable index specified in *Arg*.

## COUNT

Set this keyword equal to a named variable that will contain the number of currently valid heap variables. This value is returned as a longword integer.

# Examples

To determine if a given pointer refers to a valid heap variable:

```
IF (PTR_VALID(p)) THEN …
```

To destroy all existing pointer heap variables:

```
PTR_FREE, PTR_VALID()
```

You can use the CAST keyword to “reclaim” lost heap variables. For example:

```
A = PTR_NEW(10)
PRINT, A
```

IDL prints:

```
<PtrHeapVar2>
```

In this case, the integer index to the heap variable is 2. If we reassign the variable A, we will “lose” the pointer, but the heap variable will still exist:

```
A=0
PRINT, A, PTR_VALID()
```

IDL prints:

```
0 <PtrHeapVar2>
```

We can reclaim the lost heap variable using the CAST keyword:

```
A = PTR_VALID(2, /CAST)
PRINT, A
```

IDL prints:

```
<PtrHeapVar2>
```

## Version History

Introduced: 5.0

# PTRARR

The PTRARR function returns a pointer vector or array. The individual elements of the array are set to the Null Pointer.

## Syntax

*Result* = PTRARR( $D_1$, ... …, $D_8$ [, /ALLOCATE_HEAP | , /NOZERO] )

## Return Value

Returns a vector or array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### ALLOCATE_HEAP

Normally, PTRARR sets every element of the result to the null pointer. It you wish IDL to allocate heap variables for every element of the array instead, set the ALLOCATE_HEAP keyword. In this case, every element of the array will be initialized to point at an undefined heap variable.

### NOZERO

If ALLOCATE_HEAP is not specified, PTRARR sets every element of the result to the null pointer. If NOZERO is nonzero, this initialization is not performed and PTRARR executes faster. NOZERO is ignored if ALLOCATE_HEAP is specified.

**Warning**

If you specify NOZERO, the resulting array will have whatever value happens to exist at the system memory location that the array is allocated from. You should be careful to initialize such an array to valid pointer values.

## Example

Create P, a 3 element by 3 element pointer array with each element containing the Null Pointer by entering:

```
P = PTRARR(3, 3)
```

## Version History

Introduced: 5.0

# PUSHD

The PUSHD procedure pushes a directory onto the top of the directory stack maintained by the PUSHD and POPD procedures. The name of the current directory is pushed onto the directory stack. This directory becomes the next directory used by POPD. IDL changes directories to the one specified by the *Dir* argument. The common block DIR_STACK is used to store the directory stack.

This routine is written in the IDL language. Its source code can be found in the file `pushd.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

PUSHD, *Dir*

## Arguments

### Dir

A string containing the name of the directory to change to. The current directory is pushed onto the top of the directory stack.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

CD, POPD, PRINTD

# QGRID3

The QGRID3 function linearly interpolates the dependent variable values to points in a regularly sampled volume. Its inputs are a triangulation of scattered data points in three dimensions, and the value of a dependent variable for each point.

## Syntax

*Result* = QGRID3( *XYZ, F, Tetrahedra* [, DELTA=*vector* ] [, DIMENSION=*vector* ] [, MISSING=*value* ] [, START=*vector* ] )

or

*Result* = QGRID3( *X, Y, Z, F, Tetrahedra* [, DELTA=*array* ] [, DIMENSION=*array* ] [, MISSING=*value* ] [, START=*array* ] )

## Return Value

*Result* is a 3-dimensional array of either single or double precision floating type, of the specified dimensions.

## Arguments

### XYZ

This is a 3-by-*n* array containing the scattered points.

### X, Y, Z

One-dimensional vectors containing the *X*, *Y*, and *Z* point coordinates.

### Tetrahedra

A longword array containing the point indices of each tetrahedron, as created by QHULL.

## Keywords

**Note**

Any of the keywords may be set to a scalar if all elements are the same.

### DELTA

A scalar or three element array specifying the grid spacing in *X*, *Y*, and *Z*. If this keyword is not specified, it is set to create a grid of DIMENSION cells, enclosing the volume from START to [max(*x*), max(*y*), max(*z*)].

### DIMENSION

A three element array specifying the grid dimensions in *X*, *Y*, and *Z*. Default value is 25 for each dimension.

### MISSING

The value to be used for grid points that lie outside the convex hull of the scattered points. The default is 0.

### START

A three element array specifying the start of the grid in *X*, *Y*, and *Z*. Default value is [min(*x*), min(*y*), min(*z*)].

## Examples

### Example 1

This example interpolates a data set measured on an irregular grid.

```
; Create a dataset of N points.
n = 200
x = RANDOMU(seed, n)
y = RANDOMU(seed, n)
z = RANDOMU(seed, n)

; Create dependent variable.
f = x^2 - x*y + z^2 + 1

; Obtain a tetrahedra using the QHULL procedure.
QHULL, x, y, z, tet, /DELAUNAY

; Create a volume with dimensions [51, 51, 51]
; over the unit cube.
volume = QGRID3(x, y, z, f, tet, START=0, DIMENSION=51, $
   DELTA=0.02)

; Display the volume.
XVOLUME, BYTSCL(volume)
```

## Example 2

This example is similar to the previous one, however in this example we use a [3, *n*] array of points.

```
; Create a dataset of N points.
n = 200
p = RANDOMU(seed, 3, n)

; Create dependent variable.
f = p[0,*]^2 - p[0,*]*p[1,*] + p[2,*]^2 + 1

; Obtain a tetrahedra.
QHULL, p, tet, /DELAUNAY

; Create a volume with dimensions [51, 51, 51] over the unit cube.
volume = QGRID3(p, f, tet, START=0, DIMENSION=51, DELTA=0.02)

; Display the volume.
XVOLUME, BYTSCL(volume)
```

## Example 3

The following example uses the data from the `irreg_grid2.txt` ASCII file. This file contains scattered three-dimensional data. This file contains bore hole data for a square mile of land. The QHULL procedure is used to triangulate the three-dimensional locations. The QGRID3 function uses the results from QHULL to grid the data into a volume. The scattered data is displayed as symbol polyline objects in the XOBJVIEW utility. The resulting gridded volume is displayed in the XVOLUME utility:

```
; Import the Data:

; Determine the path to the file. This file contains bore hole
; data for a square mile of land.  The bore hole samples were
; roughly taken diagonally from the upper left corner of the
; square to the lower right corner.
file = FILEPATH('irreg_grid2.txt', $
   SUBDIRECTORY = ['examples', 'data'])

; Import the data from the file into a structure.
dataStructure = READ_ASCII(file)

; Get the imported array from the first field of
; the structure.
dataArray = TRANSPOSE(dataStructure.field1)
```

```
; Initialize the variables of this example from
; the imported array.
x = dataArray[*, 0]
y = dataArray[*, 1]
z = dataArray[*, 2]
data = dataArray[*, 3]

; Determine number of data points.
nPoints = N_ELEMENTS(data)

; Triangulate the Data with QHULL:

; Construct the convex hulls of the volume.
QHULL, x, y, z, tetrahedra, /DELAUNAY

; Grid the Data and Display the Results:

; Initialize volume parameters.
cubeSize = [51, 51, 51]
; Grid the data into a volume.
volume = QGRID3(x, y, z, data, tetrahedra, START = 0, $
   DIMENSION = cubeSize, DELTA = 0.02)
; Scale the volume to be able to view the full data value range
; with the color tables provided in the XVOLUME utility.
scaledVolume = BYTSCL(volume)

; Display the results in the XVOLUME utility.
XVOLUME, scaledVolume

; Derive the isosurface for mineral deposits with the data value
; of 2.5.
ISOSURFACE, volume, 2.5, vertices, connectivity

; Initialize a model to contain the isosurface.
oModel = OBJ_NEW('IDLgrModel')

; Initialize the polygon object of the isosurface.
oPolygon = OBJ_NEW('IDLgrPolygon', vertices, $
   POLYGONS = connectivity, COLOR = [0, 0, 255])

; Determine the range in each direction.
xRange = [0, cubeSize[0]]
yRange = [0, cubeSize[1]]
zRange = [0, cubeSize[2]]

; Initialize an axis for each direction.
oAxes = OBJARR(3)
oAxes[0] = OBJ_NEW('IDLgrAxis', 0, RANGE = xRange, $
   LOCATION = [xRange[0], yRange[0], zRange[0]], /EXACT, $
```

```
   TICKLEN = (0.02*(yRange[1] - yRange[0])))
oAxes[1] = OBJ_NEW('IDLgrAxis', 1, RANGE = yRange, $
   LOCATION = [xRange[0], yRange[0], zRange[0]], /EXACT, $
   TICKLEN = (0.02*(xRange[1] - xRange[0])))
oAxes[2] = OBJ_NEW('IDLgrAxis', 2, RANGE = zRange, $
   LOCATION = [xRange[0], yRange[1], zRange[0]], /EXACT, $
   TICKLEN = (0.02*(xRange[1] - xRange[0])))

; Add the polygon and axes object to the model.
oModel -> Add, oPolygon
oModel -> Add, oAxes

; Rotate the model for a better perspective.
oModel -> Rotate, [0, 0, 1], 30.
oModel -> Rotate, [1, 0, 0], -45.

; Display the model, which contains the isosurface.
XOBJVIEW, oModel, /BLOCK, SCALE = 0.75, $
   TITLE = 'Isosurface at the Value of 2.5'

; Cleanup object references.
OBJ_DESTROY, [oModel]
```

## Version History

Introduced: 5.5

## See Also

QHULL

# QHULL

The QHULL procedure constructs convex hulls, Delaunay triangulations, and Voronoi diagrams of a set of points of 2-dimensions or higher. It uses and is based on the program QHULL, which is described in Barber, Dobkin and Huhdanpaa, “The Quickhull Algorithm for Convex Hulls,” *ACM Transactions on Mathematical Software*, Vol. 22, No 4, December 1996, Pages 469-483.

For more information about QHULL see http://www.geom.umn.edu/software/qhull/.

## Syntax

QHULL, *V*, *Tr*

or,

QHULL, *V0* , *V1*, [, *V2* ... [, *V*6] ] , *Tr*

**Keywords:** [, BOUNDS=*variable* ] [, CONNECTIVITY=*variable* ] [, /DELAUNAY ] [, SPHERE=*variable* ] [, VDIAGRAM=*array* ] [, VNORMALS=*array* ] [, VVERTICES=*array* ]

## Arguments

### V

An input argument providing an *nd*-by-*np* array containing the locations of *np* points, in *nd* dimensions. The number of dimensions, *nd*, must be greater than or equal to 2.

### V0, V1, V2, ..., V(N–1)

Input vectors of dimension *np*-by-1 elements each containing the *i*-th coordinate of *np* points in *nd* dimensions. A maximum of seven input vectors may be specified.

### Tr

An *nd1*-by-*nt* array containing the indices of either the convex hull (*nd1* is equal to *nd*), or the Delaunay triangulation (*nd1* is equal to *nd*+1) of the input points.

# Keywords

## BOUNDS

Set this keyword equal to a named variable that will contain the indices of the vertices of the convex hull.

**Note**

The order of the vertices returned in this variable is unspecified.

## CONNECTIVITY

Set this keyword to a named variable in which the adjacency list for each of the *np* nodes is returned. The list has the following form:

> Each element *i*, $0 \leq i < np$, contains the starting index of the connectivity list (*list*) for node *i* within the list array. To obtain the adjacency list for node *i*, extract the list elements from *list*[*i*] to *list*[*i*+1] – 1. The adjacency list is not ordered. To obtain the connectivity list, either the DELAUNAY or SPHERE keywords must also be specified.

For example, to perform a spherical triangulation, use the following procedure call:

```
QHULL, lon, lat, CONNECTIVITY = list, SHPERE = sphere
```

which returns the adjacency list in the variable list. The subscripts of the nodes adjacent to *lon*[*i*] and *lat*[*i*] are contained in the array: *list*[*list*[*i*] :*list*[*i*+1] – 1].

## DELAUNAY

Performs a Delaunay triangulation and returns the vertex indices of the resulting polyhedra; otherwise, the convex hull of the data are returned.

## SPHERE

Computes the Delaunay triangulation of the points which lie on the surface of a sphere. The *V0* argument contains the longitude, in degrees, and *V1* contains the latitude, in degrees, of each point.

## VDIAGRAM

When specified, this keyword returns the connectivity of the Voronoi diagram.

For two-dimensional arrays, VDIAGRAM is a 4-by-*nv* integer array. For each Voronoi ridge, *i*, VDIAGRAM[0:1, *i*] contains the index of the two input points the ridge bisects. VDIAGRAM [2:3, *i*] contains the indices within VVERTICES of the

Voronoi vertices. In the case of an unbounded half-space, VDIAGRAM[2, *i*] is set to a negative index, *j*, indicating that the corresponding Voronoi ridge is unbounded, and that the equation for the ridge is contained in VNORMAL[*, –*j*-1], and starts at Voronoi vertex [3, *i*].

For three-dimensional or higher dimensional arrays, VDIAGRAM is returned as a connectivity vector. This vector has the form [*n*, v0, v1, i0, i1, ..., in-3], where n is the number of points needed to describe that particular Voronoi ridge, v0 and v1 contain the indices for the two input points that the ridge bisects, and i0...in -3 contain the indices within VVERTICES of the Voronoi vertices. In the case of an unbounded half-space, VDIAGRAM[*i*] is set to a negative index, *j*, indicating that the corresponding Voronoi ridge is unbounded, and that the equation for the ridge is contained in VNORMAL[*, –*j*-1], and starts at VDIAGRAM[*i*+1].

### VNORMALS

When specified, this keyword returns the normals of each Voronoi ridge that is unbounded. The normals consist of a (*nd*+1)-by-nu array, where *nd* is the number of dimensions, and nu is the number of unbounded vertices. The first nd elements in each row contain the equation for the unbounded ridge, normalized by the last element in each row. See the preceding description of VDIAGRAM for details.

### VVERTICES

When specified, this keyword returns the Voronoi vertices.

## Examples

```
pro ex_qhull

    ; Create a collection of random points.
    n = 20
    seed = 15
    x = RANDOMU(seed, n)
    y = RANDOMU(seed, n)

    ; Construct the Delaunay triangulation
    ; and the Voronoi diagram.
    QHULL, x, y, triangle, /DELAUNAY, $
        VDIAGRAM=vdiag, VVERTICES=vvert, VNORM=vnorm

    ; Plot our input points.
    PLOT, [-0.1, 1.1], [-0.1, 1.1], /NODATA, $
        XSTYLE=4, YSTYLE=4
    PLOTS, x, y, PSYM=4
```

```
    ; Plot the Voronoi diagram.
    for i=0,N_ELEMENTS(vdiag[2,*])-1 do begin
        j = vdiag[2,i] + 1
        ; Bounded or unbounded?
        if (j gt 0) then begin   ; Bounded.
            PLOTS, vvert[*, vdiag[2:3,i]], PSYM=-5
        endif else begin
            ; Unbounded, retrieve normal equation.
            ; Vnorm[2,*] contains the normalization parameter.
            offset = [vnorm[1,-j], -vnorm[0,-j]]*vnorm[2,-j]
            xy1 = vvert[*, vdiag[3,i]]
            ; Reverse the normal direction if necessary.
            if (xy1[1] lt xy1[0]) then offset = -offset
            PLOTS, [[xy1], [xy1 + 5*offset]]
        endelse
    endfor

end
```

For some other examples using the QHULL procedure, see the QGRID3 function.

## Version History

Introduced: 5.5

## See Also

QGRID3

# QROMB

The QROMB function evaluates the integral of a function over the closed interval [*A*, *B*] using Romberg integration.

QROMB is based on the routine `qromb` described in section 4.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = QROMB( *Func*, *A*, *B* [, /DOUBLE] [, EPS=*value*] [, JMAX=*value*] [, K=*value*] )

## Return Value

The result will have the same structure as the smaller of *A* and *B*, and the resulting type will be single- or double-precision floating, depending on the input types.

## Arguments

### Func

A scalar string specifying the name of a user-supplied IDL function to be integrated. This function must accept a single scalar argument *X* and return a scalar result. It must be defined over the closed interval [*A*, *B*].

For example, if we wish to integrate the cubic polynomial

$$y = x^3 + (x - 1)^2 + 3$$

we define a function CUBIC to express this relationship in the IDL language:

```
FUNCTION cubic, X
   RETURN, X^3 + (X - 1.0)^2 + 3.0
END
```

### A

The lower limit of the integration. *A* can be either a scalar or an array.

### B

The upper limit of the integration. *B* can be either a scalar or an array.

**Note**

If arrays are specified for *A* and *B*, then QROMB integrates the user-supplied function over the interval $[A_i, B_i]$ for each *i*. If either *A* or *B* is a scalar and the other an array, the scalar is paired with each array element in turn.

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## EPS

The desired fractional accuracy. For single-precision calculations, the default value is $1.0 \times 10^{-6}$. For double-precision calculations, the default value is $1.0 \times 10^{-12}$.

## JMAX

$2^{(JMAX - 1)}$ is the maximum allowed number of steps. If this keyword is not specified, a default of 20 is used.

## K

Integration is performed by Romberg's method of order 2K. If not specified, the default is K=5. (K=2 is Simpson's rule).

# Examples

## Example 1

To integrate the CUBIC function (listed above) over the interval [0, 3] and print the result:

```
PRINT, QROMB('cubic', 0.0, 3.0)
```

IDL prints:

```
 32.2500
```

This is the exact solution.

## Example 2

This example evaluates the volume under a surface using the following double integration:

$$volume = \int_0^1 \int_0^1 (9x^2y^2 + 4xy + 1)dxdy$$

The exact solution to this equation is 3.

The example consists of four routines: the main routine, the integration in the y direction, the second integration of the x coefficient, and the second integration of the $x^2$ coefficient. The main routine is the last routine in the program. To run this example, copy the text of all four routines, paste them into an IDL editor window, and save the window's contents as `DoubleIntegration.pro`.

```
FUNCTION XSquaredCoef, x

   ; Integration of the x squared coefficient.
   secondIntegration = 9.*x^2
   RETURN, secondIntegration

END

FUNCTION XCoef, x

   ; Integration of the linear x coefficient.
   secondIntegration = x
   RETURN, secondIntegration

END

FUNCTION YDirection, y

   ; Re-write equation to consider both x coefficents.
   firstIntegration = QROMB('XSquaredCoef', 0., 1.)*y^2 $
   + 4.*(QROMB('XCoef', 0., 1.))*y + 1.
   RETURN, firstIntegration

END

PRO DoubleIntegration

   ; Determine the volume under the surface represented
   ; by 9x^2y^2 + 4xy + 1 over a specific region.
   volume = QROMB('YDirection', 0., 1. )
```

```
   ; Output results.
   PRINT, 'Resulting Volume:  ', volume

END
```

## Example 3

This example evaluates the mass of a volume using the following triple integration on a three-dimensional equation representing its density:

$$\text{mass} = \int_0^1 \int_0^1 \int_0^1 (9x^2y^2 + 8xyz + 1)dxdydz$$

The exact solution to this equation is 3.

The example consists of six routines: the main routine, the integration in the z-direction, the second integration of the xy coefficient, the second integration of the second $x^2y^2$ coefficient, the third integration in the x coefficient, and the third integration in the $x^2$ coefficient. The main routine is the last routine in the program. To run this example, copy the text of all six routines, paste them into an IDL editor window, and save the window's contents as `TripleIntegration.pro`.

```
FUNCTION XSquaredCoef, x

   ; Integration of the x squared coefficient.
   thirdIntegration = 9.*x^2
   RETURN, thirdIntegration

END

FUNCTION XCoef, x

   ; Integration of the linear x coefficient.
   thirdIntegration = x
   RETURN, thirdIntegration

END

FUNCTION XSquaredYSquaredCoef, y

   ; Integration of the y squared coefficient.
   secondIntegration = QROMB('XSquaredCoef', 0., 1.)*y^2
   RETURN, secondIntegration

END
```

```
FUNCTION XYCoef, y

   ; Integration of the linear y coefficient.
   secondIntegration = QROMB('XCoef', 0., 1.)*y
   RETURN, secondIntegration

END

FUNCTION ZDirection, z

   ; Re-write equation to consider all the x and y
   ; coefficients.
   firstIntegration = QROMB('XSquaredYSquaredCoef', 0., 1.) + $
   8.*(QROMB('XYCoef', 0., 1.))*z + 1.
   RETURN, firstIntegration

END

PRO TripleIntegration

   ; Determine the mass of the density represented
   ; by 9x^2y^2 + 8xyz + 1 over a specific region.
   mass = QROMB('ZDirection', 0., 1. )

   ; Output results.
   PRINT, 'Resulting Mass:  ', mass

END
```

## Version History

Introduced: 4.0

## See Also

INT_2D, INT_3D, INT_TABULATED, QROMO, QSIMP

# QROMO

The QROMO function evaluates the integral of a function over the open interval (*A*, *B*) using a modified Romberg's method.

QROMO is based on the routine `qromo` described in section 4.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = QROMO(*Func*, *A* [, *B*] [, /DOUBLE] [, EPS=*value*] [, JMAX=*value*] [, K=*value*] [, /MIDEXP | , /MIDINF | , /MIDPNT | , /MIDSQL | , /MIDSQU] )

## Return Value

Returns the integral of the function.

## Arguments

### Func

A scalar string specifying the name of a user-supplied IDL function to be integrated. This function must accept a single scalar argument *X* and return a scalar result. It must be defined over the open interval (*A*, *B*).

For example, if we wish to integrate the fourth-order polynomial

$$y = 1 / x^4$$

we define a function HYPER to express this relationship in the IDL language:

```
FUNCTION hyper, X
   RETURN, 1.0 / X^4
END
```

### A

The lower limit of the integration. *A* can be either a scalar or an array.

### B

The upper limit of the integration. *B* can be either a scalar or an array. If the MIDEXP keyword is specified, *B* is assumed to be infinite, and should not be supplied by the user.

Note: If arrays are specified for *A* and *B*, then QROMO integrates the user-supplied function over the interval [$A_i$, $B_i$] for each *i*. If either *A* or *B* is a scalar and the other an array, the scalar is paired with each array element in turn.

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## EPS

The fractional accuracy desired, as determined by the extrapolation error estimate. For single-precision calculations, the default value is $1.0 \times 10^{-6}$. For double-precision calculations, the default value is $1.0 \times 10^{-12}$.

## JMAX

Set to specify the maximum allowed number of mid quadrature points to be $3^{(JMAX - 1)}$. The default value is 14.

## K

Integration is performed by Romberg's method of order 2K. If not specified, the default is K=5.

## MIDEXP

Use the `midexp()` function (see *Numerical Recipes*, section 4.4) as the integrating function. If the MIDEXP keyword is specified, argument B is assumed to be infinite, and should not be supplied by the user.

## MIDINF

Use the `midinf()` function (see *Numerical Recipes*, section 4.4) as the integrating function.

## MIDPNT

Use the `midpnt()` function (see *Numerical Recipes*, section 4.4) as the integrating function. This is the default if no other integrating function keyword is specified.

### MIDSQL

Use the `midsql()` function (see *Numerical Recipes*, section 4.4) as the integrating function.

### MIDSQU

Use the `midsqu()` function (see *Numerical Recipes*, section 4.4) as the integrating function.

## Examples

Consider the following function:

```
FUNCTION hyper, X
   RETURN, 1.0 / X^4
END
```

This example integrates the HYPER function over the open interval (2, ∞) and prints the result:

```
PRINT, QROMO('hyper', 2.0, /MIDEXP)
```

IDL prints:

```
 0.0412050
```

**Warning**

When using the MIDEXP keyword, the upper integration limit is assumed to be infinity and is not supplied.

## Version History

Introduced: 4.0

## See Also

INT_2D, INT_3D, INT_TABULATED, QROMB, QSIMP

# QSIMP

The QSIMP function performs numerical integration of a function over the closed interval [*A*, *B*] using Simpson's rule.

QSIMP is based on the routine `qsimp` described in section 4.2 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = QSIMP( *Func*, *A*, *B* [, /DOUBLE] [, EPS=*value*] [, JMAX=*value*] )

## Return Value

The result will have the same structure as the smaller of *A* and *B*, and the resulting type will be single- or double-precision floating, depending on the input types.

## Arguments

### Func

A scalar string specifying the name of a user-supplied IDL function to be integrated. This function must accept a single scalar argument *X* and return a scalar result. It must be defined over the closed interval [*A*, *B*].

For example, if we wish to integrate the fourth-order polynomial

$$y = (x^4 - 2x^2) \sin(x)$$

we define a function SIMPSON to express this relationship in the IDL language:

```
FUNCTION simpson, X
   RETURN, (X^4 - 2.0 * X^2) * SIN(X)
END
```

### A

The lower limit of the integration. *A* can be either a scalar or an array.

### B

The upper limit of the integration. *B* can be either a scalar or an array.

**Note**

If arrays are specified for *A* and *B*, then QSIMP integrates the user-supplied function over the interval $[A_i, B_i]$ for each *i*. If either *A* or *B* is a scalar and the other an array, the scalar is paired with each array element in turn.

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## EPS

The desired fractional accuracy. For single-precision calculations, the default value is $1.0 \times 10^{-6}$. For double-precision calculations, the default value is $1.0 \times 10^{-12}$.

## JMAX

$2^{(JMAX - 1)}$ is the maximum allowed number of steps. If not specified, a default of 20 is used.

# Examples

To integrate the SIMPSON function (listed above) over the interval $[0, \pi/2]$ and print the result:

```
; Define lower limit of integration:
A = 0.0

; Define upper limit of integration:
B = !PI/2.0

PRINT, QSIMP('simpson', A, B)
```

IDL prints:

```
 -0.479158
```

The exact solution can be found using the integration-by-parts formula:

```
FB = 4.*B*(B^2-7.)*SIN(B) - (B^4-14.*B^2+28.)*COS(B)
FA = 4.*A*(A^2-7.)*SIN(A) - (A^4-14.*A^2+28.)*COS(A)
exact = FB - FA
PRINT, exact
```

IDL prints:

```
-0.479156
```

## Version History

Introduced: 4.0

## See Also

INT_2D, INT_3D, INT_TABULATED, QROMB, QROMO

# QUERY_* Routines

Query routines allow users to obtain information about an image file without having to read the file. The following QUERY_* routines are available in IDL:

- QUERY_BMP
- QUERY_DICOM
- QUERY_IMAGE
- QUERY_JPEG
- QUERY_MRSID
- QUERY_PICT
- QUERY_PNG
- QUERY_PPM
- QUERY_SRF
- QUERY_TIFF
- QUERY_WAV
-

All of the QUERY_* routines return a result, which is a long with the value of 1 if the query was successful (and the file type was correct) or 0 on failure. If the query was successful, the return argument will be an anonymous structure containing all of the available information for that image format.

The status is intended to be used to determine if it is appropriate to use the corresponding READ_ routine for a given file. The return status of the QUERY_* will indicate success if the corresponding READ_ routine is likely to be able to read the file. The return status will indicate failure for cases that contain formats that are not supported by the READ_ routines, even though the files may be valid outside of the IDL environment. For example, IDL's READ_BMP does not support 1-bit-deep images and so the QUERY_BMP function would return failure in the case of a monochrome BMP file.

The returned anonymous structure will have (minimally) the following fields for all file formats. If the file does not support multiple images in a single file, the NUM_IMAGES field will always be 1 and the IMAGE_INDEX field will always be 0. Individual routines document additional fields which are returned for a specific format.

## General Query * Routine Info Structures

| Field | IDL data type | Description |
|---|---|---|
| CHANNELS | Long | Number of samples per pixel |
| DIMENSIONS | 2-D long array | Size of the image in pixels |
| HAS_PALETTE | Integer | True if a palette is present |
| NUM_IMAGES | Long | Number of images in the file |
| IMAGE_INDEX | Long | Image number for which this structure is valid |
| PIXEL_TYPE | Integer | IDL basic type code for a pixel sample |
| TYPE | String | String identifying the file format |

*Table 78: Query Routines Info Structure*

All the routines accept the IMAGE_INDEX keyword although formats which do not support multiple images in a single file will ignore this keyword.

## QUERY_TIFF-Specific Routine Info Structures

| Field | IDL data type | Description |
|---|---|---|
| BITS_PER_SAMPLE | Long | Number of bits per channel. Possible values are 1, 4, 8, 16, or 32. |

*Table 79: QUERY_TIFF Routine Info Structure*

| Field | IDL data type | Description |
|---|---|---|
| ORIENTATION | Long | Image orientation (columns, rows):<br>• 1 = Left to right, top to bottom (default)<br>• 2 = Right to left, top to bottom<br>• 3 = Right to left, bottom to top<br>• 4 = Left to right, bottom to top<br>• 5 = Top to bottom, left to right<br>• 6 = Top to bottom, right to left<br>• 7 = Bottom to top, right to left<br>• 8 = Bottom to top, left to right |
| PLANAR_CONFIG | Long | How the components of each pixel are stored. Possible values are:<br>• 1 = Pixel interleaved RGB image or a two-dimensional image (no interleaving exists). Pixel components (such as RGB) are stored contiguously.<br>• 2 = Image interleaved. Pixel components are stored in separate planes. |
| PHOTOMETRIC | Long | Color mode used for the image data. Possible values are:<br>• 0 = White is zero<br>• 1 = Black is zero<br>• 2 = RGB color model<br>• 3 = Palette color model<br>• 4 = Transparency mask<br>• 5 = Separated (usually CMYK) |

*Table 79: QUERY_TIFF Routine Info Structure (Continued)*

| Field | IDL data type | Description |
|---|---|---|
| RESOLUTION | Float array | Two-element vector [*X resolution*, *Y resolution*] containing the number of pixels per *unit* (as reported in the UNITS field). |
| UNITS | Long | Units of measurement for RESOLUTION:<br>• 1 = No units<br>• 2 = Inches (the default)<br>• 3 = Centimeters<br>For example, if the UNITS field contains the value 2, then the values in the RESOLUTION field represent pixels per inch. |
| TILE_SIZE | Long array | Two-element vector [*Tile width*, *Tile height*]. Non-tiled images will contain [*Image width*, 1] |

*Table 79: QUERY_TIFF Routine Info Structure (Continued)*

# QUERY_BMP

QUERY_BMP is a method of obtaining information about a BMP image file without having to read the file. See “QUERY_* Routines” on page 1551 for more information.

## Syntax

*Result* = QUERY_BMP ( *Filename* [, *Info*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the pathname of the BMP file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘BMP’.

**Note**

See “General Query * Routine Info Structures” on page 1552 for detailed structure information.

## Keywords

There are no keywords for this routine.

## Version History

Introduced: 5.2

## See Also

QUERY_* Routines, READ_BMP, WRITE_BMP

# QUERY_DICOM

The QUERY_DICOM function tests a file for compatibility with READ_DICOM and returns an optional structure containing information about images in the DICOM file. This function supports cases in which a blank DICOM tag is supplied.

This routine is written in the IDL language. Its source code can be found in the file `query_dicom.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = QUERY_DICOM( *Filename* [, *Info*] [, IMAGE_INDEX=*index*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful or 0 (zero) on failure. A result of 1 means it is likely that the file can be read by READ_DICOM.

## Arguments

### Filename

A scalar string containing the full pathname of the file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘DICOM’.

**Note**

See “General Query * Routine Info Structures” on page 1552 for detailed structure information.

## Keywords

### IMAGE_INDEX

Set this keyword to the index (zero based) of the image being queried in the file. This keyword has no effect on files containing a single image.

## Examples

DICOM palette vectors are 16 bit quantities and may not cover the entire dynamic range of the image. To view a paletted DICOM image use the following:

```
IF (QUERY_DICOM('file.dcm',info)) THEN BEGIN
   IF (info.has_palette) THEN BEGIN
      TV, READ_IMAGE('file.dcm',r, g, b), /ORDER
      TVLCT,r/256, g/256, b/256
   ENDIF
ENDIF
```

## Version History

Introduced: 5.2

## See Also

READ_DICOM

# QUERY_IMAGE

The QUERY_IMAGE function determines whether a file is recognized as a supported image file. QUERY_IMAGE first checks the filename suffix, and if found, calls the corresponding QUERY_ routine. For example, if the specified file is image.bmp, QUERY_BMP is called to determine if the file is a valid .bmp file. If the file does not contain a filename suffix, or if the query fails on the specified filename suffix, QUERY_IMAGE checks against all supported file types.

## Syntax

*Result* = QUERY_IMAGE ( *Filename*[, *Info*] [, CHANNELS=*variable*]
[, DIMENSIONS=*variable*] [, HAS_PALETTE=*variable*]
[, IMAGE_INDEX=*index*] [, NUM_IMAGES=*variable*] [, PIXEL_TYPE=*variable*]
[, SUPPORTED_READ=*variable*] [, SUPPORTED_WRITE=*variable*]
[, TYPE=*variable*] )

## Return Value

Result is a long with the value of 1 if the query was successful (the file was recognized as an image file) or 0 on failure. The return status will indicate failure for files that contain formats that are not supported by the corresponding READ_* routine, even though the file may be valid outside the IDL environment.

If the file is a supported image file, an optional structure containing information about the image is returned. If the file is not a supported image file, QUERY_IMAGE returns 0.

## Arguments

### Filename

A scalar string containing the name of the file to query.

### Info

An optional anonymous structure containing information about the image. This structure is valid only when the return value of the function is 1. The Info structure for all image types has the following fields:

| Tag | Type |
|---|---|
| CHANNELS | Long |
| DIMENSIONS | Two-dimensional long array |
| FILENAME | Scalar string |
| HAS_PALETTE | Integer |
| IMAGE_INDEX | Long |
| NUM_IMAGES | Long |
| PIXEL_TYPE | Integer |
| TYPE | Scalar string |

*Table 80: The Info Structure for All Image Types*

## Keywords

### CHANNELS

Set this keyword to a named variable to retrieve the number of channels in the image.

### DIMENSIONS

Set this keyword to a named variable to retrieve the image dimensions as a two-dimensional array.

### HAS_PALETTE

Set this keyword to a named variable to equal to 1 if a palette is present, else 0.

### IMAGE_INDEX

Set this keyword to the index of the image to query from the file. The default is 0, the first image.

## NUM_IMAGES

Set this keyword to a named variable to retrieve the number of images in the file.

## PIXEL_TYPE

Set this keyword to a named variable to retrieve the IDL Type Code of the image pixel format. See the documentation for the SIZE routine for a complete list of IDL Type Codes.

The valid types for PIXEL_TYPE are:

- 1 = Byte
- 2 = Integer
- 3 = Longword Integer
- 4 = Floating Point
- 5 = Double-precision Floating Point
- 12 = Unsigned Integer
- 13 - Unsigned Longword Integer
- 14 - 64-bit Integer
- 15 - Unsigned 64-bit Integer

## SUPPORTED_READ

Set this keyword to a named variable to retrieve a string array of image types recognized by READ_IMAGE. If the SUPPORTED_READ keyword is used the filename and info arguments are optional.

## SUPPORTED_WRITE

Set this keyword to a named variable to retrieve a string array of image types recognized by WRITE_IMAGE. If the SUPPORTED_WRITE keyword is used the filename and info arguments are optional.

## TYPE

Set this keyword to a named variable to retrieve the image type as a scalar string. Possible return values are BMP, JPEG, PNG, PPM, SRF, TIFF, or DICOM.

## Version History

Introduced: 5.3

# QUERY_JPEG

QUERY_JPG is a method of obtaining information about a JPEG image file without having to read the file. See “QUERY_* Routines” on page 1551 for more information.

## Syntax

*Result* = QUERY_JPEG ( *Filename* [, *Info*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the pathname of the JPEG file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘JPEG’.

**Note**

See “General Query * Routine Info Structures” on page 1552 for detailed structure information.

## Keywords

None.

## Version History

Introduced: 5.2

## See Also

QUERY_* Routines, READ_JPEG, WRITE_JPEG

# QUERY_MRSID

The QUERY_MRSID function allows you to obtain information about a MrSID image file without having to read the file. It is a wrapper around the object interface that presents MrSID image loading in a familiar way to users of the QUERY_* image routines. (See “QUERY_* Routines” on page 1551 for more information.) However this function is not as efficient as the object interface and the object interface should be used whenever possible. See “IDLffMrSID” on page 2629 for information about the object interface.

## Syntax

*Result* = QUERY_MRSID( *Filename* [, *Info*] [, LEVEL=*lvl*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the full path and filename of the MrSID file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value 'MrSID'.

The anonymous structure is detailed in the QUERY_* Routines documentation. However, the info structure filled in by QUERY_MRSID has additional members appended to the end:

- info.LEVELS – a named variable that will contain a two-element integer vector of the form [minlvl, maxlvl] that specifies the range of levels within the current image. Higher levels are lower resolution. A level of 0 equals full resolution. Negative values specify higher levels of resolution.
- Info.GEO_VALID – a long integer with a value of 1 if the file contains valid georeferencing data, or 0 if the georeferencing data is nonexistent or unsupported.

**Note**

Always verify that this keyword returns 1 before using the data returned by any other GEO_* keyword.

- Info.GEO_PROJTYPE – unsigned integer.
- Info.GEO_ORIGIN – 2-element double precision array.
- Info.GEO_RESOLUTION – 2-element double precision array.

See "IDLffMrSID::GetProperty" on page 2637 for more information on GEO_* values.

# Keywords

## LEVEL

Set this keyword to an integer that specifies the level to which the DIMENSIONS field of the info structure corresponds. This can be used, for example, to determine what level is required to fit the image into a certain area. If this keyword is not specified, the dimensions at level 0 are returned.

# Examples

```
; Select the image file.
file = QUERY_MRSID(FILEPATH('test_gs.sid', $
   SUBDIRECTORY=['examples', 'data']), info, LEVEL = -2)

HELP, file
; IDL returns 1 indicating the correct file type
; and successful query.

; Print the range of levels of resolution available within
; the file.
PRINT, 'Range of image levels = ', info.LEVELS

; Print the image dimensions when the image level is set to -2
; as specified by LEVEL = -2 in the QUERY_MRSID statement.
PRINT, 'dimensions of image at LEVEL is -2 =', info.DIMENSIONS
; IDL returns 2048 by 2048

; Check for valid georeferencing data.
PRINT, 'Result of georeferencing query', info.GEO_VALID
; IDL returns 0 indicating that the file does not contain
; georeferencing data.
```

## Version History

Introduced: 5.5

# QUERY_PICT

QUERY_PICT is a method of obtaining information about a PICT image file without having to read the file. See “QUERY_* Routines” on page 1551 for more information.

## Syntax

*Result* = QUERY_PICT ( *Filename* [, *Info*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the pathname of the PICT file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘PICT’.

**Note**

See “General Query * Routine Info Structures” on page 1552 for detailed structure information.

## Keywords

None

## Version History

Introduced: 5.2

## See Also

QUERY_* Routines, READ_PICT, WRITE_PICT

# QUERY_PNG

QUERY_PNG is a method of obtaining information about a PNG image file without having to read the file. See “QUERY_* Routines” on page 1551 for more information.

## Syntax

*Result* = QUERY_PNG ( *Filename* [, *Info*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the pathname of the PNG file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘PNG’.

**Note**

See “General Query * Routine Info Structures” on page 1552 for detailed structure information.

## Keywords

None

## Examples

Query included in creating RGBA (16-bit/channel) and Color Indexed (8-bits/channel) image.

```
rgbdata = UINDGEN(4,320,240)
cidata = BYTSCL(DIST(256))
red = indgen(256)
```

```
green = indgen(256)
blue = indgen(256)
WRITE_PNG,'rgb_image.png',rgbdata
WRITE_PNG,'ci_image.png',cidata,red,green,blue

; Query and Read the data:
names = ['rgb_image.png','ci_image.png','unknown.png']

FOR i=0,N_ELEMENTS(names)-1 DO BEGIN
   ok = QUERY_PNG(names[i],s)
   IF (ok) THEN BEGIN
   HELP,s,/STRUCTURE
   IF (s.HAS_PALETTE) THEN BEGIN
      img = READ_PNG(names[i],rpal,gpal,bpal)
      HELP,img,rpal,gpal,bpal
   ENDIF ELSE BEGIN
      img = READ_PNG(names[i])
      HELP,img
   ENDELSE
   ENDIF ELSE BEGIN
      PRINT,names[i],' is not a PNG file'
   ENDELSE
ENDFOR
END
```

## Version History

Introduced: 5.2

## See Also

QUERY_* Routines, READ_PNG, WRITE_PNG

# QUERY_PPM

QUERY_PPM is a method of obtaining information about a PPM image file without having to read the file. See “QUERY_* Routines” on page 1551 for more information.

## Syntax

*Result* = QUERY_PPM ( *Filename* [, *Info*] [, MAXVAL=*variable*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the pathname of the PPM file to query.

### Info

Returns an anonymous structure containing information about the image. The Info.TYPE field will return the value ‘PPM’.

Additional field in the Info structure: MAXVAL - maximum pixel value in the image.

**Note**

See “General Query * Routine Info Structures” on page 1552 for detailed structure information.

## Keywords

### MAXVAL

Set this keyword to a named variable to retrieve the maximum pixel value in the image.

## Version History

Introduced: 5.2

## See Also

QUERY_* Routines, READ_PPM, WRITE_PPM

# QUERY_SRF

QUERY_SRF is a method of obtaining information about an SRF image file without having to read the file. See “QUERY_* Routines” on page 1551 for more information.

## Syntax

*Result* = QUERY_SRF (*Filename* [, *Info*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the pathname of the SRF file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘SRF’.

**Note**

See “General Query * Routine Info Structures” on page 1552 for detailed structure information.

## Keywords

None.

## Version History

Introduced: 5.2

## See Also

QUERY_* Routines, READ_SRF, WRITE_SRF

# QUERY_TIFF

QUERY_TIFF is a method of obtaining information about a TIFF image file without having to read the file. See “QUERY_* Routines” on page 1551 for more information.

## Syntax

*Result* = QUERY_TIFF ( *Filename* [, *Info*] [, IMAGE_INDEX=*index*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the pathname of the TIFF file to query.

### Info

Returns an anonymous structure containing information about the image in the file. The Info.TYPE field will return the value ‘TIFF’.

**Note**

In addition to the fields returned in the Info structure for all image types, there are a number of extra fields in the Info structure for TIFF images. See “QUERY_TIFF-Specific Routine Info Structures” on page 1552 for detailed structure info.

## Keywords

### IMAGE_INDEX

Image number index. If this value is larger than the number of images in the file, the function returns 0 (failure).

## Examples

This is an example of using QUERY_TIFF to write and read a multi-image TIFF file. The first image is a 16-bit, single channel image stored using compression. The second image is an RGB image stored using 32-bits/channel uncompressed.

```
; Write the image data:
data = FIX(DIST(256))
rgbdata = LONARR(3,320,240)
WRITE_TIFF,'multi.tif',data,COMPRESSION=1,/SHORT
WRITE_TIFF,'multi.tif',rgbdata,/LONG,/APPEND

; Read the image data back:
ok = QUERY_TIFF('multi.tif',s)
IF (ok) THEN BEGIN
   FOR i=0,s.NUM_IMAGES-1 DO BEGIN
      imp = QUERY_TIFF('multi.tif',t,IMAGE_INDEX=i)
      img = READ_TIFF('multi.tif',IMAGE_INDEX=i)
      HELP,t,/STRUCTURE
      HELP,img
   ENDFOR
ENDIF
```

## Version History

Introduced: 5.2

## See Also

QUERY_* Routines, READ_TIFF, WRITE_TIFF

# QUERY_WAV

The QUERY_WAV function checks that the file is actually a .WAV file and that the READ_WAV function can read the data in the file. Optionally, it can return additional information about the data in the file.

## Syntax

*Result* = QUERY_WAV ( *Filename*[, *Info*] )

## Return Value

This routine returns a long with the value of 1 (one) if the query was successful (and the file type was correct) or 0 (zero) on failure.

## Arguments

### Filename

A scalar string containing the full pathname of the .WAV file to read.

### Info

An anonymous structure containing information about the data in the file. The fields are defined as:

| Tag | Type | Definition |
|---|---|---|
| CHANNELS | INT | Number of data channels in the file. |
| SAMPLES_PER_SEC | LONG | Data sampling rate in samples per second. |
| BITS_PER_SAMPLE | INT | Number of valid bits in the data. |

*Table 81: The Info Structure for Info Fields*

## Keywords

None.

## Version History

Introduced: 5.3

# R_CORRELATE

The R_CORRELATE function computes Spearman's (rho) or Kendalls's (tau) rank correlation of two sample populations *X* and *Y*. The result is a two-element vector containing the rank correlation coefficient and the two-sided significance of its deviation from zero. The significance is a value in the interval [0.0, 1.0]; a small value indicates a significant correlation.

$$\text{rho} = \frac{\sum_{i=0}^{N-1} (Rx_i - \overline{Rx})(Ry_i - \overline{Ry})}{\sqrt{\sum_{i=0}^{N-1} (Rx_i - \overline{Rx})^2} \sqrt{\sum_{i=0}^{N-1} (Ry_i - \overline{Ry})^2}}$$

where $Rx_i$ and $Ry_i$ are the magnitude-based ranks among *X* and *Y*, respectively. Elements of identical magnitude are ranked using a rank equal to the mean of the ranks that would otherwise be assigned.

This routine is written in the IDL language. Its source code can be found in the file `r_correlate.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = R_CORRELATE( *X*, *Y* [, D=*variable*] [, /KENDALL] [, PROBD=*variable*] [, ZD=*variable*] )

## Return Value

Returns a two-element vector indicating the rank correlation coefficient and the significance of its deviation from zero.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector.

### Y

An *n*-element integer, single-, or double-precision floating-point vector.

# Keywords

## D

Set this keyword to a named variable that will contain the sum-squared difference of ranks. If the KENDALL keyword is set, this parameter is returned as zero.

## KENDALL

Set this keyword to compute Kendalls's (tau) rank correlation. By default, Spearman's (rho) rank correlation is computed.

## PROBD

Set this keyword to a named variable that will contain the two-sided significance level of ZD. If the KENDALL keyword is set, this parameter is returned as zero.

## ZD

Set this keyword to a named variable that will contain the number of standard deviations by which D deviates from its null-hypothesis expected value. If the KENDALL keyword is set, this parameter is returned as zero.

# Examples

```
; Define two n-element sample populations:
X = [257, 208, 296, 324, 240, 246, 267, 311, 324, 323, 263, $
     305, 270, 260, 251, 275, 288, 242, 304, 267]
Y = [201, 56, 185, 221, 165, 161, 182, 239, 278, 243, 197, $
     271, 214, 216, 175, 192, 208, 150, 281, 196]

; Compute Spearman's (rho) rank correlation of X and Y.
result = R_CORRELATE(X, Y)
PRINT, 'Spearman's (rho) rank correlation: ', result

; Compute Kendalls's (tau) rank correlation of X and Y:
result = R_CORRELATE(X, Y, /KENDALL)
PRINT, 'Kendalls's (tau) rank correlation: ', result
```

IDL prints:

```
Spearman's (rho) rank correlation:   0.835967  4.42899e-006
Kendalls's (tau) rank correlation:   0.624347  0.000118729
```

## Version History

Introduced: 4.0

## See Also

A_CORRELATE, C_CORRELATE, CORRELATE, M_CORRELATE, P_CORRELATE

# R_TEST

The R_TEST function tests the hypothesis that a binary population (a sequence of 1s and 0s) represents a “random sampling”.

This routine is written in the IDL language. Its source code can be found in the file `r_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = R_TEST( *X* [, N0=*variable*] [, N1=*variable*] [, R=*variable*] )

## Return Value

The result is a two-element vector containing the nearly-normal test statistic Z and its associated probability. This two-tailed test is based on the “theory of runs” and is often referred to as the “Runs Test for Randomness.”

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector. Elements not equal to 0 or 1 are removed and the length of *X* is correspondingly reduced.

## Keywords

### N0

Set this keyword to a named variable that will contain the number of 0s in *X*.

### N1

Set this keyword to a named variable that will contain the number of 1s in *X*.

### R

Set this keyword to a named variable that will contain the number of runs (clusters of 0s and 1s) in *X*.

## Examples

```
; Define a binary population:
X = [0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0, $
   1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1]

; Test the hypothesis that X represents a random sampling against
; the hypothesis that it does not represent a random sampling at
; the 0.05 significance level:
result = R_TEST(X, R = r, N0 = n0, N1 = n1)
PRINT, result
```

IDL prints:

```
[2.26487, 0.0117604]
```

Print the values of the keyword parameters:

```
PRINT, 'Runs: ', r & PRINT, 'Zeros: ', n0 & PRINT, 'Ones: ', n1
Runs:     22
Zeros:    16
Ones:     14
```

The computed probability (0.0117604) is less than the 0.05 significance level and therefore we reject the hypothesis that *X* represents a random sampling. The results show that there are too many runs, indicating a non-random cyclical pattern.

## Version History

Introduced: 4.0

## See Also

CTI_TEST, FV_TEST, KW_TEST, LNP_TEST, MD_TEST, RS_TEST, S_TEST, TM_TEST, XSQ_TEST

# RADON

The RADON function implements the Radon transform, used to detect features within a two-dimensional image. This function can be used to return either the Radon transform, which transforms lines through an image to points in the Radon domain, or the Radon backprojection, where each point in the Radon domain is transformed to a straight line in the image.

## Radon Transform Theory

The Radon transform is used to detect features within an image. Given a function $A(x, y)$, the Radon transform is defined as:

$$R(\theta, \rho) = \int_{-\infty}^{\infty} A(\rho \cos\theta - s \sin\theta, \rho \sin\theta + s \cos\theta) ds$$

This equation describes the integral along a line $s$ through the image, where $\rho$ is the distance of the line from the origin and $\theta$ is the angle from the horizontal.

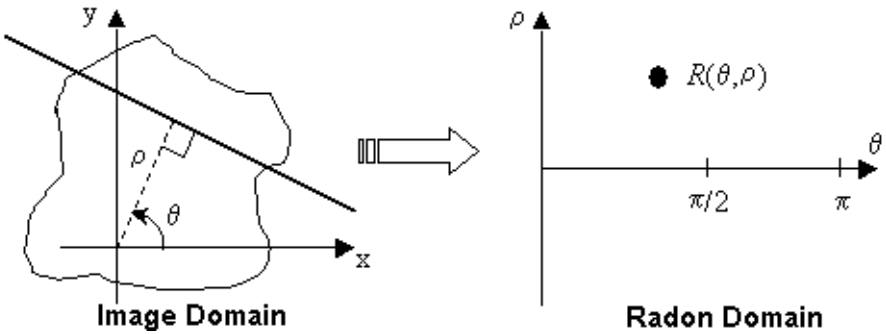



*Figure 16: The Radon Transform*

In medical imaging, each point $R(\theta, \rho)$ is called a ray-sum, while the resulting image is called a shadowgram. An image can be reconstructed from its ray-sums using the backprojection operator:

$$B(x, y) = \int_0^{\pi} R(\theta, x \cos\theta + y \sin\theta) d\theta$$

where the output, $B(x, y)$, is an image of $A(x, y)$ blurred by the Radon transform.

## How IDL Implements the Radon Transform

To avoid the use of a two-dimensional interpolation and decrease the interpolation errors, the Radon transform equation is rotated by θ, and the interpolation is then done along the line *s*. The transform is divided into two regions, one for nearly-horizontal lines ($\theta \le 45°$; $135° \le \theta \le 180°$), and the other for steeper lines ($45° < \theta < 135°$), where θ is assumed to lie on the interval [0°, 180°].

For nearest-neighbor interpolation (the default), the discrete transform formula for an image $A(m, n)$ [$m = 0, ..., M–1$, $n = 0, ..., N–1$] is:

$$R(\theta, \rho) = \begin{cases} \dfrac{\Delta x}{|\sin\theta|} \sum_m A(m,[am + b]) & |\sin\theta| > \dfrac{\sqrt{2}}{2} \\ \dfrac{\Delta y}{|\cos\theta|} \sum_n A([a'n + b'],n) & |\sin\theta| \le \dfrac{\sqrt{2}}{2} \end{cases}$$

where brackets [ ] indicate rounding to the nearest integer, and the slope and offsets are given by:

$$a = -\frac{\Delta x}{\Delta y}\frac{\cos\theta}{\sin\theta} \qquad b = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta y \sin\theta}$$

$$a' = \frac{1}{a} \qquad b' = \frac{\rho - x_{\min}\cos\theta - y_{\min}\sin\theta}{\Delta x \cos\theta}$$

For linear interpolation, the transform is:

where the slope and offsets are the same as above, and $\lfloor\ \rfloor$ indicates flooring to the nearest lower integer. The weighting *w* is given by the difference between $am + b$ and its floored value, or between $a'n + b'$ and its floored value.

$$R(\theta,\rho) = \begin{cases} \frac{\Delta x}{|\sin\theta|} \sum_m (1-w)A(m,\lfloor am+b \rfloor) + wA(m,\lfloor am+b \rfloor + 1) & |\sin\theta| > \frac{\sqrt{2}}{2} \\ \frac{\Delta y}{|\cos\theta|} \sum_n (1-w)A(\lfloor a'n+b' \rfloor,n) + wA(\lfloor a'n+b' \rfloor + 1,n) & |\sin\theta| \le \frac{\sqrt{2}}{2} \end{cases}$$

## How IDL Implements the Radon Backprojection

For the backprojection transform, the discrete formula for nearest-neighbor interpolation is:

$$B(m,n) = \Delta\theta \sum_t R(\theta_t,[\rho])$$

with the nearest-neighbor for ρ given by:

$$\rho = \{(m\Delta x + x_{\min})\cos\theta_t + (n\Delta y + y_{\min})\sin\theta_t - \rho_{\min}\}\Delta\rho^{-1}$$

For backprojection with linear interpolation:

$$B(m,n) = \Delta\theta \sum_t (1-w)R(\theta_t,\lfloor \rho \rfloor) + wR(\theta_t,\lfloor \rho \rfloor + 1)$$

$$w = \rho - \lfloor \rho \rfloor$$

and ρ is the same as in the nearest-neighbor.

# Syntax

**Radon Transform:**

*Result* = RADON( *Array* [, /DOUBLE] [, DRHO=*scalar*] [, DX=*scalar*] [, DY=*scalar*] [, /GRAY] [, /LINEAR] [, NRHO=*scalar*] [, NTHETA=*scalar*] [, RHO=*variable*] [, RMIN=*scalar*] [, THETA=*variable*] [, XMIN=*scalar*] [, YMIN=*scalar*] )

**Radon Backprojection:**

*Result* = RADON( *Array*, /BACKPROJECT, RHO=*variable*, THETA=*variable* [, /DOUBLE] [, DX=*scalar*] [, DY=*scalar*] [, /LINEAR] [, NX=*scalar*] [, NY=*scalar*] [, XMIN=*scalar*] [, YMIN=*scalar*] )

# Return Value

The result of this function is a two-dimensional floating-point array, or a complex array if the input image is complex. If *Array* is double-precision, or if the DOUBLE keyword is set, the result is double-precision, otherwise, the result is single-precision.

# Arguments

## Array

The two-dimensional array of size *M* by *N* to be transformed.

# Keywords

## BACKPROJECT

If set, the backprojection is computed, otherwise, the forward transform is computed.

**Note**

The Radon backprojection does not return the original image. Instead, it returns an image blurred by the Radon transform. Because the Radon transform is not one-to-one, multiple (*x*, *y*) points are mapped to a single (θ, ρ).

## DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

## DRHO

Set this keyword equal to a scalar specifying the spacing between ρ coordinates, expressed in the same units as *Array*. The default is one-half of the diagonal distance between pixels, $0.5[(DX^2 + DY^2)]^{1/2}$. Smaller values produce finer resolution, and are useful for zooming in on interesting features. Larger values may result in undersampling, and are not recommended. If BACKPROJECT is specified, this keyword is ignored.

## DX

Set this keyword equal to a scalar specifying the spacing between the horizontal (*x*) coordinates. The default is 1.0.

## DY

Set this keyword equal to a scalar specifying the spacing between the vertical (*y*) coordinates. The default is 1.0.

## GRAY

Set or omit this keyword to perform a weighted Radon transform, with the weighting given by the pixel values. If GRAY is explicitly set to zero, the image is treated as a binary image with all nonzero pixels considered as 1.

## LINEAR

Set this keyword to use linear interpolation rather than the default nearest-neighbor sampling. Results are more accurate but slower when linear interpolation is used.

## NRHO

Set this keyword equal to a scalar specifying the number of ρ coordinates to use. The default is 2 CEIL([MAX($x^2$ + $y^2$)]$^{1/2}$ / DRHO) + 1. If BACKPROJECT is specified, this keyword is ignored.

## NTHETA

Set this keyword equal to a scalar specifying the number of θ coordinates to use over the interval [0, π]. The default is CEIL(π [($M^2$+ $N^2$)/2]$^{1/2}$). Larger values produce smoother results, and are useful for filtering before backprojection. Smaller values result in broken lines in the transform, and are not recommended. If BACKPROJECT is specified, this keyword is ignored.

## NX

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of horizontal coordinates in the output *Result*. The default is FLOOR(2 MAX(|RHO|)($DX^2$ + $DY^2$)$^{-1/2}$ + 1). For the forward transform this keyword is ignored.

## NY

If BACKPROJECT is specified, set this keyword equal to a scalar specifying the number of vertical coordinates in the output *Result*. The default is FLOOR(2 MAX(|RHO|)$(DX^2 + DY^2)^{-1/2}$ + 1). For the forward transform, this keyword is ignored.

## RHO

For the forward transform, set this keyword to a named variable that will contain the radial (ρ) coordinates. If BACKPROJECT is specified, this keyword must contain the ρ coordinates of the input *Array*. The ρ coordinates should be evenly spaced and in increasing order.

## RMIN

Set this keyword equal to a scalar specifying the minimum ρ coordinate to use for the forward transform. The default is –0.5(NRHO – 1) DRHO. If BACKPROJECT is specified, this keyword is ignored.

## THETA

For the forward transform, set this keyword to a named variable containing a vector of angular (θ) coordinates to use for the transform. If NTHETA is specified instead, and THETA is set to a named variable, on exit THETA will contain the θ coordinates. If BACKPROJECT is specified, this keyword must contain the θ coordinates of the input *Array*.

## XMIN

Set this keyword equal to a scalar specifying the *x*-coordinate of the lower-left corner of the input *Array*. The default is – (*M*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the *x*-coordinate of the lower-left corner of the *Result*. In this case the default is –DX (NX–1)/2.

## YMIN

Set this keyword equal to a scalar specifying the *y*-coordinate of the lower-left corner of the input *Array*. The default is – (*N*–1)/2, where *Array* is an *M* by *N* array. If BACKPROJECT is specified, set this keyword equal to a scalar specifying the *y*-coordinate of the lower-left corner of the *Result*. In this case, the default is –DY (NY–1)/2.

# Examples

This example displays the Radon transform and the Radon backprojection:

```
PRO radon_example

   DEVICE, DECOMPOSED=0

   ;Create an image with a ring plus random noise:
   x = (LINDGEN(128,128) MOD 128) - 63.5
   y = (LINDGEN(128,128)/128) - 63.5
   radius = SQRT(x^2 + y^2)
   array = (radius GT 40) AND (radius LT 50)
   array = array + RANDOMU(seed,128,128)

   ;Create display window, set graphics properties:
   WINDOW, XSIZE=440,YSIZE=700, TITLE='Radon Example'
   !P.BACKGROUND = 255  ; white
   !P.COLOR = 0 ; black
   !P.FONT=2
   ERASE

   XYOUTS, .05, .94, 'Ring and Random Pixels', /NORMAL
   ;Display the image. 255b changes black values to white:
   TVSCL, 255b - array, .05, .75, /NORMAL

   ;Calculate and display the Radon transform:
   XYOUTS, .05, .70, 'Radon Transform', /NORMAL
   result = RADON(array, RHO=rho, THETA=theta)
   TVSCL, 255b - result, .08, .32, /NORMAL
   PLOT, theta, rho, /NODATA, /NOERASE, $
      POSITION=[0.08,0.32, 1, 0.68], $
      XSTYLE=9,YSTYLE=9,XTITLE='Theta', YTITLE='R'

   ;For simplicity in this example, remove everything except
   ;the two stripes. A better (and more complicated) method would
   ;be to choose a threshold for the result at each value of theta,
   ;perhaps based on the average of the result over the theta
   ;dimension.
   result[*,0:55] = 0
   result[*,73:181] = 0
   result[*,199:*] = 0

   ;Find the Radon backprojection and display the output:
   XYOUTS, .05, .26, 'Radon Backprojection', /NORMAL
   backproject = RADON(result, /BACKPROJECT, RHO=rho, THETA=theta)
   TVSCL, 255b - backproject, .05, .07, /NORMAL
```

```
END
```

The following figure displays the program output. The top image is an image of a ring and random pixels, or noise. The center image is the Radon transform, and displays the line integrals through the image. The bottom image is the Radon backprojection, after filtering all noise except for the two strong horizontal stripes in the middle image.

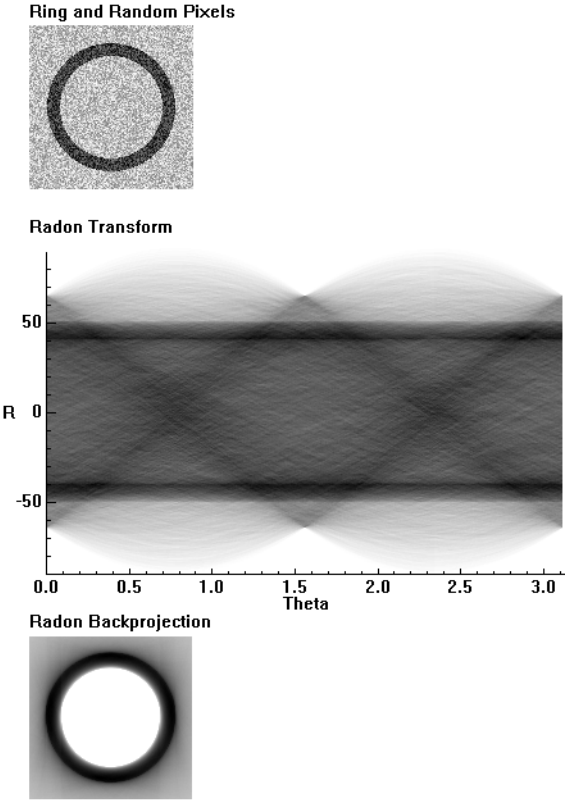



*Figure 17: Radon Example - Original image (top), Radon transform (center), and backprojection of the altered Radon transform (bottom).*

# References

1. Herman, Gabor T. *Image Reconstruction from Projections*. New York: Academic Press, 1980.

2. Hiriyannaiah, H. P. X-ray computed tomography for medical imaging. IEEE Signal Processing Magazine, March 1997: 42-58.
3. Jain, Anil K. *Fundamentals of Digital Image Processing*. Englewood Cliffs, NJ: Prentice-Hall, 1989.
4. Toft, Peter. *The Radon Transform: Theory and Implementation*. Denmark: Technical University; 1996. Ph.D. Thesis.

## Version History

Introduced: 5.4

## See Also

HOUGH, VOXEL_PROJ

# RANDOMN

The RANDOMN function returns one or more normally-distributed, floating-point, pseudo-random numbers with a mean of zero and a standard deviation of one. RANDOMN uses the Box-Muller method for generating normally-distributed (Gaussian) random numbers.

## Syntax

*Result* = RANDOMN( *Seed [, $D_1$ [, ..., $D_8$]]* [ [, BINOMIAL=*[trials, probability]*] [, /DOUBLE] [, GAMMA=*integer*{>0}] [, /NORMAL] [, POISSON=*value*] [, /UNIFORM] | [, /LONG] ] )

## Return Value

Returns an array containing the random numbers of the specified dimensions.

## Arguments

### Seed

A variable or constant used to initialize the random sequence on input, and in which the state of the random number generator is saved on output.

The state of the random number generator is contained in a long integer vector. This state is saved in the Seed argument when the argument is a named variable. To continue the pseudo-random number sequence, input the variable containing the saved state as the Seed argument in the next call to RANDOMN or RANDOMU. Each independent random number sequence should maintain its own state variable. To maintain a state over repeated calls to a procedure, the seed variable may be stored in a COMMON block.

In addition to states maintained by the user in variables, the RANDOMU and RANDOMN functions contain a single shared generic state that is used if a named variable is not supplied as the Seed argument or the named variable supplied is undefined. The generic state is initialized once using the time-of-day, and may be re-initialized by providing a Seed argument that is a constant or expression.

If the Seed argument is:

- an undefined variable — the generic state is used and the resulting generic state array is stored in the variable.

- a named variable that contains a longword array of the proper length — it is used to continue the pseudo-random sequence, and is updated.
- a named variable containing a scalar — the scalar value is used to start a new sequence and the resulting state array is stored back in the variable.
- a constant or expression — the value is used to re-initialize the generic state.

**Note**

RANDOMN and RANDOMU use the same sequence. Starting or restarting the sequence for one starts or restarts the sequence for the other. Some IDL routines use the random number generator, so using them will initialize the seed sequence. An example of such a routine is CLUST_WTS.

**Note**

Do not alter the seed value returned by this function. The only valid use for the seed argument is to pass it back to a subsequent call. Changing the value of the seed will corrupt the random sequence.

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If no dimensions are specified, RANDOMN returns a scalar result

## Keywords

The formulas for the binomial, gamma, and Poisson distributions are from section 7.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press.

### BINOMIAL

Set this keyword to a 2-element array, [*n*, *p*], to generate random deviates from a binomial distribution. If an event occurs with probability *p*, with *n* trials, then the number of times it occurs has a binomial distribution.

**Note**

For $n > 1.0 \times 10^7$, you should set the DOUBLE keyword.

## DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

RANDOMN constructs double-precision uniform random deviates using the formula:

$$Y = \frac{(i1 - 1) \cdot imax + i2}{\text{imax}^2 + 1}$$

where *i1* and *i2* are integer random deviates in the range [1...*imax*], and *imax* = $2^{31}$ - 2 is the largest possible integer random deviate. The *Y* values will be in the range 0 < *Y* < 1.

## GAMMA

Set this keyword to an integer order *i* > 0 to generate random deviates from a gamma distribution. The gamma distribution is the waiting time to the *i*th event in a Poisson random process of unit mean. A gamma distribution of order equal to 1 is the same as the exponential distribution.

**Note**

For GAMMA > 1.0 x $10^7$, you should set the DOUBLE keyword.

## LONG

Set this keyword to return integer uniform random deviates in the range [1...$2^{31}$ – 2]. If LONG is set, all other keywords are ignored.

## NORMAL

Set this keyword to generate random deviates from a normal distribution.

## POISSON

Set this keyword to the mean number of events occurring during a unit of time. The POISSON keyword returns a random deviate drawn from a Poisson distribution with that mean.

**Note**

For POISSON > 1.0 x $10^7$, you should set the DOUBLE keyword.

### UNIFORM

Set this keyword to generate random deviates from a uniform distribution.

## Examples

If you start the sequence with an *undefined* variable—if RANDOMN has already been called, *Seed* is no longer undefined—IDL initializes the sequence with the system time:

```
; Generate one random variable and initialize the sequence with an
; undefined variable:
randomValue = RANDOMN(seed)
```

The new state is saved in seed. To generate repeatable experiments, begin the sequence with a particular seed:

```
seed_value = 5L

; Generate one random variable and initialize the sequence with 5:
randomValue = RANDOMN(seed_value)

PRINT, randomValue
```

IDL prints:

```
0.521414
```

To restart the sequence with a particular seed, re-initialize the variable:

```
seed = 5L

;Get a normal random number, and restart the sequence with a seed
;of 5.
randomValue = RANDOMN(seed)

PRINT, randomValue
```

IDL prints:

```
0.521414
```

To continue the same sequence:

```
PRINT, RANDOMN(seed)
```

IDL prints:

```
-0.945489
```

To create a 10 by 10 array of normally-distributed, random numbers, type:

```
R = RANDOMN(seed, 10, 10)
```

Since seed is undefined, the generic state is used to initialize the random number generator. Print the resulting values by entering:

```
PRINT, R
```

A more interesting example plots the probability function of 2000 numbers returned by RANDOMN. Type:

```
PLOT, HISTOGRAM(RANDOMN(SEED, 2000), BINSIZE=0.1)
```

To obtain a sequence of 1000 exponential (gamma distribution, order 1) deviates, type:

```
Result = RANDOMN(seed, 1000, GAMMA=1)
```

Intuitively, the result contains a random series of waiting times for events occurring an average of one per time period.

To obtain a series of 1000 random elapsed times required for the arrival of two events, type:

```
;Returns a series of 1000 random elapsed times required for the
;arrival of two events.
Result = RANDOMN(seed, 1000, GAMMA=2)
```

To obtain a 128 x 128 array filled with Poisson deviates, with a mean of 1.5, type:

```
Result = RANDOMN(seed, 128, 128, POISSON=1.5)
```

To simulate the count of “heads” obtained when flipping a coin 10 times, type:

```
Result = RANDOMN(seed, BINOMIAL=[10,.5])
```

## Version History

Introduced: Original

## See Also

RANDOMU

# RANDOMU

The RANDOMU function returns one or more uniformly-distributed, floating-point, pseudo-random numbers in the range $0 < Y < 1.0$.

The random number generator is taken from: “Random Number Generators: Good Ones are Hard to Find”, Park and Miller, *Communications of the ACM*, Oct 1988, Vol 31, No. 10, p. 1192. To remove low-order serial correlations, a Bays-Durham shuffle is added, resulting in a random number generator similar to ran1() in Section 7.1 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press.

## Syntax

*Result* = RANDOMU( *Seed [, $D_1$ [, ..., $D_8$]]* [ [, BINOMIAL=*[trials, probability]*] [, /DOUBLE] [, GAMMA=*integer*{>0}] [, /NORMAL] [, POISSON=*value*] [, /UNIFORM] | [, /LONG] ] )

## Return Value

Returns an array of uniformly distributed random numbers of the specified dimensions.

## Arguments

### Seed

A variable or constant used to initialize the random sequence on input, and in which the state of the random number generator is saved on output.

The state of the random number generator is contained in a long integer vector. This state is saved in the Seed argument when the argument is a named variable. To continue the pseudo-random number sequence, input the variable containing the saved state as the Seed argument in the next call to RANDOMN or RANDOMU. Each independent random number sequence should maintain its own state variable. To maintain a state over repeated calls to a procedure, the seed variable may be stored in a COMMON block.

In addition to states maintained by the user in variables, the RANDOMU and RANDOMN functions contain a single shared generic state that is used if a named variable is not supplied as the Seed argument or the named variable supplied is

undefined. The generic state is initialized once using the time-of-day, and may be re-initialized by providing a Seed argument that is a constant or expression.

If the Seed argument is:

- an undefined variable — the generic state is used and the resulting generic state array is stored in the variable.
- a named variable that contains a longword array of the proper length — it is used to continue the pseudo-random sequence, and is updated.
- a named variable containing a scalar — the scalar value is used to start a new sequence and the resulting state array is stored back in the variable.
- a constant or expression — the value is used to re-initialize the generic state.

**Note**

RANDOMN and RANDOMU use the same sequence, so starting or restarting the sequence for one starts or restarts the sequence for the other. Some IDL routines use the random number generator, so using them will initialize the seed sequence. An example of such a routine is CLUST_WTS.

**Note**

Do not alter the seed value returned by this function. The only valid use for the seed argument is to pass it back to a subsequent call. Changing the value of the seed will corrupt the random sequence.

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If no dimensions are specified, RANDOMU returns a scalar result

## Keywords

The formulas for the binomial, gamma, and Poisson distributions are from Section 7.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press.

## BINOMIAL

Set this keyword to a 2-element array, [*n*, *p*], to generate random deviates from a binomial distribution. If an event occurs with probability *p*, with *n* trials, then the number of times it occurs has a binomial distribution.

**Note**

For $n > 1.0 \times 10^7$, you should set the DOUBLE keyword.

## DOUBLE

Set this keyword to force the computation to be done using double-precision arithmetic.

RANDOMU constructs double-precision uniform random deviates using the formula:

$$Y = \frac{(i1 - 1) \cdot imax + i2}{\text{imax}^2 + 1}$$

where *i1* and *i2* are integer random deviates in the range [1...*imax*], and *imax* = $2^{31} - 2$ is the largest possible integer random deviate. The *Y* values will be in the range $0 < Y < 1$.

## GAMMA

Set this keyword to an integer order $i > 0$ to generate random deviates from a gamma distribution. The gamma distribution is the waiting time to the *i*th event in a Poisson random process of unit mean. A gamma distribution of order equal to 1 is the same as the exponential distribution.

**Note**

For GAMMA > 1.0 x $10^7$, you should set the DOUBLE keyword.

## LONG

Set this keyword to return integer uniform random deviates in the range [1...$2^{31} - 2$]. If LONG is set, all other keywords are ignored.

## NORMAL

Set this keyword to generate random deviates from a normal distribution.

### POISSON

Set this keyword to the mean number of events occurring during a unit of time. The POISSON keyword returns a random deviate drawn from a Poisson distribution with that mean.

**Note**

For POISSON > $1.0 \times 10^7$, you should set the DOUBLE keyword.

### UNIFORM

Set this keyword to generate random deviates from a uniform distribution.

## Examples

This example simulates rolling two dice 10,000 times and plots the distribution of the total using RANDOMU. Enter:

```
PLOT, HISTOGRAM(FIX(6 * RANDOMU(S, 10000)) + $
   FIX(6 * RANDOMU(S, 10000)) + 2)
```

In the above statement, the expression RANDOMU(S, 10000) is a 10,000-element, floating-point array of random numbers greater than or equal to 0 and less than 1. Multiplying this array by 6 converts the range to $0 \le Y < 6$.

Applying the FIX function yields a 10,000-point integer vector with values from 0 to 5, one less than the numbers on one die. This computation is done twice, once for each die, then 2 is added to obtain a vector from 2 to 12, the total of two dice.

The HISTOGRAM function makes a vector in which each element contains the number of occurrences of dice rolls whose total is equal to the subscript of the element. Finally, this vector is plotted by the PLOT procedure.

An example of reusing a state vector to generate a repeatable sequence:

```
; Init seed for a repeatable sequence:
seed = 1001L

; Print 1st 5 numbers of sequence:
print,randomu(seed,5)
```

IDL prints:

```
      0.705884     0.285924     0.231151     0.715447     0.532836
```

Reuse a state vector:

```
; Re-init seed to same sequence:
seed = 1001L

; Get 5 number of sequence with 5 calls:
for i=0,4 do print, randomu(seed)
```

IDL prints:

```
      0.705884
      0.285924
      0.231151
      0.715447
      0.532836
```

## Version History

Introduced: Original

## See Also

RANDOMN

# RANKS

The RANKS function computes the magnitude-based ranks of a sample population *X*. Elements of identical magnitude “ties” are ranked according to the mean of the ranks that would otherwise be assigned.

This routine is written in the IDL language. Its source code can be found in the file `ranks.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = RANKS(*X*)

## Return Value

The result is a vector of ranks equal in length to *X*.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector. The elements of this vector must be in ascending order based on their magnitude.

## Keywords

None.

## Examples

```
; Define an n-element sample population:
X = [-0.8, 0.1, -2.3, -0.6, 0.2, 1.1, -0.3, 0.6, -0.2, 1.1, $
     -0.7, -0.2, 0.6, 0.4, -0.1, 1.1, -0.3, 0.3, -1.3, 1.1]

; Allocate a two-column, n-row array to store the results:
array = FLTARR(2, N_ELEMENTS(X))

; Sort the sample population and store in the 0th column of ARRAY:
array[0, *] = X[SORT(X)]
; Compute the ranks of the sorted sample population and store in
; the 1st column of ARRAY:
array[1, *] = RANKS(X[SORT(X)])
```

```
; Display the sorted sample population and corresponding ranks
; with a two-decimal format:
PRINT, array, FORMAT = '(2(5x, f5.2))'
```

IDL prints:

```
-2.30      1.00
-1.30      2.00
-0.80      3.00
-0.70      4.00
-0.60      5.00
-0.30      6.50
-0.30      6.50
-0.20      8.50
-0.20      8.50
-0.10     10.00
 0.10     11.00
 0.20     12.00
 0.30     13.00
 0.40     14.00
 0.60     15.50
 0.60     15.50
 1.10     18.50
 1.10     18.50
 1.10     18.50
 1.10     18.50
```

## Version History

Introduced: 4.0

## See Also

R_CORRELATE

# RDPIX

The RDPIX procedure interactively displays the X position, Y position, and pixel value at the cursor.

This routine is written in the IDL language. Its source code can be found in the file `rdpix.pro` in the `lib` subdirectory of the IDL distribution.

### Using RDPIX

RDPIX displays a stream of X, Y, and pixel values when the mouse cursor is moved over a graphics window. Press the left or center mouse button to create a new line of output. Press the right mouse button to exit the procedure.

## Syntax

RDPIX, *Image* [, *X0*, *Y0*]

## Arguments

### Image

The array that contains the image being displayed. This array may be of any type. Rather than reading pixel values from the display, values are taken from this parameter, avoiding scaling difficulties.

### X0, Y0

The location of the lower-left corner of the image area on screen. If these parameters are not supplied, they are assumed to be zero.

## Keywords

None.

## Version History

Introduced: Original

## See Also

CURSOR, TVRD

# READ/READF

The READ procedures perform formatted input into variables.

READ performs input from the standard input stream (IDL file unit 0), while READF requires a file unit to be explicitly specified.

## Syntax

READ, [*Prompt*,] $Var_1$, ..., $Var_n$

READF, [*Prompt*,] *Unit*, $Var_1$, ..., $Var_n$

**Keywords:** [, AM_PM=*[string, string]*] [, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*] [, MONTHS=*string_array*{12 names}] [, PROMPT=*string*]

## Arguments

### Prompt

**Note**

The PROMPT keyword should be used instead of the *Prompt* argument for compatibility with window-based versions of IDL.

A string or explicit expression (i.e, not a named variable) to be used as a prompt. This argument should not be included if the FORMAT keyword is specified. Also, if this argument begins with the characters "$(", it is taken to be a format specification as described below under "Format Compatibility".

Using the *Prompt* argument does not work well with IDL for Windows. The desired prompt string is written to the log window instead of the command input window. To create custom prompts compatible with these versions of IDL, use the PROMPT keyword, described below.

### Unit

For READF, Unit specifies the file unit from which the input is taken.

### $Var_i$

The named variables to receive the input.

**Note**

*Var*$_i$ may *not* be an element of an array variable (`arrayvar[n]`) or a field within a structure variable (`structvar.tag`). See "Parameter Passing Mechanism" in Chapter 4 of the *Building IDL Applications* manual for details.

If the variable specified for the *Var*$_i$ argument has not been previously defined, the input data is assumed to be of type float, and the variable will be created as a float.

# Keywords

## AM_PM

Supplies a string array of two names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

## DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

## FORMAT

If FORMAT is not specified, IDL uses its default rules for formatting the input. FORMAT allows the format of the input to be specified in precise detail, using a FORTRAN-style specification. See "Using Explicitly Formatted Input/Output" in Chapter 10 of the *Building IDL Applications* manual.

## MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

## PROMPT

Set this keyword to a scalar string to be used as a customized prompt for the READ command. If the PROMPT keyword or *Prompt* argument is not supplied, IDL uses a colon followed by a space (": ") as the input prompt.

## Obsolete Keywords

The following keywords are obsolete:

- KEY_ID
- KEY_MATCH
- KEY_VALUE

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Format Compatibility

If the FORMAT keyword is not present and READ is called with more than one argument, and the first argument is a scalar string starting with the characters “$(”, this initial argument is taken to be the format specification, just as if it had been specified via the FORMAT keyword. This feature is maintained for compatibility with version 1 of VMS IDL.

## Examples

To read a string value into the variable B from the keyboard, enter:

```
; Define B as a string before reading:
B = ''

; Read input from the terminal:
READ, B, PROMPT='Enter Name: '
```

To read formatted data from the previously-opened file associated with logical unit number 7 into variable C, use the command:

```
READF, 7, C
```

## Version History

Introduced: Original

## See Also

READS, READU, WRITEU

# READ_ASCII

The READ_ASCII function reads data from an ASCII file into an IDL structure variable. READ_ASCII may be used with templates created by the ASCII_TEMPLATE function.

This routine handles ASCII files consisting of an optional header of a fixed number of lines, followed by columnar data. One or more rows of data constitute a *record*. Each data element within a record is considered to be in a different column, or *field*. The data in one field must be of, or promotable to, a single type (e.g., FLOAT). Adjacent fields may be collected into multi-column fields, called *groups*. Files may also contain comments, which exist between a user-specified comment string and the corresponding end-of-line.

READ_ASCII is designed to be used with templates created by the ASCII template function.

This routine is written in the IDL language. Its source code can be found in the file `read_ascii.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = READ_ASCII( [*Filename*] [, COMMENT_SYMBOL=*string*] [, COUNT=*variable*] [, DATA_START=*lines_to_skip*] [, DELIMITER=*string*] [, HEADER=*variable*] [, MISSING_VALUE=*value*] [, NUM_RECORDS=*value*] [, RECORD_START=*index*] [, TEMPLATE=*value*] [, /VERBOSE] )

## Arguments

### Filename

A string containing the name of an ASCII file to read into an IDL variable. If *filename* is not specified, a dialog allows the user to choose a file.

## Keywords

You can define the attributes of a field in two ways. If you use a template, you can either use a previously generated template, or create a template with ASCII_TEMPLATE. You can use COMMENT_SYMBOL, DATA_START, DELIMITER, or MISSING_VALUE to either override template attributes or to provide one-time attributes for the file to be read, without a template.

## COMMENT_SYMBOL

Set this keyword to a string that identifies the character used to delineate comments in the ASCII file to be read. When READ_ASCII encounters the comment character, it discards data from that point until it reaches the end of the current line, identifying the rest of the line as a comment. The default character the null string, ‘’, specifying that no comments will be recognized.

## COUNT

Set this keyword equal to a named variable that will contain the number of records read.

## DATA_START

Set this keyword equal to the number of header lines you want to skip. The default value is 0 if no template is specified.

## DELIMITER

Set this keyword to a string that identifies the end of a field. If no delimiter is specified, READ_ASCII uses information provided by the template in use. The default is a space, ‘ ’, specifying that an empty element constitutes the end of a field.

## HEADER

Set this keyword equal to a named variable that will contain the header in a string array of length DATA_START. If no header exists, an empty string is returned.

## MISSING_VALUE

Set this keyword equal to a value used to replace any missing or invalid data. The default value, if no template is supplied, is !VALUES.F_NAN. See “!VALUES” on page 3895 for details.

## NUM_RECORDS

Set this keyword equal to the number of records to read. The default is to read up to and including the last record.

## RECORD_START

Set this keyword equal to the index of the first record to read. The default is the first record of the file (record 0).

### TEMPLATE

Use this keyword to specify the ASCII file template (generated by the function ASCII_TEMPLATE), that defines attributes of the file to be read. Specific attributes of the template may be overridden by the following keywords: COMMENT_SYMBOL, DATA_START, DELIMITER, MISSING_VALUE.

### VERBOSE

Set this keyword to print runtime messages.

## Examples

To read ASCII data using default file attributes, except for setting the number of skipped header lines to 10, type:

```
data = READ_ASCII(file, DATA_START=10)
```

To use a template to define file attributes, overriding the number of skipped header lines defined in the template, type:

```
data = READ_ASCII(file, TEMPLATE=template, DATA_START=10)
```

To use the ASCII_TEMPLATE GUI to generate a template within the function, type:

```
data = READ_ASCII(myfile, TEMPLATE=ASCII_TEMPLATE(myfile))
```

## Version History

Introduced: 5.0

## See Also

ASCII_TEMPLATE

# READ_BINARY

The READ_BINARY function reads the contents of a binary file using a passed template or basic command line keywords. Data is read from the given filename or from the current file position in the open file pointed to by FileUnit. If no template is provided, keywords can be used to read a single IDL array of data.

## Syntax

*Result* = READ_BINARY ([*Filename*] | *FileUnit* [, TEMPLATE=*template*] | [[, DATA_START=*value*] [, DATA_TYPE=*typecodes*] [, DATA_DIMS=*array*] [, ENDIAN=*string*]] )

## Return Value

The result is an array or anonymous structure containing all of the entities read from the file.

## Arguments

### Filename

A scalar string containing the name of the binary file to read. If *filename* and file unit are not specified, a dialog allows the user to choose a file.

### FileUnit

A scalar containing an open IDL file unit number to read from.

## Keywords

### DATA_DIMS

Set this keyword to a scalar or array of up to eight elements specifying the size of the data to be read and returned. For example, DATA_DIMS=[512,512] specifies that a two-dimensional, 512 by 512 array be read and returned. DATA_DIMS=0 specifies that a single, scalar value be read and returned. Default is -1, which, if a TEMPLATE is not supplied that specifies otherwise, indicates that READ_BINARY will read to end-of-file and store the result in a 1-D array.

### DATA_START

Set this keyword to specify where to begin reading in a file. This value is as an offset, in bytes, that will be applied to the initial position in the file. The default is 0.

### DATA_TYPE

Set this keyword to an IDL typecode of the data to be read. See documentation for the SIZE function for a listing of typecodes. Default is 1 (IDL's BYTE typecode).

### ENDIAN

Set this keyword to one of three string values: 'big", "little" or "native" which specifies the byte ordering of the file to be read. If the computer running READ_BINARY uses byte ordering that is different than that of the file, READ_BINARY will swap the order of bytes in multi-byte data types read from the file. (Default: "native" = perform no byte swapping.)

### TEMPLATE

Set this keyword to a template structure (created using the BINARY_TEMPLATE function) describing the file to be read. The TEMPLATE keyword cannot be used simultaneously with keywords DATA_START, DATA_TYPE, DATA_DIMS, or ENDIAN.

When a template is used with READ_BINARY, the the return value is a structure containing fields specified by the template. If a template is not used, the return value is an array.

## Version History

Introduced: 5.3

## See Also

BINARY_TEMPLATE

# READ_BMP

The READ_BMP function reads a Microsoft Windows Version 3 device independent bitmap file (.BMP) and returns the image.

READ_BMP does not handle 1-bit-deep images or compressed images, and is not fast for 4-bit images. The algorithm works best on images where the number of bytes in each scan-line is evenly divisible by 4.

This routine is written in the IDL language. Its source code can be found in the file `read_bmp.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

To find information about a potential BMP file before trying to read its data, use the QUERY_BMP function.

## Syntax

*Result* = READ_BMP( *Filename*, [, *R*, *G*, *B*] [, *Ihdr*] [, /RGB] )

## Return Value

Returns a byte array containing the image. Dimensions are taken from the BITMAPINFOHEADER of the file. In the case of 4-bit or 8-bit images, the dimensions of the resulting array are (`biWidth`, `biHeight`).

For 24-bit images, the dimensions are (3, `biWidth`, `biHeight`). Color interleaving is blue, green, red; i.e., Result[*0*,*i*,*j*] = blue, Result[*1*,*i*,*j*] = green, etc.

## Arguments

### Filename

A scalar string specifying the full path name of the bitmap file to read.

### R, G, B

Named variables that will contain the color tables from the file. There 16 elements each for 4 bit images, 256 elements each for 8 bit images. Color tables are not defined or used for 24 bit images.

### Ihdr

A named variable that will contain a structure holding the BITMAPINFOHEADER from the file. Tag names are as defined in the MS Windows Programmer's Reference Manual, Chapter 7.

## Keywords

### RGB

If this keyword is set, color interleaving of 16- and 24-bit images will be R, G, B, i.e., Result[*0*,*i*,*j*] = red, Result[*1*,*i*,*j*] = green, Result[2,*i*,*j*] = blue.

## Examples

To open, read, and display the BMP file named `foo.bmp` in the current directory and store the color vectors in the variables R, G, and B, enter:

```
; Read and display an image:
TV, READ_BMP('foo.bmp', R, G, B)

; Load its colors:
TVLCT, R, G, B
```

Many applications that use 24-bit BMP files outside IDL expect BMP files to be stored as BGR. For example, enter the following commands.

```
; Make a red square image:
a = BYTARR(3, 200, 200)
a[0, *, *] = 255

;View the image:
TV, a, /TRUE
WRITE_BMP, 'foo.bmp', a
```

If you open the `.bmp` file in certain bitmap editors, you may find that the square is blue.

```
image = READ_BMP('foo.bmp')

; IDL reads the image back in and interprets it as red:
TV, image, /TRUE

; Flip the order of the indices by adding the RGB keyword:
image = READ_BMP('foo.bmp', /RGB)

; Displays the image in blue:
TV, image, /TRUE
```

## Version History

Introduced: Pre 4.0

## See Also

WRITE_BMP, QUERY_BMP

# READ_DICOM

The READ_DICOM function reads an image from a DICOM file along with any associated color table.The return array type depends on the DICOM image pixel type.

This routine is written in the IDL language. Its source code can be found in the file `read_dicom.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = READ_DICOM (*Filename* [, *Red*, *Green*, *Blue*] [, IMAGE_INDEX=*index*])

## Return Value

The return value can be a 2-D array for grayscale or a 3-D array for TrueColor images. TrueColor images are always returned in pixel interleave format.

## Arguments

### Filename

This argument is a scalar string that contains the full pathname of the file to read.

### Red, Green, Blue

Named variables that will contain the red, green, and blue color vectors from the DICOM file if they exist.

**Note**

DICOM color vectors contain 16- bit color values that may need to be converted for use with IDL graphics routines.

## Keywords

### IMAGE_INDEX

Set this keyword to the index of the image to read from the file.

## Examples

```
TVSCL,READ_DICOM(FILEPATH('mr_knee.dcm',$
   SUBDIR=['examples','data']))
```

## Version History

Introduced: 5.2

## See Also

QUERY_DICOM

# READ_IMAGE

The READ_IMAGE function reads the image contents of a file and returns the image in an IDL variable. If the image contains a palette it can be returned as well in three IDL variables. READ_IMAGE returns the image in the form of a two-dimensional array (for grayscale images) or a (3, n, m) array (for TrueColor images). READ_IMAGE can read most types of image files supported by IDL. See QUERY_IMAGE for a list of supported formats.

## Syntax

*Result* = READ_IMAGE (*Filename* [, *Red*, *Green*, *Blue*] [, IMAGE_INDEX=*index*] )

## Return Value

Result is the image array read from the file or scalar value of -1 if the file could not be read.

## Arguments

### Filename

A scalar string containing the name of the file to read.

### Red

An optional named variable to receive the red channel of the color table if a color table exists.

### Green

An optional named variable to receive the green channel of the color table if a color table exists.

### Blue

An optional named variable to receive the blue channel of the color table if a color table exists.

# Keywords

## IMAGE_INDEX

Set this keyword to the index of the image to read from the file. The default is 0, the first image.

# Version History

Introduced: 5.3

# READ_INTERFILE

The READ_INTERFILE procedure reads image data stored in Interfile (v3.3) format.

READ_INTERFILE can only read a series of images if all images have the same height and width. It does not get additional keyword information beyond what is needed to read the image data. If any problems occur when reading the file, READ_INTERFILE prints a message and stops.

If the data is stored on a bigendian machine and read on a littleendian machine (or vice versa) the order of bytes in each pixel element may be reversed, requiring a call to BYTEORDER

This routine is written in the IDL language. Its source code can be found in the file `read_interfile.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

READ_INTERFILE, *File*, *Data*

## Return Value

Returns a 3-D array containing the image data.

## Arguments

### File

A scalar string containing the name of the Interfile to read. Note: if the Interfile has a header file and a data file, this should be the name of the header file (also called the administrative file).

### Data

A named variable that will contain a 3-D array of data as read from the file. Assumed to be a series of 2-D images.

## Keywords

None.

## Examples

```
READ_INTERFILE, '0_11.hdr', X
```

## Version History

Introduced: Pre 4.0

# READ_JPEG

The READ_JPEG procedure reads JPEG (Joint Photographic Experts Group) format compressed images from files or memory. JPEG is a standardized compression method for full-color and gray-scale images. This procedure reads JFIF, the JPEG File Interchange Format, including those produced by WRITE_JPEG. Such files are usually simply called JPEG files

READ_JPEG can optionally quantize TrueColor images contained in files to a pseudo-color palette with a specified number of colors, and with optional color dithering.

This procedure is based in part on the work of the Independent JPEG Group. For a brief explanation of JPEG, see "WRITE_JPEG" on page 2351.

**Note**

All JPEG files consist of byte data. Input data is converted to bytes before being written to a JPEG file.

**Note**

To find information about a potential JPEG file before trying to read its data, use the QUERY_JPEG function.

## Syntax

READ_JPEG [, *Filename* | , UNIT=*lun*] , *Image* [, *Colortable*] [, BUFFER=*variable*] [, COLORS=*value*{8 to 256}] [, DITHER={0 | 1 | 2}] [, /GRAYSCALE] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /TWO_PASS_QUANTIZE ]

## Arguments

### Filename

A scalar string specifying the full pathname of the JFIF format (JPEG) file to be read. If this parameter is not present, the UNIT and/or the BUFFER keywords must be specified.

### Image

A named variable to contain the image data read from the file.

### Colortable

A named variable to contain the colormap, when reading a TrueColor image that is to be quantized. On completion, this variable contains a byte array with dimensions (NCOLORS, 3). This argument is filled only if the image is color quantized (refer to the COLORS keyword).

## Keywords

### BUFFER

Set this keyword to a named variable that is used for a buffer. A buffer variable need only be supplied when reading multiple images per file. Initialize the buffer variable to empty by setting it to 0.

### COLORS

If the image file contains a TrueColor image that is to be displayed on an indexed color destination, set COLORS to the desired number of colors to be quantized. COLORS can be set to a value from 8 to 256. The DITHER and TWO_PASS_QUANTIZE keywords affect the method, speed, and quality of the color quantization. These keywords have no effect if the file contains a grayscale image.

### DITHER

Set this keyword to use dithering with color quantization (i.e., if the COLORS keyword is in use). Dithering is a method that distributes the color quantization error to surrounding pixels, to achieve higher-quality results. Set the DITHER keyword to one of the following values:

- 0 = No dithering. Images are read quickly, but quality is low.
- 1 = Floyd-Steinberg dithering. This method is relatively slow, but produces the highest quality results. This is the default behavior.
- 2 = Ordered dithering. This method is faster than Floyd-Steinberg dithering, but produces lower quality results.

### GRAYSCALE

Set this keyword to return a monochrome (grayscale) image, regardless of whether the file contains an RGB or grayscale image.

### ORDER

JPEG/JFIF images are normally written in top-to-bottom order. If the image is to be stored into the *Image* array in the standard IDL order (from bottom-to-top) set ORDER to 0. This is the default. If the image array is to be top-to-bottom order, set ORDER to 1.

### TRUE

Use this keyword to specify the index of the dimension for color interleaving when reading a TrueColor image. The default is 1, for pixel interleaving, (3, *m*, *n*). A value of 2 indicates line interleaving (*m*, 3, *n*), and 3 indicates band interleaving, (*m*, *n*, 3).

### TWO_PASS_QUANTIZE

Set this keyword to use a two-pass color quantization method when quantization is in effect (i.e., the COLORS keyword is in use). This method requires more memory and time, but produces superior results to the default one-pass quantization method.

### UNIT

This keyword can be used to designate the logical unit number of an already open JFIF file, allowing the reading of multiple images per file or the embedding of JFIF images in other data files. When using this keyword, *Filename* should not be specified.

**Note**

When opening a file intended for use with the UNIT keyword, if the filename does not end in `.jpg`, or `.jpeg`, you must specify the STDIO keyword to OPEN in order for the file to be compatible with READ_JPEG.

## Examples

```
; Read a JPEG grayscale image:
READ_JPEG, 'test.jpg', a

; Display the image:
TV, a

; Read and display a JPEG TrueColor image on a TrueColor display:
READ_JPEG, 'test.jpg', a, TRUE=1

; Display the image returned with pixel interleaving
; (i.e., with dimensions 3, m, n):
```

```
TV, a, TRUE=1
```

Read the image, setting the number of colors to be quantized to the maximum number of available colors.

```
; Read a JPEG TrueColor image on an 8-bit pseudo-color display:
READ_JPEG, 'test.jpg', a, ctable, COLORS=!D.N_COLORS-1

; Display the image:
TV, a

; Load the quantized color table:
TVLCT, ctable
```

We could have also included the TWO_PASS_QUANTIZE and DITHER keywords to improve the image's appearance.

Using the BUFFER keyword.

```
; Initialize buffer:
buff = 0
OPENR, 1, 'images.jpg'

; Process each image:
FOR i=1, nimages DO BEGIN
   ; Read next image:
   READ_JPEG, UNIT=1, BUFFER=buff, a

   ; Display the image:
    TV, a
ENDFOR

; Done:
CLOSE, 1
```

## Version History

Introduced: Pre 4.0

## See Also

WRITE_JPEG, QUERY_JPEG

# READ_MRSID

The READ_MRSID function extracts and returns image data from a MrSID file at the specified level and location. It is a wrapper around the object interface that presents MrSID image loading in a familiar way to users of the READ_* image routines. However this function is not as efficient as the object interface and the object interface should be used whenever possible. See “IDLffMrSID” on page 2629 for information about the object interface

## Syntax

*Result* = READ_MRSID ( *Filename* [, LEVEL=*lvl*] [, SUB_RECT=*rect*] )

## Return Value

*ImageData* returns an *n*-by-*w*-by-*h* array containing the image data where *n* is 1 for grayscale or 3 for RGB images, *w* is the width and *h* is the height.

**Note**

The returned image is ordered bottom-up, the first pixel returned is located at the bottom-left of the image. This differs from how data is stored in the MrSID file where the image is top-down, meaning the pixel at the start of the file is located at the top-left of the image.

## Arguments

### Filename

A scalar string containing the full path and filename of the MrSID file to read.

## Keywords

### LEVEL

Set this keyword to an integer that specifies the level at which to read the image. If this keyword is not set, the maximum level (see QUERY_MRSID) is used which returns the minimum resolution.

### SUB_RECT

Set this keyword to a four-element vector [x, y, xdim, ydim] specifying the position of the lower left-hand corner and the dimensions of the sub-rectangle of the MrSID image to return. This is useful for displaying only a portion of the high-resolution image. If this keyword is not set, the entire image will be returned. This may require significant memory if a high-resolution level is selected. If the sub-rectangle is greater than the bounds of the image at the selected level the area outside the image bounds will be set to black.

**Note**

The elements of SUB_RECT are measured in pixels at the current level. This means the point x = 10, y = 10 at level 1 will be located at x = 20, y = 20 at level 0 and x = 5, y = 5 at level 2.

## Examples

```
; Query the file.
result = QUERY_MRSID(FILE_SEARCH(!DIR, 'test_gs.sid'), info)

; If result is not zero, read in an image from the file and
; display it.
IF (result NE 0) THEN BEGIN
   PRINT, info
   imageData = READ_MRSID(FILE_SEARCH(!DIR, 'test_gs.sid'), $
      SUB_RECT = [0, 0, 200, 200], LEVEL = 3)
   oImage = OBJ_NEW('IDLgrImage', imageData, ORDER = 0)
   XOBJVIEW, oImage, BACKGROUND = [255,255,0]
ENDIF

; Use the file access object to query the file.
oMrSID = OBJ_NEW('IDLffMrSID', FILE_SEARCH(!DIR, 'test_gs.sid'))
oMrSID -> GetProperty, PIXEL_TYPE=pt, $
   CHANNELS = chan, DIMENSIONS = dims, $
   TYPE = type, LEVELS = lvls
PRINT, pt, chan, dims, type, lvls

; Use the object to read in an image from the file.
lvls = -3
dimsatlvl = oMrSID -> GetDimsAtLevel(lvls)
PRINT, dimsatlvl
imageData = oMrSID -> GetImageData(LEVEL = 3)
PRINT, size(imageData)
OBJ_DESTROY, oImage
```

## Version History

Introduced: 5.5

# READ_PICT

The READ_PICT procedure reads the contents of a PICT (version 2) format image file and returns the image and color table vectors (if present) in the form of IDL variables. The PICT format is used by Apple Macintosh computers.

This routine is written in the IDL language. Its source code can be found in the file `read_pict.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

To find information about a potential PICT file before trying to read its data, use the QUERY_PICT function.

## Syntax

READ_PICT, *Filename*, *Image* [, *R*, *G*, *B*]

## Arguments

### Filename

A scalar string specifying the full pathname of the PICT file to read.

### Image

A named variable that will contain the 2-D image read from *Filename*.

### R, G, B

Named variables that will contain the Red, Green, and Blue color vectors read from the PICT file.

## Keywords

None.

## Examples

To open and read the PICT image file named `foo.pict` in the current directory, store the image in the variable `image1`, and store the color vectors in the variables R, G, and B, enter:

```
READ_PICT, 'foo.pict', image1, R, G, B
```

To load the new color table and display the image, enter:

```
TVLCT, R, G, B
TV, image1
```

## Version History

Introduced: Pre 4.0

## See Also

WRITE_PICT, QUERY_PICT

# READ_PNG

The READ_PNG routine reads the image contents of a Portable Network Graphics (PNG) file and returns the image in an IDL variable. If the image contains a palette (see QUERY_PNG), it can be returned as well in three IDL variables. READ_PNG supports 1, 2, 3 and 4 channel images with channel depths of 8 or 16 bits.

**Note**

IDL supports version 1.0.5 of the PNG Library.

**Note**

Only single channel 8-bit images may have palettes. If an 8-bit, single-channel image has index values marked as “transparent,” these can be retrieved as well.

**Note**

To find information about a potential PNG file before trying to read its data, use the QUERY_PNG function.

## Syntax

*Result* = READ_PNG ( *Filename* [, *R*, *G*, *B*] [,/ORDER] [, /VERBOSE] [, /TRANSPARENT] )

or

READ_PNG, *Filename*, *Image* [, *R*, *G*, *B*] [,/ORDER] [, /VERBOSE] [, /TRANSPARENT]

**Note**

The procedure form of READ_PNG is available to ease the conversion of IDL code that uses the removed READ_GIF procedure. Instances of READ_GIF can be changed to READ_PNG by simply replacing “READ_GIF” with “READ_PNG”. Note, however, that the CLOSE and MULTIPLE keywords to READ_GIF are not accepted by the READ_PNG procedure. Remember, too, that your .gif files must be converted to .png in order for READ_PNG to work."

## Return Value

For 8-bit images, *Result* will be a two- or three-dimensional array of type byte. For 16-bit images, *Result* will be of type unsigned integer (UINT).

# Arguments

## Filename

A scalar string containing the full pathname of the PNG file to read.

## R, G, B

Named variables that will contain the Red, Green, and Blue color vectors if a color table exists.

# Keywords

## ORDER

Set this keyword to indicate that the rows of the image should be read from bottom to top. The rows are read from top to bottom by default. ORDER provides compatibility with PNG files written using versions of IDL prior to IDL 5.4, which wrote PNG files from bottom to top.

## VERBOSE

Produces additional diagnostic output during the read.

## TRANSPARENT

Returns an array of pixel index values that are to be treated as “transparent” for the purposes of image display. If there are no transparent values then TRANSPARENT will be set to a long-integer scalar with the value 0.

# Examples

Create an RGBA (16-bits/channel) and a Color Indexed (8-bit/channel) image with a palette:

```
rgbdata = UINDGEN(4,320,240)
cidata = BYTSCL(DIST(256))
red = indgen(256)
green = indgen(256)
blue = indgen(256)
WRITE_PNG,'rgb_image.png',rgbdata
WRITE_PNG,'ci_image.png',cidata,red,green,blue
;Query and read the data
names = ['rgb_image.png','ci_image.png','unknown.png']
FOR i=0,N_ELEMENTS(names)-1 DO BEGIN
```

```
      ok = QUERY_PNG(names[i],s)
      IF (ok) THEN BEGIN
         HELP,s,/STRUCTURE
         IF (s.HAS_PALETTE) THEN BEGIN
            img = READ_PNG(names[i],rpal,gpal,bpal)
            HELP,img,rpal,gpal,bpal
         ENDIF ELSE BEGIN
            img = READ_PNG(names[i])
            HELP,img
         ENDELSE
      ENDIF ELSE BEGIN
         PRINT,names[i],' is not a PNG file'
      ENDELSE
   ENDFOR
   END
```

## Version History

Introduced: 5.2

## See Also

WRITE_PNG, QUERY_PNG

# READ_PPM

The READ_PPM procedure reads the contents of a PGM (gray scale) or PPM (portable pixmap for color) format image file and returns the image in the form of a 2-D byte array (for grayscale images) or a (3, *n*, *m*) byte array (for TrueColor images).

Files to be read should adhere to the PGM/PPM standard. The following file types are supported: P2 (graymap ASCII), P5 (graymap RAWBITS), P3 (TrueColor ASCII pixmaps), and P6 (TrueColor RAWBITS pixmaps). Maximum pixel values are limited to 255. Images are always stored with the top row first.

PPM/PGM format is supported by the PBMPLUS toolkit for converting various image formats to and from portable formats, and by the Netpbm package.

This routine is written in the IDL language. Its source code can be found in the file `read_ppm.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

To find information about a potential PPM file before trying to read its data, use the QUERY_PPM function.

## Syntax

READ_PPM, *Filename*, *Image* [, MAXVAL=*variable*]

## Arguments

### Filename

A scalar string specifying the full path name of the PGM or PPM file to read.

### Image

A named variable that will contain the image. For grayscale images, *Image* is a 2-D byte array. For TrueColor images, *Image* is a (3, *n*, *m*) byte array.

## Keywords

### MAXVAL

A named variable that will contain the maximum pixel value.

## Examples

To open and read the PGM image file named “foo.pgm” in the current directory and store the image in the variable IMAGE1:

```
READ_PPM, 'foo.pgm', IMAGE1
```

## Version History

Introduced: 4.0

## See Also

WRITE_PPM, QUERY_PPM

# READ_SPR

The READ_SPR function reads a row-indexed sparse array. Row-indexed sparse arrays are created using the SPRSIN function and written to a file using the WRITE_SPR function.

This routine is written in the IDL language. Its source code can be found in the file `read_spr.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = READ_SPR(*Filename*)

## Return Value

Returns the row-indexed sparse array from the specified file.

## Arguments

### Filename

A scalar string specifying the name of the file containing a row-indexed sparse array.

## Examples

Suppose we have already saved a row-indexed sparse array to a file named `sprs.as`, as described in the documentation for the WRITE_SPR routine. To read the sparse array from the file and store it in a variable `sprs`, use the following command:

```
sprs = READ_SPR('sprs.as')
```

## Version History

Introduced: Pre 4.0

## See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSIN, WRITE_SPR

# READ_SRF

The READ_SRF procedure reads the contents of a Sun rasterfile and returns the image and color table vectors (if present) in the form of IDL variables.

READ_SRF only handles 1-, 8-, 24-, and 32-bit rasterfiles of type `RT_OLD` and `RT_STANDARD`. See the file `/usr/include/rasterfile.h` for the structure of Sun rasterfiles.

This routine is written in the IDL language. Its source code can be found in the file `read_srf.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

To find information about a potential SRF file before trying to read its data, use the QUERY_SRF function.

## Syntax

READ_SRF, *Filename*, *Image* [, *R*, *G*, *B*]

## Arguments

### Filename

A scalar string containing the name of the rasterfile to read.

### Image

A named variable that will contain the 2-D byte array (image).

### R, G, B

Named variables that will contain the Red, Green, and Blue color vectors, if the rasterfile contains colormaps.

## Keywords

None.

## Examples

To open and read the Sun rasterfile named `sun.srf` in the current directory, store the image in the variable `image1`, and store the color vectors in the variables `R`, `G`, and `B`, enter:

```
READ_SRF, 'sun.srf', image1, R, G, B
```

To load the new color table and display the image, enter:

```
TVLCT, R, G, B
TV, image1
```

## Version History

Introduced: Original

## See Also

WRITE_SRF, QUERY_SRF

# READ_SYLK

The READ_SYLK function reads the contents of a SYLK (Symbolic Link) format spreadsheet data file and returns the contents of the file, or of a cell data range, in an IDL variable.

**Note**

This routine reads only numeric and string SYLK data. It ignores all spreadsheet and cell formatting information (cell width, text justification, font type, date, time, and monetary notations, etc). Note also that the data in a given cell range must be of the same data type (all integers, for example) in order for the read operation to succeed. See the example below for further information.

This routine is written in the IDL language. Its source code can be found in the file `read_sylk.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = READ_SYLK( *File* [, /ARRAY] [, /COLMAJOR] [, NCOLS=*columns*] [, NROWS=*rows*] [, STARTCOL=*column*] [, STARTROW=*row*] [, /USEDOUBLES] [, /USELONGS] )

## Return Value

READ_SYLK returns either a vector of structures or a 2-D array containing the spreadsheet cell data. By default, READ_SYLK returns a vector of structures, each of which contains the data from one *row* of the table being read. In this case, the individual fields in the structures have the tag names “Col0”, “Col1”, ..., “Col*n*”. If the COLMAJOR keyword is specified, each of the structures returned contains data from one *column* of the table, and the tag names are “Row0”, “Row1”, ..., “Row*n*”.

## Arguments

### File

A scalar string specifying the full path name of the SYLK file to read.

# Keywords

## ARRAY

Set this keyword to return an IDL array rather than a vector of structures. Note that all the data in the cell range specified must be of the same data type to successfully return an array.

## COLMAJOR

Set this keyword to create a vector of structures each containing data from a single *column* of the table being read. If you are creating an array rather than a vector of structures (the ARRAY keyword is set), setting COLMAJOR has the same effect as transposing the resulting array.

This keyword should be set when importing spreadsheet data which has column major organization (data stored in columns rather than rows).

## NCOLS

Set this keyword to the number of spreadsheet columns to read. If not specified, all of the cell columns found in the file are read.

## NROWS

Set this keyword to the number of spreadsheet rows to read. If not specified, all of the cell rows found in the file are read.

## STARTCOL

Set this keyword to the first column of spreadsheet cells to read. If not specified, the read operation begins with the first column found in the file (column 0).

## STARTROW

Set this keyword to the first row of spreadsheet cells to read. If not specified, the read operation begins with the first row of cells found in the file (row 0).

## USEDOUBLES

Set this keyword to read any floating-point cell data as double-precision rather than the default single-precision.

### USELONGS

Set this keyword to read any integer cell data as long integer type rather than the default integer type.

## Examples

Suppose the following spreadsheet table, with the upper left cell (value = “Index”) at location (0, 0), has been saved as the SYLK file “file.slk”:

```
Index  Name  Gender  Platform
1      Beth   F       Windows
2      Lubos  M       UNIX
3      Louis  M       Windows
4      Thierry  M       UNIX
```

Note that the data format of the title row (*string*, *string*, *string*, *string*) is inconsistent with the following four rows (*int*, *string*, *string*, *string*) in the table. Because of this, it is impossible to read all of the table into a single IDL variable. The following two commands, however, will read all of the data:

```
title = READ_SYLK("file.slk", NROWS = 1)
table = READ_SYLK("file.slk", STARTROW = 1)

;Display the top row of the table.
PRINT, title
```

IDL prints:

```
{ Index Name Gender Platform}
```

Print the table:

```
PRINT, table
```

IDL prints:

```
{1 Beth F Windows}{2 Lubos M UNIX}{3 Louis M Windows}{4 Thierry M
UNIX}
```

To retrieve only the “Name” column:

```
names = READ_SYLK("file.slk", /ARRAY, STARTROW = 1, $
    STARTCOL = 1, NCOLS = 1)
PRINT, names
```

IDL prints:

```
Beth Lubos Louis Thierry
```

To retrieve the “Name” column in column format:

```
namescol = READ_SYLK("file.slk", /ARRAY, /COLMAJOR, $
    STARTROW = 1, STARTCOL = 1, NCOLS = 1)
PRINT, namescol
```

IDL prints:

```
Beth
Lubos
Louis
Thierry
```

## Version History

Introduced: 4.0

## See Also

WRITE_SYLK

# READ_TIFF

The READ_TIFF function reads single or multi-channel images from TIFF format files and returns the image and color table vectors in the form of IDL variables.

**Note**

To find information about a potential TIFF file before trying to read its data, use the QUERY_TIFF function. The obsolete routine TIFF_DUMP may also be used to examine the structure and tags of a TIFF file.

**Note**

READ_TIFF does not support LZW-compressed files.

## Syntax

*Result* = READ_TIFF( *Filename* [, *R*, *G*, *B*] [, CHANNELS=*scalar or vector*] [, GEOTIFF=*variable*] [, IMAGE_INDEX=*value*] [, INTERLEAVE={0 | 1 |2}] [, ORIENTATION=*variable*] [, PLANARCONFIG=*variable*] [, SUB_RECT=*[x, y, width, height]*] [, /VERBOSE] )

## Return Value

READ_TIFF returns a byte, unsigned integer, long, or float array (based on the data format in the TIFF file) containing the image data. The dimensions of the *Result* are [*Columns*, *Rows*] for single-channel images, or [*Channels*, *Columns*, *Rows*] for multi-channel images, unless a different type of interleaving is specified with the INTERLEAVE keyword.

For 1-bit (bilevel) images, the image values are 0 or 1. For 4-bit grayscale images the image values are in the range 0 to 15.

RGB images are a special case of multi-channel images, and contain three channels. Most TIFF readers and writers can handle only images with one or three channels.

As a special case, for three-channel TIFF image files that are stored in planar interleave format, and if four parameters are provided, READ_TIFF returns the integer value zero, sets the variable defined by the PLANARCONFIG keyword to 2, and returns three separate images in the variables defined by the *R*, *G*, and *B* arguments.

# Arguments

## Filename

A scalar string specifying the full pathname of the TIFF file to read.

## R, G, B

Named variables that will contain the Red, Green, and Blue color vectors of the color table from the file if one exists. If the TIFF file is written as a three-channel image, interleaved by plane, and the R, G, and B parameters are present, the three channels of the image are returned in the R, G, and B variables.

# Keywords

## CHANNELS

Set this keyword to a scalar or vector giving the channel numbers to be returned for a multi-channel image, starting with zero. The default is to return all of the channels. This keyword is ignored for single-channel images, or for three-channel planar-interleaved images when the *R*, *G*, and *B* arguments are specified.

## GEOTIFF

Returns an anonymous structure containing one field for each of the GeoTIFF tags and keys found in the file. If no GeoTIFF information is present in the file, the returned variable is undefined.

The GeoTIFF structure is formed using fields named from the following table.

| Anonymous Structure Field Name | IDLDatatype |
|---|---|
| **TAGS:** | |
| "MODELPIXELSCALETAG" | DOUBLE[3] |
| "MODELTRANSFORMATIONTAG" | DOUBLE[4,4] |
| "MODELTIEPOINTTAG" | DOUBLE[6,*] |
| **KEYS:** | |
| "GTMODELTYPEGEOKEY" | INT |

*Table 82: GEOTIFF Structures*

| Anonymous Structure Field Name | IDLDatatype |
|---|---|
| "GTRASTERTYPEGEOKEY" | INT |
| "GTCITATIONGEOKEY" | STRING |
| "GEOGRAPHICTYPEGEOKEY" | INT |
| "GEOGCITATIONGEOKEY" | STRING |
| "GEOGGEODETICDATUMGEOKEY" | INT |
| "GEOGPRIMEMERIDIANGEOKEY" | INT |
| "GEOGLINEARUNITSGEOKEY" | INT |
| "GEOGLINEARUNITSIZEGEOKEY" | DOUBLE |
| "GEOGANGULARUNITSGEOKEY" | INT |
| "GEOGANGULARUNITSIZEGEOKEY" | DOUBLE |
| "GEOGELLIPSOIDGEOKEY" | INT |
| "GEOGSEMIMAJORAXISGEOKEY" | DOUBLE |
| "GEOGSEMIMINORAXISGEOKEY" | DOUBLE |
| "GEOGINVFLATTENINGGEOKEY" | DOUBLE |
| "GEOGAZIMUTHUNITSGEOKEY" | INT |
| "GEOGPRIMEMERIDIANLONGGEOKEY" | DOUBLE |
| "PROJECTEDCSTYPEGEOKEY" | INT |
| "PCSCITATIONGEOKEY" | STRING |
| "PROJECTIONGEOKEY" | INT |
| "PROJCOORDTRANSGEOKEY" | INT |
| "PROJLINEARUNITSGEOKEY" | INT |
| "PROJLINEARUNITSIZEGEOKEY" | DOUBLE |
| "PROJSTDPARALLEL1GEOKEY" | DOUBLE |
| "PROJSTDPARALLEL2GEOKEY" | DOUBLE |

*Table 82: GEOTIFF Structures (Continued)*

| Anonymous Structure Field Name | IDLDatatype |
|---|---|
| "PROJNATORIGINLONGGEOKEY" | DOUBLE |
| "PROJNATORIGINLATGEOKEY" | DOUBLE |
| "PROJFALSEEASTINGGEOKEY" | DOUBLE |
| "PROJFALSENORTHINGGEOKEY" | DOUBLE |
| "PROJFALSEORIGINLONGGEOKEY" | DOUBLE |
| "PROJFALSEORIGINLATGEOKEY" | DOUBLE |
| "PROJFALSEORIGINEASTINGGEOKEY" | DOUBLE |
| "PROJFALSEORIGINNORTHINGGEOKEY" | DOUBLE |
| "PROJCENTERLONGGEOKEY" | DOUBLE |
| "PROJCENTERLATGEOKEY" | DOUBLE |
| "PROJCENTEREASTINGGEOKEY" | DOUBLE |
| "PROJCENTERNORTHINGGEOKEY" | DOUBLE |
| "PROJSCALEATNATORIGINGEOKEY" | DOUBLE |
| "PROJSCALEATCENTERGEOKEY" | DOUBLE |
| "PROJAZIMUTHANGLEGEOKEY" | DOUBLE |
| "PROJSTRAIGHTVERTPOLELONGGEOKEY" | DOUBLE |
| "VERTICALCSTYPEGEOKEY" | INT |
| "VERTICALCITATIONGEOKEY" | STRING |
| "VERTICALDATUMGEOKEY" | INT |
| "VERTICALUNITSGEOKEY" | INT |

*Table 82: GEOTIFF Structures (Continued)*

**Note**

If a GeoTIFF key appears multiple times in a file, only the value for the first instance of the key is returned.

## IMAGE_INDEX

Selects the image number within the file to be read (see QUERY_TIFF to determine the number of images in the file).

## INTERLEAVE

For multi-channel images, set this keyword to one of the following values to force the *Result* to have a specific interleaving, regardless of the type of interleaving in the file being read:

| Value | Description |
|---|---|
| 0 | Pixel interleaved: *Result* will have dimensions [*Channels*, *Columns*, *Rows*]. |
| 1 | Scanline (row) interleaved: *Result* will have dimensions [*Columns*, *Channels*, *Rows*]. |
| 2 | Planar interleaved: *Result* will have dimensions [*Columns*, *Rows*, *Channels*]. |

*Table 83: INTERLEAVE Keyword Values*

If this keyword is not specified, the *Result* will always be pixel interleaved, regardless of the type of interleaving in the file being read. For files stored in planar-interleave format, this keyword is ignored if the *R*, *G*, and *B* arguments are specified.

## ORIENTATION

Set this keyword to a named variable that will contain the orientation value from the TIFF file. Possible return values are:

| Value | Description |
|---|---|
| 0 | Column 0 represents the left-hand side, and row 0 represents the bottom (same as 4) |
| 1 | Column 0 represents the left-hand side, and row 0 represents the top. |
| 2 | Column 0 represents the right-hand side, and row 0 represents the top. |

*Table 84: ORIENTATION Keyword Values*

| Value | Description |
|---|---|
| 3 | Column 0 represents the right-hand side, and row 0 represents the bottom. |
| 4 | Column 0 represents the left-hand side, and row 0 represents the bottom (same as 0) |
| 5 | Column 0 represents the top, and row 0 represents the left-hand side. |
| 6 | Column 0 represents the top, and row 0 represents the right-hand side. |
| 7 | Column 0 represents the bottom, and row 0 represents the right-hand side. |
| 8 | Column 0 represents the bottom, and row 0 represents the left-hand side. |

*Table 84: ORIENTATION Keyword Values (Continued)*

If an orientation value does not appear in the TIFF file, an orientation of 0 is returned.

## PLANARCONFIG

Set this keyword to a named variable that will contain the interleave parameter for the TIFF file. This parameter is returned as 1 for TIFF files that are GrayScale, Palette, or interleaved by pixel. This parameter is returned as 2 for multi-channel TIFF files interleaved by image.

## SUB_RECT

Set this keyword to a four-element array, [*x*, *y*, *width*, *height*], that specifies a rectangular region within the file to extract. Only the rectangular portion of the image selected by this keyword is read and returned. The rectangle is measured in pixels from the lower left corner (right hand coordinate system).

**Tip**

For tiled TIFF images, use the TILE_SIZE tag returned by QUERY_TIFF to determine the optimal sizes for the SUB_RECT keyword.

## VERBOSE

Produce additional diagnostic output during the read.

### Obsolete Keywords

The following keywords are obsolete:

- ORDER
- UNSIGNED

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Examples

### Example 1

Read the file `my.tif` in the current directory into the variable `image`, and save the color tables in the variables, `R`, `G`, and `B` by entering:

```
image = READ_TIFF('my.tif', R, G, B)
```

To view the image, load the new color table and display the image by entering:

```
TVLCT, R, G, B
TV, image
```

### Example 2

Write and read a multi-image TIFF file. The first image is a 16-bit single-channel image stored using compression. The second image is an RGB image stored using 32-bits/channel uncompressed.

```
; Write the image data:
data = FIX(DIST(256))
rgbdata = LONARR(3,320,240)
WRITE_TIFF,'multi.tif',data,COMPRESSION=1,/SHORT
WRITE_TIFF,'multi.tif',rgbdata,/LONG,/APPEND

; Read the image data back:
ok = QUERY_TIFF('multi.tif',s)
IF (ok) THEN BEGIN
FOR i=0,s.NUM_IMAGES-1 DO BEGIN
imp = QUERY_TIFF('multi.tif',t,IMAGE_INDEX=i)
img = READ_TIFF('multi.tif',IMAGE_INDEX=i)
HELP,t,/STRUCTURE
HELP,img
ENDFOR
ENDIF
```

### Example 3

Write and read a multi-channel image:

```
data = LINDGEN(10, 256, 256)   ; 10 channels

; Write the image data:
WRITE_TIFF, 'multichannel.tif', data, /LONG

; Read back only channels [0,2,4,6,8], using planar-interleaving
img = READ_TIFF('multichannel.tif', CHANNELS=[0,2,4,6,8], $
   INTERLEAVE=2)

HELP, img
```

IDL prints:

```
IMG      LONG     = Array[256, 256, 5]
```

## Version History

Introduced: 5.0

## See Also

WRITE_TIFF, QUERY_TIFF

# READ_WAV

The READ_WAV function reads the audio stream from the named .WAV file. Optionally, it can return the sampling rate of the audio stream.

## Syntax

*Result* = READ_WAV ( *Filename* [, *Rate*] )

## Return Value

In the case of a single channel stream, the returned variable is a BYTE or INT (depending on the number of bits per sample) one-dimensional array. In the case of a file with multiple channels, a similar two-dimensional array is returned, with the leading dimension being the channel number.

## Arguments

### Filename

A scalar string containing the full pathname of the .WAV file to read.

### Rate

Returns an IDL long containing the sampling rate of the stream in samples per second.

## Keywords

None.

## Version History

Introduced: 5.3

# READ_WAVE

The READ_WAVE procedure reads a `.wave` or `.bwave` file created by the Wavefront Advanced Data Visualizer into a series of IDL variables.

**Note**

READ_WAVE only preserves the structure of the variables if they are regularly gridded.

This routine is written in the IDL language. Its source code can be found in the file `read_wave.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

READ_WAVE, *File*, *Variables*, *Names*, *Dimensions* [, MESHNAMES=*variable*]

## Arguments

### File

A scalar string containing the name of the Wavefront file to read.

### Variables

A named variable that will contain a block of the variables contained in the wavefront file. Since each variable in a wavefront file can have more than one field (for instance, a vector variable has 3 fields), the fields of each variable make up the major index into the variable block. For instance, if a Wavefront file had one scalar variable and one vector variable, the scalar would be extracted as follows:

```
scalar_variable = variables[0,*,*,*]
```

and the vector variable would be extracted as follows:

```
vector_variable = variables[1:3,*,*,*]
```

To find the dimensions of the returned variable, see the description of the *Dimensions* argument.

### Names

A named variable that will contain the string names of each variable contained in the file.

### Dimensions

A named variable that will contain a long array describing how many fields in the large returned variable block each variable occupies. In the above example of one scalar variable followed by a vector variable, the dimension variable would be `[1,3]`.

This indicates that the first field of the returned variable block would be the scalar variable and the following 3 fields would comprise the vector variable.

## Keywords

### MESHNAMES

Set this keyword to a named variable that will contain the name of the mesh used in the Wavefront file for each variable.

## Version History

Introduced: Pre 4.0

## See Also

WRITE_WAVE

# READ_X11_BITMAP

The READ_X11_BITMAP procedure reads bitmaps stored in the X Windows X11 format. The X Windows `bitmap` program produces a C header file containing the definition of a bitmap produced by that program. This procedure reads such a file and creates an IDL byte array containing the bitmap. It is used primarily to read bitmaps to be used as IDL widget button labels.

This routine is written in the IDL language. Its source code can be found in the file `read_x11_bitmap.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

READ_X11_BITMAP, *File*, *Bitmap* [, *X*, *Y*] [, /EXPAND_TO_BYTES]

## Arguments

### File

A scalar string containing the name of the file containing the bitmap.

### Bitmap

A named variable that will contain the bitmap. This variable is returned as a byte array.

### X

A named variable that will contain the width of the bitmap.

### Y

A named variable that will contain the height of the bitmap.

## Keywords

### EXPAND_TO_BYTES

Set this keyword to instruct READ_X11_BITMAP to return a 2-D array which has one bit per byte (0 for a 0 bit, 255 for a 1 bit) instead.

## Examples

To open and read the X11 bitmap file named `my.x11` in the current directory, store the bitmap in the variable `bitmap1`, and the width and height in the variables `X` and `Y`, enter:

```
READ_X11_BITMAP, 'my.x11', bitmap1, X, Y
```

To display the new bitmap, enter:

```
READ_X11_BITMAP, 'my.x11', image, /EXPAND_TO_BYTES
TV, image, /ORDER
```

## Version History

Introduced: Pre 4.0

## See Also

READ_XWD

# READ_XWD

The READ_XWD function reads the contents of a file created by the `xwd` (X Windows Dump) command and returns the image and color table vectors in the form of IDL variables.

**Note**

This function is intended to be used only on files containing 8-bit pixmaps created with `xwd` version 6 or later.

This routine is written in the IDL language. Its source code can be found in the file `read_xwd.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = READ_XWD( *Filename*[, *R*, *G*, *B*] )

## Return Value

READ_XWD returns a 2-D byte array containing the image. If the file cannot be open or read, the return value is zero.

## Arguments

### Filename

A scalar string specifying the full pathname of the XWD file to read.

### R, G, B

Named variables that will contain the Red, Green, and Blue color vectors, if the XWD file contains color tables.

## Keywords

None.

## Examples

To open and read the X Windows Dump file named `my.xwd` in the current directory, store the image in the variable `image1`, and store the color vectors in the variables, `R`, `G`, and `B`, enter:

```
image1 = READ_XWD('my.xwd', R, G, B)
```

To load the new color table and display the image, enter:

```
TVLCT, R, G, B
TV, image1
```

## Version History

Introduced: Pre 4.0

## See Also

READ_X11_BITMAP

# READS

The READS procedure performs formatted input from a string variable and writes the results into one or more output variables. This procedure differs from the READ procedure only in that the input comes from memory instead of a file.

This routine is useful when you need to examine the format of a data file before reading the information it contains. Each line of the file can be read into a string using READF. Then the components of that line can be read into variables using READS.

## Syntax

READS, *Input*, $Var_1$, ..., $Var_n$ [, AM_PM=*[string, string]*]
[, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*]
[, MONTHS=*string_array*{12 names}]

## Arguments

### Input

The string variable from which the input is taken. If the supplied argument is not a string, it is automatically converted. The argument can be scalar or array. If *Input* is an array, the individual string elements are treated as successive lines of input.

### $Var_i$

The named variables to receive the input.

**Note**

If the variable specified for the $Var_i$ argument has not been previously defined, the input data is assumed to be of type float, and the variable will be cast as a float.

## Keywords

### AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

### DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

### FORMAT

If FORMAT is not specified, IDL uses its default rules for formatting the input. FORMAT allows the format of the input to be specified in precise detail, using a FORTRAN-style specification. See "Using Explicitly Formatted Input/Output" in Chapter 10 of the *Building IDL Applications* manual.

### MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

## Version History

Introduced: Pre 4.0

## See Also

READ/READF, READU

# READU

The READU procedure reads unformatted binary data from a file into IDL variables. READU transfers data directly with no processing of any kind performed on the data.

## Syntax

READU, *Unit*, $Var_1$, ..., $Var_n$ [, TRANSFER_COUNT=*variable*]

## Arguments

### Unit

The IDL file unit from which input is taken.

### $Var_i$

Named variables to receive the data. For non-string variables, the number of bytes required for Var are read. When READU is used with a variable of type string, IDL reads exactly the number of bytes contained in the existing string. For example, to read a 5-character string, enter:

```
temp = '12345'
READU, unit, temp
```

## Keywords

### TRANSFER_COUNT

Set this keyword to a named variable in which to return the number of elements transferred by the input operation. Note that the number of elements is not the same as the number of bytes (except in the case where the data type being transferred is bytes). For example, transferring 256 floating-point numbers yields a transfer count of 256, not 1024 (the number of bytes transferred).

This keyword is useful with files opened with the RAWIO keyword to the OPEN routines. Normally, attempting to read more data than is available from a file causes the unfilled space to be zeroed and an error to be issued. This does not happen with files opened with the RAWIO keyword. Instead, the programmer must keep track of the transfer count.

### Obsolete Keywords

The following keywords are obsolete:

- KEY_ID
- KEY_MATCH
- KEY_VALUE

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Examples

The following commands can be used to open the IDL distribution file people.dat and read an image from that file:

```
; Open the file for reading as file unit 1:
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])

; The image is a 192 by 192 byte array, so make B that size:
B = BYTARR(192, 192)

; Read the data into B:
READU, 1, B

; Close the file:
CLOSE, 1

; Display the image:
TV, B
```

## Version History

Introduced: Original

## See Also

READ/READF, READS, WRITEU, Chapter 10, “Files and Input/Output” in the *Building IDL Applications* manual, “Unformatted Input/Output with Structures” in Chapter 7 of the *Building IDL Applications* manual.

# REAL_PART

The REAL_PART function returns the real part of its complex-valued argument.

## Syntax

*Result* = REAL_PART(*Z*)

## Return Value

If the complex-valued argument is double-precision, the result will be double-precision, otherwise the result will be single-precision floating-point. If the argument is not complex, then the result will be double-precision if the argument is double-precision, otherwise the result will be single-precision.

## Arguments

### Z

A scalar or array for which the real part is desired. Z may be of any numeric type.

## Examples

The following example demonstrates how you can use REAL_PART to obtain the real parts of an array of complex variables.

```
; Create an array of complex values:
cValues = COMPLEX([1, 2, 3],[4, 5, 6])

; Print just the real parts of each element in cValues:
PRINT, REAL_PART(cValues)
```

IDL prints:

```
 1.00000   2.00000   3.00000
```

## Version History

Introduced: 5.5

## See Also

COMPLEX, DCOMPLEX, IMAGINARY

# REBIN

The REBIN function resizes a vector or array to dimensions given by the parameters $D_i$. The supplied dimensions must be integral multiples or factors of the original dimension. The expansion or compression of each dimension is independent of the others, so that each dimension can be expanded or compressed by a different value.

If the dimensions of the desired result are not integer multiples of the original dimensions, use the CONGRID function.

## Syntax

*Result* = REBIN( *Array, $D_1$ [, ..., $D_8$]* [, /SAMPLE] )

## Return Value

Returns the resized array or vector of the specified dimensions.

## Arguments

### Array

The array to be resampled. *Array* can be of any basic type except complex or string.

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

**Note**

The dimensions of the resulting resampled array must be integer multiples or factors of the corresponding original dimensions.

## Keywords

### SAMPLE

Normally, REBIN uses bilinear interpolation when magnifying and neighborhood averaging when minifying. Set the SAMPLE keyword to use nearest neighbor

sampling for both magnification and minification. Bilinear interpolation gives higher quality results but requires more time.

## Rules Used by REBIN

Assume the original vector *X* has *n* elements and the result is to have *m* elements.

Let $f = n/m$, the ratio of the size of the original vector, *X* to the size of the result. $1/f$ must be an integer if $n < m$ (expansion). *f* must be an integer if compressing, ($n > m$). The various resizing options can be described as:

- Expansion, $n < m$, SAMPLE = 0: $Y_i = F(X, f \cdot i)$ $\quad i = 0, 1, \ldots, m\text{-}1$

  The linear interpolation function, $F(X, p)$ that interpolates *X* at location *p*, is defined as:

$$F(X, p) = \begin{cases} X_{\lfloor p \rfloor} + (p - \lfloor p \rfloor) \cdot (X_{\lfloor p \rfloor + 1} - X_{\lfloor p \rfloor}) & \text{if } p < n - 1 \\ X_{\lfloor p \rfloor} & \text{if } p \geq n - 1 \end{cases}$$

- Expansion, $n < m$, SAMPLE = 1:

$$Y_i = X_{\lfloor fi \rfloor}$$

- Compression, $n > m$, SAMPLE = 0:

$$Y_i = (1/f) \sum_{j = fi}^{f(i+1)-1} X_j$$

- Compression, $n > m$, SAMPLE = 1:

$$Y_i = X_{\lfloor fi \rfloor}$$

- No change, $n = m$: $Y_i = X_i$

## Endpoint Effects When Expanding

When expanding an array, REBIN *interpolates*, it never *extrapolates*. Each of the *n*-1 intervals in the *n*-element input array produces *m/n* interpolates in the *m*-element output array. The last *m/n* points of the result are obtained by duplicating element *n*-1 of the input array because their interpolates would lie outside the input array.

For example

```
; A four point vector:
A = [0, 10, 20, 30]

; Expand by a factor of 3:
B = REBIN(A, 12)

PRINT, B
```

IDL prints:

```
0 3 6 10 13 16 20 23 26 30 30 30
```

Note that the last element is repeated three times. If this effect is undesirable, use the INTERPOLATE function. For example, to produce 12 equally spaced interpolates from the interval 0 to 30:

```
B = INTERPOLATE(A, 3./11. * FINDGEN(12))
PRINT, B
```

IDL prints:

```
0 2 5 8 10 13 16 19 21 24 27 30
```

Here, the sampling ratio is (*n* - 1)/(*m* - 1).

## Examples

Create and display a simple image by entering:

```
D = SIN(DIST(50)/4) & TVSCL, D
```

Resize the image to be 5 times its original size and display the result by entering:

```
D = REBIN(D, 250, 250) & TVSCL, D
```

## Version History

Introduced: Original

## See Also

CONGRID

# RECALL_COMMANDS

The RECALL_COMMANDS function returns a string array containing the entries in IDL's command recall buffer.

## Syntax

*Result* = RECALL_COMMANDS()

## Return Value

The size of the returned array is the size of recall buffer, even if fewer than commands have been entered (any "empty" buffer entries will contain null strings). The default size of the command recall buffer is 20 lines. (See "!EDIT_INPUT" on page 3905 for more information about the command recall buffer.)

Element zero of the returned array contains the most recent command.

## Arguments

None.

## Keywords

None.

## Version History

Introduced: 5.0

# RECON3

The RECON3 function can reconstruct a three-dimensional data array from two or more images (or projections) of an object. For example, if you placed a dark object in front of a white background and then photographed it three times (each time rotating the object a known amount) then these three images could be used with RECON3 to approximate a 3-D volumetric representation of the object. RECON3 also works with translucent projections of an object. RECON3 returns a 3-D byte array.

This routine is written in the IDL language. Its source code can be found in the file `recon3.pro` in the `lib` subdirectory of the IDL distribution.

## Using RECON3

Images used in reconstruction should show strong light/dark contrast between the object and the background. If the images contain low (dark) values where the object is and high (bright) values where the object isn't, the MODE keyword should be set to +1 and the returned volume will have low values where the object is, and high values where the object isn't. If the images contain high (bright) values where the object is and low (dark) values where the object isn't, the MODE keyword should be set to -1 and the returned volume will have high values where the object is, and low values where the object isn't.

In general, the object must be CONVEX for a good reconstruction to be possible. Concave regions are not easily reconstructed. An empty coffee cup, for example, would be reconstructed as if it were full.

The more images the better. Images from many different angles will improve the quality of the reconstruction. It is also important to supply images that are parallel and perpendicular to any axes of symmetry. Using the coffee cup as an example, at least one image should be looking through the opening in the handle. Telephoto images are also better for reconstruction purposes than wide angle images.

# Syntax

*Result* = RECON3( *Images*, *Obj_Rot*, *Obj_Pos*, *Focal*, *Dist*,*Vol_Pos*, *Img_Ref*, *Img_Mag*, *Vol_Size* [, /CUBIC] [, MISSING=*value*] [, MODE=*value*] [, /QUIET] )

# Return Value

Returns a 3-D data array.

# Arguments

## Images

A 3-D array containing the images to use to reconstruct the volume. Execution time increases linearly with more images. *Images* must be an 8-bit (byte) array with dimensions (*x*, *y*, *n*) where *x* is the horizontal image dimension, *y* is the vertical image dimension, and *n* is the number of images. Note that *n* must be at least 2.

## Obj_Rot

A 3 x *n* floating-point array specifying the amount the object is rotated to make it appear as it does in each image. The object is first rotated about the X axis, then about the Y axis, and finally about the Z axis (with the object's reference point at the origin). *Obj_Rot*[0, *] is the X rotation for each image, *Obj_Rot*[1, *] is the Y rotation, and *Obj_Rot*[2, *] is the Z rotation.

## Obj_Pos

A 3 x *n* floating-point array specifying the position of the object's reference point relative to the camera lens. The camera lens is located at the coordinate origin and points in the negative Z direction (the view up vector points in the positive Y direction). *Obj_Pos* should be expressed in this coordinate system. *Obj_Pos*[0, *] is the X position for each image, *Obj_Pos*[1, *] is the Y position, and *Obj_Pos*[2, *] is the Z position. All the values in *Obj_Pos*[2, *] should be less than zero. Note that the values for *Obj_Pos*, *Focal*, *Dist*, and *Vol_Pos* should all be expressed in the same units (mm, cm, m, in, ft, etc.).

## Focal

An *n*-element floating-point array specifying the focal length of the lens for each image. Focal may be set to zero to indicate a parallel image projection (infinite focal length).

## Dist

An *n*-element floating-point array specifying the distance from the camera lens to the image plane (film) for each image. *Dist* should be greater than *Focal*.

## Vol_Pos

A 3 x 2 floating-point array specifying the two opposite corners of a cube that surrounds the object. *Vol_Pos* should be expressed in the object's coordinate system

relative to the object's reference point. *Vol_Pos*[*, 0] specifies one corner and *Vol_Pos*[*, 1] specifies the opposite corner.

### Img_Ref

A 2 x *n* integer or floating-point array that specifies the pixel location at which the object's reference point appears in each of the images. *Img_Ref*[0, *] is the X coordinate for each image and *Img_Ref*[1, *] is the Y coordinate.

### Img_Mag

A 2 x *n* integer or floating-point array that specifies the magnification factor for each image. This number is actually the length (in pixels) that a test object would appear in an image if it were *n* units long and *n* units distant from the camera lens. *Img_Mag*[0, *] is the X dimension (in pixels) of a test object for each image, and *Img_Mag*[1, *] is the Y dimension. All elements in *Img_Mag* should be greater than or equal to 1.

### Vol_Size

A 3-element integer or floating-point array that specifies the size of the 3-D byte array to return. Execution time (and resolution) increases exponentially with larger values for *Vol_Size*. *Vol_Size*[0] specifies the X dimension of the volume, *Vol_Size*[1] specifies the Y dimension, and *Vol_Size*[2] specifies the Z dimension.

## Keywords

### CUBIC

Set this keyword to use cubic interpolation. The default is to use tri-linear interpolation, which is slightly faster.

### MISSING

Set this keyword equal to a byte value for cells in the 3-D volume that do not map to any of the supplied images. The value of MISSING is passed to the INTERPOLATE function. The default value is zero.

### MODE

Set this keyword to a value less than zero to define each cell in the 3-D volume as the *minimum* of the corresponding pixels in the images. Set MODE to a value greater than zero to define each cell in the 3-D volume as the *maximum* of the corresponding pixels in the images. If MODE is set equal to zero then each cell in the 3-D volume is defined as the *average* of the corresponding pixels in the images.

MODE should usually be set to -1 when the images contain a bright object in front of a dark background or to +1 when the images contain a dark object in front of a light background. Setting MODE=0 (the default) requires more memory since the volume array must temporarily be kept as an integer array instead of a byte array.

### QUIET

Set this keyword to suppress the output of informational messages when the processing of each image is completed.

## Examples

Assumptions for this example:

- The object's major axis is parallel to the Z axis.
- The object's reference point is at its center.
- The camera lens is pointed directly at this reference point.
- The reference point is 5000 mm in front of the camera lens.
- The focal length of the camera lens is 200 mm.

If the camera is focused on the reference point, then the distance from the lens to the camera's image plane must be:

dist = (d * f) / (d - f) = (5000 * 200) / (5000 - 200) = (1000000 / 4800) = 208.333 mm

The object is roughly 600 mm wide and 600 mm high. The reference point appears in the exact center of each image.

If the object is 600 mm high and 5000 mm distant from the camera lens, then the object image height must be:

hi = (h * f) / (d - f) = (600 * 200) / (5000 - 200) = (120000 / 4800) = 25.0 mm

The object image appears 200 pixels high so the final magnification factor is:

img_mag = (200 / 25) = 8.0

From these assumptions, we can set up the following reconstruction:

```
; First, define the variables:
imgx = 256
imgy = 256
frames = 3
images = BYTARR(imgx, imgy, frames)
obj_rot = Fltarr(3, frames)
obj_pos = Fltarr(3, frames)
focal = Fltarr(frames)
```

```
dist = Fltarr(frames)
vol_pos = Fltarr(3, 2)
img_ref = Fltarr(2, frames)
img_mag = Fltarr(2, frames)
vol_size = [40, 40, 40]

; The object is 5000 mm directly in front of the camera:
obj_pos[0, *] = 0.0
obj_pos[1, *] = 0.0
obj_pos[2, *] = -5000.0

; The focal length of the lens is constant for all the images:
focal[*] = 200.0

; The distance from the lens to the image plane is also constant:
dist[*] = 208.333

; The cube surrounding the object is 600 mm x 600 mm:
vol_pos[*, 0] = [-300.0, -300.0, -300.0]
vol_pos[*, 1] = [ 300.0, 300.0, 300.0]

; The image reference point appears at the center of all the
; images:
img_ref[0, *] = imgx / 2
img_ref[1, *] = imgy / 2

; The image magnification factor is constant for all images.
; (The images haven't been cropped or resized):
img_mag[*,*] = 8.0

; Only the object rotation changes from one image to the next.
; Note that the object is rotated about the X axis first, then Y,
; and then Z. Create some fake images for this example:
images[30:160, 20:230, 0] = 255
images[110:180, 160:180, 0] = 180
obj_rot[*, 0] = [-90.0, 0.0, 0.0]
images[70:140, 100:130, 1] = 255
obj_rot[*, 1] = [-70.0, 75.0, 0.0]
images[10:140, 70:170, 2] = 255
images[80:90, 170:240, 2] = 150
obj_rot[*, 2] = [-130.0, 215.0, 0.0]

; Reconstruct the volume:
vol = RECON3(images, obj_rot, obj_pos, focal, dist, $
   vol_pos, img_ref, img_mag, vol_size, Missing=255B, Mode=(-1))

; Display the volume:
shade_volume, vol, 8, v, p
scale3, xrange=[0,40], yrange=[0,40], zrange=[0,40]
```

```
image = polyshade(v, p, /t3d, xs=400, ys=400)
tvscl, image
```

## Version History

Introduced: Pre 4.0

## See Also

POLYSHADE, SHADE_VOLUME, VOXEL_PROJ

# REDUCE_COLORS

The REDUCE_COLORS procedure reduces the number of colors used in an image by eliminating pixel values without members.

The pixel distribution histogram is obtained and the WHERE function is used to find bins with non-zero values. Next, a lookup table is made where table[old_pixel_value] contains new_pixel_value, and is then applied to the image.

This routine is written in the IDL language. Its source code can be found in the file `reduce_colors.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

REDUCE_COLORS, *Image*, *Values*

## Arguments

### Image

On input, a variable that contains the original image array. On output, this variable contains the color-reduced image array, writing over the original.

### Values

A named variable that, on output, contains a vector of non-zero pixel values. If *Image* contains pixel values from 0 to M, *Values* will be an M+1 element vector containing the mapping from the old values to the new. *Values[i]* contains the new color index of old pixel index *i*.

## Keywords

None.

## Examples

To reduce the number of colors and display an image with the original color tables R, G, B enter the commands:

```
REDUCE_COLORS, image, v
TVLCT, R[V], G[V], B[V]
```

## Version History

Introduced: Pre 4.0

## See Also

COLOR_QUAN

# REFORM

The REFORM function changes the dimensions of an array without changing the total number of elements.

## Syntax

*Result* = REFORM( *Array, $D_1$ [, ..., $D_8$]* [, /OVERWRITE] )

## Return Value

If no dimensions are specified, REFORM returns a copy of *Array* with all dimensions of size 1 removed. If dimensions are specified, the result is given those dimensions. Only the dimensions of *Array* are changed – the actual data remains unmodified.

## Arguments

### Array

The array to have its dimensions modified.

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. *Array* must have the same number of elements as specified by the product of the new dimensions.

## Keywords

### OVERWRITE

Set this keyword to cause the specified dimensions to overwrite the present dimensions of the *Array* parameter. No data are copied, only the internal array descriptor is changed. The result of the function, in this case, is the *Array* parameter with its newly-modified dimensions. For example, to change the dimensions of the variable a, without moving data, enter:

```
a = REFORM(a, n1, n2, /OVERWRITE)
```

## Examples

REFORM can be used to remove “degenerate” leading dimensions of size one. Such dimensions can appear when a subarray is extracted from an array with more dimensions. For example

```
; a is a 3-dimensional array:
a = INTARR(10,10,10)

; Extract a "slice" from a:
b = a[5,*,*]

; Use HELP to show what REFORM does:
HELP, b, REFORM(b)
```

Executing the above statements produces the output:

```
B            INT = Array[1, 10, 10]
<Expression> INT = Array[10, 10]
```

The statements:

```
b = REFORM(a,200,5)
b = REFORM(a,[200,5])
```

have identical effect. They create a new array, b, with dimensions of (200, 5), from a.

## Version History

Introduced: Original

## See Also

REVERSE, ROT, ROTATE, TRANSPOSE

# REGION_GROW

The REGION_GROW function performs region growing for a given region within an N-dimensional array by finding all pixels within the array that are connected neighbors to the region pixels and that fall within provided constraints. The constraints are specified either as a threshold range (a minimum and maximum pixel value) or as a multiple of the standard deviation of the region pixel values. If the threshold is used (this is the default), the region is grown to include all connected neighboring pixels that fall within the given threshold range. If the standard deviation multiplier is used, the region is grown to include all connected neighboring pixels that fall within the range of the mean (of the region's pixel values) plus or minus the given multiplier times the sample standard deviation.

## Syntax

*Result* = REGION_GROW(*Array*, *ROIPixels* [, /ALL_NEIGHBORS] [, STDDEV_MULTIPLIER=*value* | THRESHOLD=[*min*,*max*]] )

## Return Value

REGION_GROW returns the vector of array indices that represent pixels within the grown region. The grown region will not include pixels at the edges of the input array. If no pixels fall within the grown region, this function will return the value -1.

## Arguments

### Array

An N-dimensional array of data values. The region will be grown according to the data values within this array.

### ROIPixels

A vector of indices into *Array* that represent the initial region that is to be grown.

## Keywords

### ALL_NEIGHBORS

Set this keyword to indicate that all adjacent neighbors to a given pixel should be considered during region growing (sometimes known as 8-neighbor searching when

the array is two-dimensional). The default is to search only the neighbors that are exactly one unit in distance from the current pixel (sometimes known as 4-neighbor searching when the array is two-dimensional).

### STDDEV_MULTIPLIER

Set this keyword to a scalar value that serves as the multiplier of the sample standard deviation of the original region pixel values. The expanded region includes neighboring pixels that fall within the range of the mean of the region's pixel values plus or minus the given multiplier times the sample standard deviation as follows:

Mean +/- StdDevMultiplier * StdDev

This keyword is mutually exclusive of THRESHOLD. If both keywords are specified, a warning message will be issued and the THRESHOLD value will be used.

### THRESHOLD

Set this keyword to a two-element vector, [*min*,*max*], of the inclusive range within which the pixel values of the grown region must fall. The default is the range of pixel values within the initial region. This keyword is mutually exclusive of STDDEV_MULTIPLIER. If both keywords are specified, a warning message will be issued and the THRESHOLD value will be used.

**Note**

If neither keyword is specified, THRESHOLD is used by default. The range of threshold values is based upon the pixel values within the original region and therefore does not have to be provided.

## Examples

The following example demonstrates how you can grow a pre-defined region within an image of human red blood cells.

```
; Load an image.
fname = FILEPATH('rbcells.jpg', SUBDIR=['examples','data'])
READ_JPEG, fname, img
imgDims = SIZE(img, /DIMENSIONS)

; Define original region pixels.
x = FINDGEN(16*16) MOD 16 + 276.
y = LINDGEN(16*16) / 16 + 254.
roiPixels = x + y * imgDims[0]

; Grow the region.
```

```
newROIPixels = REGION_GROW(img, roiPixels)

; Load a grayscale color table.
DEVICE, DECOMPOSED = 0
LOADCT, 0

; Set the topmost color table entry to red.
topClr = !D.TABLE_SIZE-1
TVLCT, 255, 0, 0, topClr

; Show the results.
tmpImg = BYTSCL(img, TOP=(topClr-1))
tmpImg[roiPixels] = topClr
WINDOW, 0, XSIZE=imgDims[0], YSIZE=imgDims[1], $
   TITLE='Original Region'
TV, tmpImg

tmpImg = BYTSCL(img, TOP=(topClr-1))
tmpImg[newROIPixels] = topClr
WINDOW, 2, XSIZE=imgDims[0], YSIZE=imgDims[1], $
   TITLE='Grown Region'
TV, tmpImg
```

## Version History

Introduced: 5.5

# REGISTER_CURSOR

The REGISTER_CURSOR procedure associates the given name with the given cursor information. This name can then be used with the IDLgrWindow::SetCurrentCursor method.

## Syntax

REGISTER_CURSOR, *Name*, *Image*[, MASK=*value*] [, HOTSPOT=*value*] [, /OVERWRITE]

## Arguments

### Name

This argument sets the name to associate with this cursor. The name is case-insensitive. Once registered, the name can be used with the IDLgrWindow::SetCurrentCursor method.

### Image

Set this argument to a 16 line by 16 column bitmap, contained in a 16-element short integer vector, specifying the cursor pattern. The offset from the upper-left pixel to the point that is considered the "hot spot" can be provided using the HOTSPOT keyword.

## Keywords

### MASK

This keyword can be used to simultaneously specify the mask that should be used. In the mask, bits that are set indicate bits in the IMAGE that should be seen and bits that are not are "masked out".

### HOTSPOT

Set this keyword to a two-element vector specifying the [*x*, *y*] pixel offset of the cursor "hot spot", the point which is considered to be the mouse position, from the lower-left corner of the cursor image. The cursor image is displayed top-down (the first row is displayed at the top).

### OVERWRITE

By default, if the cursor already exists, the values are not changed. By setting this keyword to true, the current cursor value is updated with the values provided by this routine call.

## Version History

Introduced: 5.6

## See Also

IDLgrWindow::SetCurrentCursor

# REGRESS

The REGRESS function performs a multiple linear regression fit and returns an *Nterm*-element column vector of coefficients.

REGRESS fits the function:

$$y_i = const + a_0 x_{0,\,i} + a_1 x_{1,\,i} + ... + a_{\text{Nterms-1}} x_{\text{Nterms-1, i}}$$

This routine is written in the IDL language. Its source code can be found in the file `regress.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = REGRESS( *X*, *Y*, [, CHISQ=*variable*] [, CONST=*variable*] [, CORRELATION=*variable*] [, /DOUBLE] [, FTEST=*variable*] [, MCORRELATION=*variable*] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*] [, STATUS=*variable*] [, YFIT=*variable*] )

## Return Value

REGRESS returns a 1 x *Nterm* array of coefficients. If the DOUBLE keyword is set, or if *X* or *Y* are double-precision, then the result will be double precision, otherwise the result will be single precision.

## Arguments

### X

An *Nterms* by *Npoints* array of independent variable data, where *Nterms* is the number of coefficients (independent variables) and *Npoints* is the number of samples.

### Y

An *Npoints*-element vector of dependent variable points.

### Weights

*The Weights argument is obsolete, and has been replaced by the MEASURE_ERRORS keyword. Code that uses the Weights argument will continue to work as before, but new code should use the MEASURE_ERRORS keyword instead. Note that the definition of the MEASURE_ERRORS keyword is different from that of the Weights argument. Using the Weights argument, SQRT(1/Weights[i]) represents*

*the measurement error for each point Y[i]. Using the MEASURE_ERRORS keyword, the measurement error for each point is represented as simply MEASURE_ERRORS[i]. Also note that the RELATIVE_WEIGHTS keyword is not necessary when using the MEASURE_ERRORS keyword.*

### Yfit, Const, Sigma, Ftest, R, Rmul, Chisq, Status

*The Yfit, Const, Sigma, Ftest, R, Rmul, Chisq, and Status arguments are obsolete, and have been replaced by the YFIT, CONST, SIGMA, FTEST, CORRELATION, MCORRELATION, CHISQ, and STATUS keywords, respectively. Code that uses these arguments will continue to work as before, but new code should use the keywords instead.*

## Keywords

### CHISQ

Set this keyword equal to a named variable that will contain the value of the chi-square goodness-of-fit.

### CONST

Set this keyword to a named variable that will contain the constant term of the fit.

### CORRELATION

Set this keyword to a named variable that will contain the vector of linear correlation coefficients.

### DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic.

### FTEST

Set this keyword to a named variable that will contain the F-value for the goodness-of-fit test.

### MCORRELATION

Set this keyword to a named variable that will contain the multiple linear correlation coefficient.

## MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

**Note**

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(*Y*).

## RELATIVE_WEIGHT

*This keyword is obsolete. Code using the Weights argument and RELATIVE_WEIGHT keyword will continue to work as before, but new code should use the MEASURE_ERRORS keyword, for which case the RELATIVE_WEIGHT keyword is not necessary. Using the Weights argument, it was necessary to specify the RELATIVE_WEIGHT keyword if no weighting was desired. This is not the case with the MEASURE_ERRORS keyword—when MEASURE_ERRORS is omitted, REGRESS assumes you want no weighting.*

## SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters.

**Note**

If MEASURE_ERRORS is omitted, then you are assuming that the regression model is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

## STATUS

Set this keyword to a named variable that will contain the status of the operation. Possible status values are:

- 0 = successful completion
- 1 = singular array (which indicates that the inversion is invalid)
- 2 = warning that a small pivot element was used and that significant accuracy was probably lost.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

### YFIT

Set this keyword to a named variable that will contain the vector of calculated *Y* values.

## Examples

```
; Create two vectors of independent variable data:
X1 = [1.0, 2.0, 4.0, 8.0, 16.0, 32.0]
X2 = [0.0, 1.0, 2.0, 3.0, 4.0, 5.0]
; Combine into a 2x6 array
X = [TRANSPOSE(X1), TRANSPOSE(X2)]

; Create a vector of dependent variable data:
Y = 5 + 3*X1 - 4*X2

; Assume Gaussian measurement errors for each point:
measure_errors = REPLICATE(0.5, N_ELEMENTS(Y))

; Compute the fit, and print the results:
result = REGRESS(X, Y, SIGMA=sigma, CONST=const, $
   MEASURE_ERRORS=measure_errors)
PRINT, 'Constant: ', const
PRINT, 'Coefficients: ', result[*]
PRINT, 'Standard errors: ', sigma
```

IDL prints:

```
Constant:    4.99999
Coefficients:    3.00000    -3.99999
Standard errors:    0.0444831    0.282038
```

## Version History

Introduced: Original

## See Also

CURVEFIT, GAUSSFIT, LINFIT, LMFIT, POLY_FIT, SFIT, SVDFIT

# REPEAT...UNTIL

The REPEAT...UNTIL statement repeats its subject statement(s) until an expression evaluates to true. The condition is checked after the subject statement is executed. Therefore, the subject statement is always executed at least once, even if the expression evaluates to true the first time.

**Note**

For information on using REPEAT_UNTIL and other IDL program control statements, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

REPEAT *statement* UNTIL *expression*

or

REPEAT BEGIN

*statements*

ENDREP UNTIL *expression*

## Examples

This example shows that because the subject of a REPEAT statement is evaluated before the expression, it is always executed at least once:

```
i = 1

REPEAT BEGIN

   PRINT, i

ENDREP UNTIL (i EQ 1)
```

## Version History

Introduced: Original

# REPLICATE

The REPLICATE function returns an array with the given dimensions, filled with the scalar value specified as the first parameter.

## Syntax

*Result* = REPLICATE( *Value*, $D_1$ *[*, ..., $D_8$*]* )

## Return Value

Returns the array of the given dimensions.

## Arguments

### Value

The scalar value with which to fill the resulting array. The type of the result is the same as that of *Value*. *Value* can be any single element expression such as a scalar or 1 element array. This includes structures.

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Create D, a 5-element by 5-element array with every element set to the string “IDL” by entering:

```
D = REPLICATE('IDL', 5, 5)
```

REPLICATE can also be used to create arrays of structures. For example, the following command creates a structure named “emp” that contains a string name field and a long integer employee ID field:

```
employee = {emp, NAME:' ', ID:0L}
```

To create a 10-element array of this structure, enter:

```
emps = REPLICATE(employee, 10)
```

## Version History

Introduced: Original

## See Also

MAKE_ARRAY

# REPLICATE_INPLACE

The REPLICATE_INPLACE procedure updates an existing array by replacing all or selected parts of it with a specified value. REPLICATE_INPLACE can be faster and use less memory than the IDL function REPLICATE or the IDL array notation for large arrays that already exist.

**Note**

REPLICATE_INPLACE is much faster when operating on entire arrays and rows, than when used on columns or higher dimensions.

## Syntax

REPLICATE_INPLACE, *X*, *Value* [, *D1*, *Loc1* [, *D2*, *Range*]]

## Arguments

### X

The array to be updated. *X* can be of any numeric type. REPLICATE_INPLACE does not change the size and type of *X*.

### Value

The value which will fill all or part of *X*. *Value* may be any scalar or one-element array that IDL can convert to the type of *X*. REPLICATE_INPLACE does not change *Value*.

### D1

An optional parameter indicating which dimension of *X* is to be updated.

### Loc1

An array with the same number of elements as the number of dimensions of *X*. The *Loc1* and *D1* arguments together determine which one-dimensional subvector (or subvectors, if *D1* and *Range* are provided) of *X* is to be updated.

### D2

An optional parameter, indicating in which dimension of *X* a group of one-dimensional subvectors are to be updated. *D2* should be different from *D1*.

### Range

An array of indices of dimension *D2* of *X*, indicating where to put one-dimensional updates of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

```
; Create a multidimensional zero array:
A = FLTARR( 40, 90, 10)

; Populate it with the value 4.5. (i.e., A[*]= 4.5 ):
REPLICATE_INPLACE, A, 4.5
;Update a single subvector.(i.e., A[*,4,0]= 20. ):
REPLICATE_INPLACE, A, 20, 1, [0,4,0]

; Update a group of subvectors.(i.e., A[ 0, [0, 5,89], * ] = -8 ):
REPLICATE_INPLACE, A, -8, 3, [0,0,0], 2, [0,5,89]

; Update a 2-dimensional slice of A (i.e., A[9,*, *] = 0.):
REPLICATE_INPLACE, A, 0., 3, [9,0,0] , 2, LINDGEN(90)
```

## Version History

Introduced: 5.1

## See Also

REPLICATE, BLAS_AXPY

# RESOLVE_ALL

The RESOLVE_ALL procedure iteratively resolves (by compiling) any uncompiled procedures or functions that are called in any already-compiled procedure or function. The process ends when there are no unresolved routines left to compile. If an unresolved procedure or function is not in the IDL search path, this routine exits with an error, and no additional routines are compiled.

RESOLVE_ALL is of special interest when using SAVE to construct an IDL `.sav` file containing the compiled code for a package of routines. If you are constructing such a `.sav` file and it contains calls to built-in IDL system functions that are not present under all operating systems (e.g., IOCTL), you must make sure to use FORWARD_FUNCTION to tell IDL that these names are functions. Otherwise, IDL may interpret them as arrays and generate unintended results.

**Warning**

RESOLVE_ALL does not resolve procedures or functions that are called via quoted strings such as CALL_PROCEDURE, CALL_FUNCTION, or EXECUTE, or in keywords that can contain procedure names such as TICKFORMAT or EVENT_PRO. You must manually compile these routines if they are not called normally elsewhere.

Similarly, RESOLVE_ALL does not resolve widget event handler procedures based on a call to the widget routine that uses the event handler. In general, it is best to include the event handling routine in the same program file as the widget creation routine—building widget programs in this way ensures that RESOLVE_ALL will "catch" the event handler for a widget application.

This routine is written in the IDL language. Its source code can be found in the file `resolve_all.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

RESOLVE_ALL [, CLASS=*string*] [, /CONTINUE_ON_ERROR] [, /QUIET]

## Arguments

None.

# Keywords

## CLASS

Set this keyword to a string or string array containing object class names.

RESOLVE_ALL's rules for finding uncompiled functions and procedures are not able to find object definitions or methods, because those things are not known to IDL until the object classes are actually instantiated and the methods called. However, if the CLASS keyword is set, RESOLVE_ALL will ensure that the `*__define.pro` files for the specified classes and their superclasses are compiled and executed. RESOLVE_ALL then locates all methods for the specified classes and their superclasses, and makes sure they are also compiled.

## CONTINUE_ON_ERROR

Set this keyword to allow continuation upon error.

## QUIET

Set this keyword to suppress informational messages.

# Version History

Introduced: 4.0

Added CLASS keyword: 6.0

# See Also

.COMPILE, RESOLVE_ROUTINE, ROUTINE_INFO

# RESOLVE_ROUTINE

The RESOLVE_ROUTINE procedure compiles user-written or library procedures or functions, given their names. Routines are compiled even if they are already defined. RESOLVE_ROUTINE looks for the given filename in IDL's search path. If the file is not found in the path, then the routine exits with an error.

## Syntax

RESOLVE_ROUTINE, *Name* [, /COMPILE_FULL_FILE ]
[, /EITHER | , /IS_FUNCTION] [, /NO_RECOMPILE]

## Arguments

### Name

A scalar string or string array containing the name or names of the procedures to compile. If *Name* contains functions rather than procedures, set the IS_FUNCTION keyword. The *Name* argument cannot contain the path to the `.pro` file—it must contain only a `.pro` filename. If you want to specify a path to the `.pro` file, use the .COMPILE executive command.

## Keywords

### COMPILE_FULL_FILE

When compiling a file to find a specified routine, IDL normally stops compiling when the desired routine (*Name*) is found. If set, COMPILE_FULL_FILE compiles the entire file.

### EITHER

If set, indicates that the caller does not know whether the supplied routine names are functions or procedures, and will accept either. This keyword overrides the IS_FUNCTION keyword.

### IS_FUNCTION

Set this keyword to compile functions rather than procedures.

### NO_RECOMPILE

Normally, RESOLVE_ROUTINE compiles all specified routines even if they have already been compiled. Setting NO_RECOMPILE indicates that such routines are not recompiled.

## Version History

Introduced: 4.0

## See Also

.COMPILE, RESOLVE_ALL, ROUTINE_INFO

# RESTORE

The RESTORE procedure restores the IDL variables and routines saved in a file by the SAVE procedure.

**Warning**

While files containing IDL data variables can be restored by any version of IDL that supports the data types of the saved variables (in particular, by any version of IDL later than the version that created the SAVE file), files containing IDL routines and system variables can only be restored by versions of IDL that share the same internal code representation. Since the internal code representation changes regularly, you should always archive the IDL language source files (`.pro` files) for routines you are placing in IDL `.sav` files so you can recompile the code when a new version of IDL is released.

## Syntax

RESTORE [[, *Filename*] | [, FILENAME=*name*]]
[, /RELAXED_STRUCTURE_ASSIGNMENT]
[, RESTORED_OBJECTS=*variable*] [, /VERBOSE]

## Arguments

### Filename

A scalar string that contains the name of the file from which the IDL objects should be restored. If not present, the file `idlsave.dat` is used. If the file to be restored is not in your current working directory or IDL search path, you will need to specify the path to the file. See the following example for more information.

## Keywords

### FILENAME

This keyword serves exactly the same purpose as the *Filename* argument—only one of them needs to be provided.

### RELAXED_STRUCTURE_ASSIGNMENT

Normally, RESTORE is unable to restore a structure variable if the definition of its type has changed since the SAVE file was written. A common case where this occurs

is when objects are saved and the class structure of the objects change before they are restored in another IDL session. In such cases, RESTORE issues an error, skips the structure, and continues restoring the remainder of the SAVE file.

Setting the RELAXED_STRUCTURE_ASSIGNMENT keyword causes RESTORE to restore such incompatible values using “relaxed structure assignment,” in which all possible data are restored using a field-by-field copy. (See the description of the STRUCT_ASSIGN procedure for additional details.)

### RESTORED_OBJECTS

Set this keyword equal to a named variable that will contain an array of object references for any objects restored. The resulting list of objects is useful for programmatically calling the objects’ restore methods. If no objects are restored, the variable will contain a null object reference.

### VERBOSE

Set this keyword to have IDL print an informative message for each restored object.

## Examples

Suppose that you have saved all the variables from a previous IDL session with the command:

```
SAVE, /VARIABLES, FILENAME = 'session1.sav'
```

If the file `session1.sav` is located in your current working directory, the variable associated with the file can be restored by entering:

```
RESTORE, 'session1.sav'
```

**Note**

To restore a file that is not in your current working directory, you must specify the file path.

## Version History

Introduced: Original

## See Also

JOURNAL, SAVE, STRUCT_ASSIGN

# RETALL

The RETALL command returns control to the main program level. The effect is the same as entering the RETURN command at the interactive command prompt until the main level is reached.

## Syntax

RETALL

## Arguments

None

## Version History

Introduced: Original

## See Also

RETURN

# RETURN

The RETURN command causes the program context to revert to the next-higher program level. RETURN can be called at the interactive command prompt (see ".RETURN" on page 71), inside a procedure definition, or inside a function definition.

Calling RETURN from the main program level has no effect other than to print an informational message in the command log.

Calling RETURN inside a procedure definition returns control to the calling routine, or to the main level. Since the END statement in a procedure definition also returns control to the calling routine, it is only necessary to use RETURN in a procedure definition if you wish control to revert to the calling routine before the procedure reaches its END statement.

In a function definition, RETURN serves to define the value passed out of the function. Only a single value can be returned from a function.

**Note**

The value can be an array or structure containing multiple data items.

## Syntax

RETURN [, *Return_value*]

## Arguments

### Return_value

In a function definition, the *Return_value* is the value passed out of the function when it completes its processing.

Return values are not allowed in procedure definitions, or when calling RETURN at the interactive command prompt.

## Examples

You can use RETURN within a procedure definition to exit the procedure at some point other than the end. For example, note the following procedure:

```
PRO RET_EXAMPLE, value
   IF (value NE 0) THEN BEGIN
```

```
      PRINT, value, ' is nonzero'
      RETURN
      END
   PRINT, 'Input argument was zero.'
END
```

If the input argument is non-zero, the routine prints the value and exits back to the calling procedure or main level. If the input argument is zero, control proceeds until the END statement is reached.

When defining functions, use RETURN to specify the value returned from the function. For example, the following function:

```
FUNCTION RET_EXAMPLE2, value
   RETURN, value * 2
END
```

multiplies the input value by two and returns the result. If this function is defined at the main level, calling it from the IDL command prompt produces the following:

```
PRINT, RET_EXAMPLE2(4)
```

IDL prints:

```
8
```

## Version History

Introduced: Original

## See Also

RETALL

# REVERSE

The REVERSE function reverses the order of one dimension of an array.

This routine is written in the IDL language. Its source code can be found in the file `reverse.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = REVERSE( *Array* [, *Subscript_Index*] [, /OVERWRITE] )

## Return Value

Returns the reversed dimension of the array.

## Arguments

### Array

The array containing the original data.

### Subscript_Index

An integer specifying the dimension index (1, 2, 3, etc.) that will be reversed. This argument must be less than or equal to the number of dimensions of *Array*. If this argument is omitted, the first subscript is reversed.

## Keywords

### OVERWRITE

Set this keyword to conserve memory by doing the transformation “in-place.” The result overwrites the previous contents of the array. This keyword is ignored for one- or two-dimensional arrays.

## Examples

Reverse the order of an array where each element is set to the value of its subscript:

```
; Create an array:
A = [[0,1,2],[3,4,5],[6,7,8]]
```

```
; Print the array:
PRINT, 'Original Array:'
PRINT, A

; Reverse the columns of A.
PRINT, 'Reversed Columns:'
PRINT, REVERSE(A)

; Reverse the rows of A:
PRINT, 'Reversed Rows:'
PRINT, REVERSE(A, 2)
```

IDL prints:

```
Original Array:
       0       1       2
       3       4       5
       6       7       8
Reversed Columns:
       2       1       0
       5       4       3
       8       7       6
Reversed Rows:
       6       7       8
       3       4       5
       0       1       2
```

## Version History

Introduced: Original

## See Also

INVERT, REFORM, ROT, ROTATE, SHIFT, TRANSPOSE

# RK4

The RK4 function uses the fourth-order Runge-Kutta method to advance a solution to a system of ordinary differential equations one time-step *H*, given values for the variables *Y* and their derivatives *Dydx* known at *X*.

RK4 is based on the routine `rk4` described in section 16.1 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = RK4( *Y*, *Dydx*, *X*, *H*, *Derivs* [, /DOUBLE] )

## Return Value

Returns the integrations of the ordinary differential equations.

## Arguments

### Y

A vector of values for *Y* at *X*

### Dydx

A vector of derivatives for *Y* at *X*.

### X

A scalar value for the initial condition.

### H

A scalar value giving interval length or step size.

### Derivs

A scalar string specifying the name of a user-supplied IDL function that calculates the values of the derivatives *Dydx* at *X*. This function must accept two arguments: A scalar floating value *X*, and one *n*-element vector *Y*. It must return an *n*-element vector result.

For example, suppose the values of the derivatives are defined by the following relations:

$$dy_0 / dx = -0.5y_0, \qquad dy_1 / dx = 4.0 - 0.3y_1 - 0.1y_0$$

We can write a function DIFFERENTIAL to express these relationships in the IDL language:

```
FUNCTION differential, X, Y
   RETURN, [-0.5 * Y[0], 4.0 - 0.3 * Y[1] - 0.1 * Y[0]]
END
```

# Keywords

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

To integrate the example system of differential equations for one time step, H:

```
; Define the step size:
H = 0.5

; Define an initial X value:
X = 0.0

; Define initial Y values:
Y = [4.0, 6.0]

; Calculate the initial derivative values:
dydx = DIFFERENTIAL(X,Y)

; Integrate over the interval (0, 0.5):
result = RK4(Y, dydx, X, H, 'differential')

; Print the result:
PRINT, result
```

IDL prints:

```
 3.11523  6.85767
```

This is the exact solution vector to five-decimal precision.

## Version History

Introduced: 4.0

## See Also

BROYDEN, NEWTON

# ROBERTS

The ROBERTS function returns an approximation to the Roberts edge enhancement operator for images:

$$G_{jk} = \left|F_{jk} - F_{j+1,\,k+1}\right| + \left|F_{j,\,k+1} - F_{j+1,\,k}\right|$$

where (*j*, *k*) are the coordinates of each pixel $F_{jk}$ in the *Image*. This is equivalent to a convolution using the masks,

$$\begin{bmatrix} 0 & -1 \\ \underline{1} & 0 \end{bmatrix} \text{and} \begin{bmatrix} 1 & 0 \\ \underline{0} & -1 \end{bmatrix}$$

where the underline indicates the current pixel $F_{jk}$. The last column and row are set to zero.

## Syntax

*Result* = ROBERTS(*Image*)

## Return Value

ROBERTS returns a two-dimensional array of the same size as *Image*. If *Image* is of type byte or integer, then the result is of integer type, otherwise the result is of the same type as *Image*.

**Note**

To avoid overflow for integer types, the computation is done using the next larger signed type and the result is transformed back to the correct type. Values larger than the maximum for that integer type are truncated. For example, for integers the function is computed using type long, and on output, values larger than 32767 are set equal to 32767.

## Arguments

### Image

The two-dimensional array containing the image to which edge enhancement is applied.

## Keywords

None.

## Examples

If the variable `myimage` contains a two-dimensional image array, a Roberts sharpened version of `myimage` can be displayed with the command:

```
TVSCL, ROBERTS(myimage)
```

## Version History

Introduced: 4.0

## See Also

SOBEL

# ROT

The ROT function rotates an image by an arbitrary amount. At the same time, it can magnify, demagnify, and/or translate an image.

**Note**

If you want to rotate an array by a multiple of 90 degrees, you should use the ROTATE function for faster results.

This routine is written in the IDL language. Its source code can be found in the file `rot.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = ROT( *A*, *Angle*, [*Mag*, $X_0$, $Y_0$] [, /INTERP] [, CUBIC=*value*{-1 to 0}] [, MISSING=*value*] [, /PIVOT] )

## Return Value

Returns the rotated and optionally transformed image.

## Arguments

### A

The image array to be rotated. This array can be of any type, but must have two dimensions. The output image has the same dimensions and data type of the input image.

### ANGLE

Angle of rotation in degrees *clockwise*.

### MAG

An optional magnification factor. A value of 1.0 results in no change. A value greater than one performs magnification. A value less than one but greater than zero performs demagnification.

### $X_0$

X subscript for the center of rotation. If omitted, $X_0$ equals the number of columns in the image divided by 2.

### $Y_0$

Y subscript for the center of rotation. If omitted, $Y_0$ equals the number of rows in the image divided by 2.

## Keywords

### INTERP

Set this keyword to use bilinear interpolation. The default is to use nearest neighbor sampling.

### CUBIC

Set this keyword to a value between -1 and 0 to use the cubic convolution interpolation method with the specified value as the interpolation parameter. Setting this keyword equal to a value greater than zero specifies a value of -1 for the interpolation parameter. Park and Schowengerdt (see reference below) suggest that a value of -0.5 significantly improves the reconstruction properties of this algorithm.

Cubic convolution is an interpolation method that closely approximates the theoretically optimum sinc interpolation function using cubic polynomials. According to sampling theory, details of which are beyond the scope of this document, if the original signal, *f*, is a band-limited signal, with no frequency component larger than $\omega_0$, and *f* is sampled with spacing less than or equal to $1/(2\omega_0)$, then *f* can be reconstructed by convolving with a sinc function: $\text{sinc}(x) = \sin(\pi x) / (\pi x)$.

In the one-dimensional case, four neighboring points are used, while in the two-dimensional case 16 points are used.

**Note**

Cubic convolution interpolation is significantly slower than bilinear interpolation.

For further details see:

Rifman, S.S. and McKinnon, D.M., “Evaluation of Digital Correction Techniques for ERTS Images; Final Report”, Report 20634-6003-TU-00, TRW Systems, Redondo Beach, CA, July 1974.

S. Park and R. Schowengerdt, 1983 “Image Reconstruction by Parametric Cubic Convolution”, Computer Vision, Graphics & Image Processing 23, 256.

### MISSING

Set this keyword to a value to be substituted for pixels in the output image that map outside the input image.

### PIVOT

Set this keyword to cause the image to pivot around the point $(X_0, Y_0)$ so that this point maps into the same point in the output image. By default, the point $(X_0, Y_0)$ in the input image is mapped into the center of the output image.

## Examples

```
; Create a byte image:
A = BYTSCL(DIST(256))

; Display it:
TV, A

; Rotate the image 33 degrees, magnify it 15 times, and use
; bilinear interpolation to make the output look nice:
B = ROT(A, 33, 1.5, /INTERP)

; Display the rotated image:
TV, B
```

## Version History

Introduced: Original

## See Also

ROTATE

# ROTATE

The ROTATE function returns a rotated and/or transposed copy of *Array*. ROTATE can only rotate arrays in multiples of 90 degrees. To rotate by amounts other than multiples of 90 degrees, use the ROT function. Note, however, that ROTATE is more efficient.

ROTATE can also be used to reverse the order of elements in vectors. For example, to reverse the order of elements in the vector X, use the expression `ROTATE(X,2)`. If X = [0,1,2,3] then `ROTATE(X,2)` yields the resulting array, [3,2,1,0].

**Note**

Transposition, if specified, is performed before rotation.

## Syntax

*Result* = ROTATE(*Array, Direction*)

## Return Value

Returns the rotated and/or transposed array.

## Arguments

### Array

The array to be rotated. *Array* can have only one or two dimensions. The result has the same type as *Array*. The dimensions of the result are the same as those of *Array* if *Direction* is equal to 0 or 2. The dimensions are transposed if the direction is 4 or greater.

### Direction

*Direction* specifies the operation to be performed as follows:

| Direction | Transpose? | Rotation Counterclockwise | $X_1$ | $Y_1$ |
|---|---|---|---|---|
| 0 | No | None | $X_0$ | $Y_0$ |
| 1 | No | 90° | $-Y_0$ | $X_0$ |

*Table 85: Rotation Directions*

| Direction | Transpose? | Rotation Counterclockwise | $X_1$ | $Y_1$ |
|---|---|---|---|---|
| 2 | No | 180° | $-X_0$ | $-Y_0$ |
| 3 | No | 270° | $Y_0$ | $-X_0$ |
| 4 | Yes | None | $Y_0$ | $X_0$ |
| 5 | Yes | 90° | $-X_0$ | $Y_0$ |
| 6 | Yes | 180° | $-Y_0$ | $-X_0$ |
| 7 | Yes | 270° | $X_0$ | $-Y_0$ |

*Table 85: Rotation Directions (Continued)*

In the table above, ($X_0$, $Y_0$) are the original subscripts, and ($X_1$, $Y_1$) are the subscripts of the resulting array. The notation $-Y_0$ indicates a reversal of the Y axis, $Y_1 = N_y - Y_0 - 1$. *Direction* is taken modulo 8, so a rotation of -1 is the same as 7, 9 is the same as 1, etc.

**Note**

The assertion that *Array* is rotating counterclockwise may cause some confusion. Remember that when arrays are displayed on the screen (using TV or TVSCL, for example), the image is drawn by default with the origin (0,0) at the bottom left corner of the window. (This default can be changed by changing the value of the !ORDER system variable.) When arrays are printed on the console or command log window (using the PRINT command, for example), the (0,0) element is drawn in the upper left corner of the array. This means that while an image displayed in a graphics window appears to rotate counterclockwise, an array printed in the command log appears to rotate clockwise.

## Examples

Create and display a wedge image by entering:

```
F = REPLICATE(1, 256) # FINDGEN(256) & TVSCL, F
```

To display the image rotated 90 degrees counterclockwise, enter:

```
TVSCL, ROTATE(F, 1)
```

## Version History

Introduced: Original

## See Also

ROT, TRANSPOSE

# ROUND

The ROUND function rounds the argument to its closest integer.

## Syntax

*Result* = ROUND(*X* [, /L64 ] )

## Return Value

Returns the integer closest to its argument. If the input value *X* is integer type, *Result* has the same value and type as *X*. Otherwise, *Result* is returned as a 32-bit longword integer with the same structure as *X*.

## Arguments

### X

The value for which the ROUND function is to be evaluated. This value can be any numeric type (integer, floating, or complex). Note that only the real part of a complex argument is rounded and returned.

## Keywords

### L64

If set, the result type is 64-bit integer no matter what type the input has. This is useful for situations in which a floating point number contains a value too large to be represented in a 32-bit integer.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Print the rounded values of a 2-element vector:

```
PRINT, ROUND([5.1, 5.9])
```

IDL prints:

```
       5       6
```

Print the result of rounding 3000000000.1, a value that is too large to represent in a 32-bit integer:

```
PRINT, ROUND(3000000000.1D, /L64)
```

IDL prints:

```
3000000000
```

## Version History

Introduced: Pre 4.0

## See Also

CEIL, COMPLEXROUND, FLOOR

# ROUTINE_INFO

The ROUTINE_INFO function provides information about currently-compiled procedures and functions.

## Syntax

*Result* = ROUTINE_INFO( [*Routine* [[, /PARAMETERS{must specify *Routine*}] [, /SOURCE ] [, /UNRESOLVED] [, /VARIABLES] | , /SYSTEM]] [, /DISABLED] [, /ENABLED] [, /FUNCTIONS] )

## Return Value

Returns a string array consisting of the names of defined procedures or functions, or of parameters or variables used by a single procedure or function.

## Arguments

### Routine

A scalar string containing the name of routine for which information will be returned. *Routine* can be either a procedure or a function. If *Routine* is not supplied, ROUTINE_INFO returns a list of all currently-compiled procedures.

## Keywords

### DISABLED

Set this keyword to get the names of currently disabled system procedures or functions (in conjunction with the FUNCTIONS keyword). Use of DISABLED implies use of the SYSTEM keyword, since user routines cannot be disabled.

### ENABLED

Set this keyword to get the names of currently enabled system procedures or functions (in conjunction with the FUNCTIONS keyword). Use of ENABLED implies use of the SYSTEM keyword, since user routines cannot be disabled.

### FUNCTIONS

Set this keyword to return a string array containing currently-compiled functions. By default, ROUTINE_INFO returns a list of compiled procedures. If the SYSTEM

keyword is also set, ROUTINE_INFO returns a list of all IDL built-in internal functions.

## PARAMETERS

Set this keyword to return an anonymous structure with the following fields:

- **NUM_ARGS** — An integer containing the number of positional parameters used in *Routine*.
- **NUM_KW_ARGS** — An integer containing the number of keyword parameters used in *Routine*.
- **ARGS** — A string array containing the names of the positional parameters used in *Routine*.
- **KW_ARGS** — A string array containing the names of the keyword parameters used in *Routine*.

You must supply the *Routine* argument when using this keyword. If *Routine* is a function, you must specify the FUNCTIONS keyword as well. Note that specifying the SYSTEM keyword along with this keyword will generate an error.

If *Routine* does not take any arguments, the ARGS field is not included in the anonymous structure. Similarly, if *Routine* does not take any keywords, the KW_ARGS field is not included.

## SOURCE

Set this keyword to return an array of anonymous structures with the following fields:

- **NAME** — A string containing the name of the procedure or function.
- **PATH** — A string containing the full path specification of the file that contains the definition of the procedure or function.

If *Routine* is specified, information for the specified procedure is returned. If *Routine* is not specified, information for all compiled procedures is returned. If the FUNCTIONS keyword is also set, ROUTINE_INFO returns information for the specified function or for all compiled functions.

If a routine is unresolved or its path information is unavailable, the PATH field will contain a null string. If a routine has been SAVEd and then RESTOREd, the PATH field will contain the path to the SAVE file.

**Note**

Specifying the SYSTEM keyword along with this keyword will generate an error.

### SYSTEM

Set this keyword to return a string array listing all IDL built-in internal procedures. Built-in internal procedures are part of the IDL executable, and are *not* written in the IDL language. If the FUNCTIONS keyword is also set, ROUTINE_INFO returns a list of all IDL built-in internal functions.

### UNRESOLVED

Set this keyword to return a string array listing procedures that are referenced in any currently-compiled procedure or function, but which are themselves not yet compiled. If the FUNCTIONS keyword is also set, ROUTINE_INFO returns a list of functions that are referenced but not yet compiled.

Note that specifying the SYSTEM keyword along with this keyword will generate an error.

### VARIABLES

Set this keyword to return a string array listing variables defined in the procedure. If the FUNCTIONS keyword is also set, ROUTINE_INFO returns a string array listing variables defined in the function.

You must supply the *Routine* argument when using this keyword. Note that specifying the SYSTEM keyword along with this keyword will generate an error.

## Version History

Introduced: 5.0

## See Also

RESOLVE_ALL, RESOLVE_ROUTINE

# RS_TEST

The RS_TEST function tests the hypothesis that two sample populations *X* and *Y* have the same mean of distribution against the hypothesis that they differ. *X* and *Y* may be of different lengths. This type of test is often referred to as the “Wilcoxon Rank-Sum Test” or the “Mann-Whitney U-Test.”

The Mann-Whitney statistics for *X* and *Y* are defined as follows:

$$U_x = N_x N_y + \frac{N_x(N_x + 1)}{2} - W_x$$

$$U_y = N_x N_y + \frac{N_y(N_y + 1)}{2} - W_y$$

where *Nx* and *Ny* are the number of elements in *X* and *Y*, respectively, and *Wx* and *Wy* are the rank sums for *X* and *Y*, respectively. The test statistic Z, which closely follows a normal distribution for sample sizes exceeding 10 elements, is defined as follows:

$$Z = \frac{U_x - (N_x N_y)/2}{\sqrt{(N_x N_y (N_x + N_y + 1))/12}}$$

This routine is written in the IDL language. Its source code can be found in the file `rs_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = RS_TEST( *X*, *Y* [, UX=*variable*] [, UY=*variable*] )

## Return Value

The result is a two-element vector containing the nearly-normal test statistic Z and the one-tailed probability of obtaining a value of Z or greater.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector.

### Y

An *m*-element integer, single-, or double-precision floating-point vector.

## Keywords

### UX

Set this keyword to a named variable that will contain the Mann-Whitney statistic for *X*.

### UY

Set this keyword to a named variable that will contain the Mann-Whitney statistic for *Y*.

## Examples

```
; Define two sample populations:
X = [-14, 3, 1, -16, -21, 7, -7, -13, -22, -17, -14, -8, $
       7, -18, -13, -9, -22, -25, -24, -18, -13, -13, -18, -5]
Y = [-18, -9, -16, -14, -3, -9, -16, 10, -11, -3, -13, $
     -21, -2, -11, -16, -12, -13, -6, -9, -7, -11, -9]

; Test the hypothesis that two sample populations, {xi, yi}, have
; the same mean of distribution against the hypothesis in that they
; differ at the 0.05 significance level:
PRINT, RS_TEST(X, Y, UX = ux, UY = uy)

; Print the Mann-Whitney statistics:
PRINT, 'Mann-Whitney Statistics: Ux = ', ux, ', Uy = ', uy
```

IDL prints:

```
[1.45134, 0.0733429]
Mann-Whitney Statistics: Ux = 330.000, Uy = 198.000
```

The computed probability (0.0733429) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that X and Y have the same mean of distribution.

## Version History

Introduced: 4.0

## See Also

FV_TEST, KW_TEST, S_TEST, TM_TEST

# S_TEST

The S_TEST function tests the hypothesis that two sample populations *X* and *Y* have the same mean of distribution against the hypothesis that they differ.

This routine is written in the IDL language. Its source code can be found in the file `s_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = S_TEST( *X*, *Y* [, ZDIFF=*variable*] )

## Return Value

The result is a two-element vector containing the maximum number of signed differences between corresponding pairs of *xi* and *yi* and its one-tailed significance. This type of test is often referred to as the “Sign Test.”

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector.

### Y

An *n*-element integer, single-, or double-precision floating-point vector.

## Keywords

### ZDIFF

Set this keyword to a named variable that will contain the number of differences between corresponding pairs of *xi* and *yi* resulting in zero. Paired data resulting in a difference of zero are excluded from the ranking and the sample size is correspondingly reduced.

## Examples

```
; Define two n-element sample populations:
X = [47, 56, 54, 49, 36, 48, 51, 38, 61, 49, 56, 52]
Y = [71, 63, 45, 64, 50, 55, 42, 46, 53, 57, 75, 60]
```

```
; Test the hypothesis that the two sample populations have the same
; mean of distribution against the hypothesis that they differ at
; the 0.05 significance level:
PRINT, S_TEST(X, Y, ZDIFF = zdiff)
```

IDL prints:

```
[9.00000, 0.0729981]
```

The computed probability (0.0729981) is greater than the 0.05 significance level and therefore we do not reject the hypothesis that *X* and *Y* have the same mean of distribution.

## Version History

Introduced: 4.0

## See Also

FV_TEST, KW_TEST, MD_TEST, RS_TEST, TM_TEST

# SAVE

The SAVE procedure saves variables, system variables, and IDL routines in a `.sav` file using the XDR (eXternal Data Representation) format for later recovery by RESTORE. Note that variables and routines cannot be saved in the same file. Note also that save files containing routines may not be compatible between different versions of IDL, but that files containing data are always backwards-compatible.

**Note**

When using the SAVE procedure, some users identify binary files containing variable data using a .dat extension instead of a .sav extension. While any extension can be used to identify files created with SAVE, it is recommended that you use the .sav extension to easily identify files that can be restored.

## Syntax

SAVE [, *Var*$_1$, ..., *Var*$_n$] [, /ALL] [, /COMM, /VARIABLES] [, /COMPRESS] [, FILENAME=*string*] [, /ROUTINES] [, /SYSTEM_VARIABLES] [, /VERBOSE]

## Arguments

### Var$_n$

One or more strings containing the names of variables, routine definitions, or common blocks that are to be saved. If no *Var* arguments are provided, all variables, routine definitions, or common blocks are saved.

## Keywords

### ALL

Set this keyword to save all common blocks, system variables, and local variables from the current IDL session.

**Note**

Routines and variables cannot be saved in the same file. Setting the ALL keyword does not save routines.

## COMM

Set this keyword to save all main level common block definitions. Note that setting this keyword does not cause the contents of the common block to be saved unless the VARIABLES keyword is also set.

## COMPRESS

If COMPRESS is set, IDL writes all data to the SAVE file using the ZLIB compression library to reduce its size. IDL's save file compression support is based on the freely available ZLIB library by Mark Adler and Jean-loup Gailly.

Compressed `.sav` files can be restored by the RESTORE procedure in exactly the same manner as any other `.sav` file. The only visible differences are that the files will be smaller, and writing and reading them will be somewhat slower under typical conditions.

## FILENAME

A string containing the name of the file into which the IDL objects should be saved. If this keyword is not specified, the file `idlsave.dat` is used. It is recommended that the extension, `.sav`, be specified for any file created with the SAVE procedure.

## ROUTINES

Set this keyword to save user defined procedures and functions in a machine independent, binary form. If parameters are present, they must be strings containing the names of the procedures and/or functions to be saved. If no parameters are present, all compiled routines are saved. Routines and variables cannot be saved in the same file.

**Warning**

`.sav` files containing routines are not guaranteed to be compatible between successive versions of IDL. You will not be able to RESTORE `.sav` files containing routines if they are made with incompatible versions of IDL. In this case, you should recompile your original code with the newer version of IDL. A `.sav` file containing data will always be restorable.

## SYSTEM_VARIABLES

Set this keyword to save the current state of all system variables.

**Warning**

Saving system variables is not recommended, as the structure may change between versions of IDL.

### VARIABLES

Set this keyword to save all variables in the current program unit. This option is the default.

### VERBOSE

Set this keyword to print an informative message for each saved object.

## Examples

Save the status of all currently-defined variables in the file `variables1.sav` by entering:

```
SAVE, /VARIABLES, FILENAME = 'variables1.sav'
```

The variables can be restored with the RESTORE procedure.

Save the user procedures MYPROC and MYFUN:

```
SAVE, /ROUTINES, 'MYPROC', 'MYFUN', FILENAME = 'myroutines.sav'
```

## Version History

Introduced: Original

## See Also

JOURNAL, RESOLVE_ALL, RESTORE

# SAVGOL

The SAVGOL function returns the coefficients of a Savitzky-Golay smoothing filter, which can then be applied using the CONVOL function. The Savitzky-Golay smoothing filter, also known as least squares or DISPO (digital smoothing polynomial), can be used to smooth a noisy signal.

The filter is defined as a weighted moving average with weighting given as a polynomial of a certain degree. The returned coefficients, when applied to a signal, perform a polynomial least-squares fit within the filter window. This polynomial is designed to preserve higher moments within the data and reduce the bias introduced by the filter. The filter can use any number of points for this weighted average.

This filter works especially well when the typical peaks of the signal are narrow. The heights and widths of the curves are generally preserved.

**Tip**

You can use this function in conjunction with the CONVOL function for smoothing and optionally for numeric differentiation.

This routine is written in the IDL language. Its source code can be found in the file `savgol.pro` in the `lib` subdirectory of the IDL distribution.

SAVGOL is based on the Savitzky-Golay Smoothing Filters described in section 14.8 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = SAVGOL( *Nleft*, *Nright*, *Order*, *Degree* [, /DOUBLE] )

## Return Value

This function returns an array of floating-point numbers that are the coefficients of the smoothing filter.

## Arguments

### Nleft

An integer specifying the number of data points to the left of each point to include in the filter.

### Nright

An integer specifying the number of data points to the right of each point to include in the filter.

**Note**

Larger values of *Nleft* and *Nright* produce a smoother result at the expense of flattening sharp peaks.

### Order

An integer specifying the order of the derivative desired. For smoothing, use order 0. To find the smoothed first derivative of the signal, use order 1, for the second derivative, use order 2, etc.

**Note**

*Order* must be less than or equal to the value specified for *Degree*.

### Degree

An integer specifying the degree of smoothing polynomial. Typical values are 2 to 4. Lower values for *Degree* will produce smoother results but may introduce bias, higher values for *Degree* will reduce the filter bias, but may “over fit” the data and give a noisier result.

**Note**

Degree must be less than the filter width (*Nleft* + *Nright* + 1).

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

**Tip**

The DOUBLE keyword is recommended for *Degree* greater than 9.

## Examples

The following example creates a noisy 400-point vector with 4 Gaussian peaks of decreasing width. It then plots the original vector, the vector smoothed with a 33-

point Boxcar smoother (the SMOOTH function), and the vector smoothed with 33-point wide Savitzky-Golay filter of degree 4. The bottom plot shows the first derivative of the noisy signal and the first derivative using the Savitzky-Golay filter of degree 4:

```
n = 401 ; number of points
np = 4  ; number of peaks
; Form the baseline:
y = REPLICATE(0.5, n)
; Index the array:
x = FINDGEN(n)
; Add each Gaussian peak:
FOR i=0, np-1 DO BEGIN
   c = (i + 0.5) * FLOAT(n)/np ; Center of peak
   peak = -(3 * (x-c) / (75. / 1.5 ^ i))^2
   ; Add Gaussian. Cutoff of -50 avoids underflow errors for
   ; tiny exponentials:
   y = y + EXP(peak>(-50))
ENDFOR
; Add noise:
y1 = y + 0.10 * RANDOMN(-121147, n)

!P.MULTI=[0,1,3]

; Boxcar smoothing width 33:
PLOT, x, y1, TITLE='Signal+Noise; Smooth (width33)'
OPLOT, SMOOTH(y1, 33, /EDGE_TRUNCATE), THICK=3

; Savitzky-Golay with 33, 4th degree polynomial:
savgolFilter = SAVGOL(16, 16, 0, 4)
PLOT, x, y1, TITLE='Savitzky-Golay (width 33, 4th degree)'
OPLOT, x, CONVOL(y1, savgolFilter, /EDGE_TRUNCATE), THICK=3

; Savitzky-Golay width 33, 4th degree, 1st derivative:
savgolFilter = SAVGOL(16, 16, 1, 4)
PLOT, x, DERIV(y1), YRANGE=[-0.2, 0.2], TITLE=$
 'First Derivative: Savitzky-Golay(width 33, 4th degree, order 1)'
OPLOT, x, CONVOL(y1, savgolFilter, /EDGE_TRUNCATE), THICK=3
```

The following is the resulting plot. Notice how the Savitzky-Golay filter preserves the high peaks but does not do as much smoothing on the flatter regions. Note also that

the Savitzky-Golay filter is able to construct a good approximation of the first derivative.

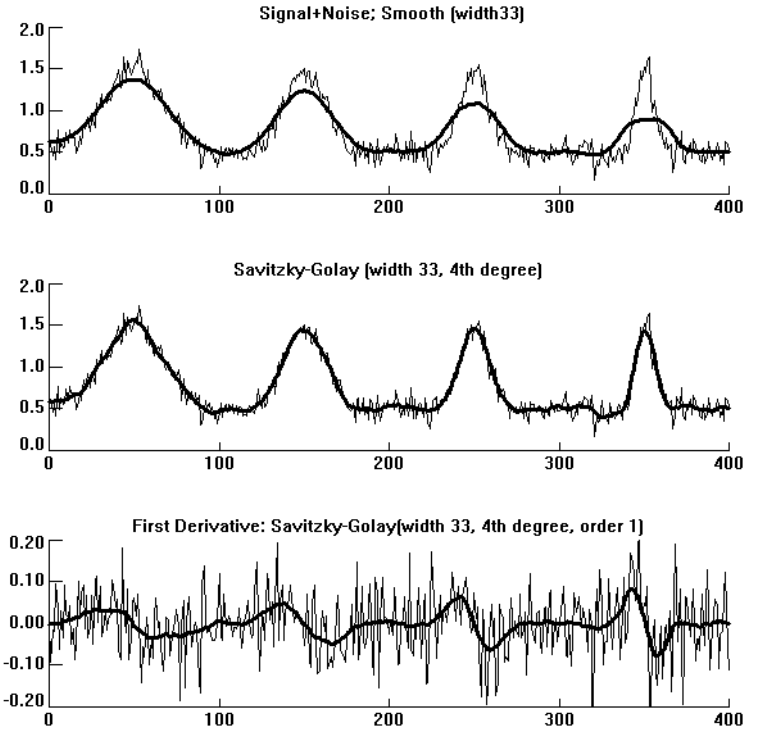



*Figure 18: SAVGOL Example*

## Version History

Introduced: 5.4

## See Also

CONVOL, DIGITAL_FILTER, SMOOTH

# SCALE3

The SCALE3 procedure sets up transformation and scaling parameters for basic 3-D viewing. This procedure is similar to SURFR and SCALE3D, except that the data ranges must be specified and the scaling does not vary with rotation. Results are stored in the system variables !P.T, !X.S, !Y.S, and !Z.S.

This routine is written in the IDL language. Its source code can be found in the file `scale3.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SCALE3 [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*] [, AX=*degrees*] [, AZ=*degrees*]

## Arguments

None.

## Keywords

### XRANGE

A two-element vector containing the minimum and maximum X values. If omitted, the X-axis scaling remains unchanged.

### YRANGE

A two-element vector containing the minimum and maximum Y values. If omitted, the Y-axis scaling remains unchanged.

### ZRANGE

A two-element vector containing the minimum and maximum Z values. If omitted, the Z-axis scaling remains unchanged.

### AX

Angle of rotation about the X axis. The default is 30 degrees.

### AZ

Angle of rotation about the Z axis. The default is 30 degrees.

## Examples

Set up a 3-D transformation where the data range is 0 to 20 for each of the 3 axes and the viewing area is rotated 20 degrees about the X axis and 55 degrees about the Z axis:

```
SCALE3, XRANGE=[0, 20], YRANGE=[0, 20], ZRANGE=[0, 20], AX=20,
AZ=55
```

## Version History

Introduced: Pre 4.0

## See Also

SCALE3D, SURFR, T3D

# SCALE3D

The SCALE3D procedure scales the 3-D unit cube (a cube with the length of each side equal to 1) into the viewing area. Eight data points are created at the vertices of the 3-D unit cube. The vertices are then transformed by the value of the system variable !P.T. The system is translated to bring the minimum (*x*,*y*,*z*) point to the origin, and then scaled to make each coordinate's maximum value equal to 1. The !P.T system variable is modified as a result.

This routine is written in the IDL language. Its source code can be found in the file `scale3D.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SCALE3D

## Arguments

None.

## Keywords

None.

## Version History

Introduced: Original

## See Also

SCALE3, SURFR, T3D

# SEARCH2D

The SEARCH2D function finds “objects” or regions of similar data values within a two-dimensional array. Given a starting location and a range of values to search for, SEARCH2D finds all the cells within the array that are within the specified range and have some path of connectivity through these cells to the starting location. In addition to searching for cells within a global range of data values, SEARCH2D can also search for adjacent cells whose values deviate from their neighbors within specified tolerances.

This routine is written in the IDL language. Its source code can be found in the file `search2d.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = SEARCH2D( *Array*, *Xpos*, *Ypos*, *Min_Val*, *Max_Val* [, DECREASE=*value*, INCREASE=*value*[, LPF_BAND=*integer*{≥3}]] [, /DIAGONAL] )

## Return Value

SEARCH2D returns a longword array that contains a list of the array subscripts that define the located object or region. The original X and Y indices of the array subscripts returned by SEARCH2D can be found with the following IDL code:

```
index_y = Result / (SIZE(Array))(1)
index_x = Result - (index_y * (SIZE(Array))(1))
```

where *Result* is the array returned by SEARCH2D and *Array* is the original input array. The object within *Array* can be subscripted as *Array*`(`*Region*`)` or *Array*`(index_x, index_y)`.

## Arguments

### Array

A two-dimensional array, of any data type, to be searched.

### Xpos

The X coordinate (dimension 0 of *Array*) of the starting location.

### Ypos

The Y coordinate (dimension 1 of *Array*) of the starting location.

### Min_Val

The minimum data value for which to search. All array subscripts of all cells that are connected to the starting cell, and have a value between *Min_Val* and *Max_Val* (inclusive) are returned.

### Max_Val

The maximum data value for which to search.

## Keywords

### DECREASE

This keyword and the INCREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. The search is limited to pixels for which the edge-enhanced gradient value lies between the DECREASE and INCREASE values. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if INCREASE is specified.

### INCREASE

This keyword and the DECREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. The search is limited to pixels for which the edge-enhanced gradient value lies between the DECREASE and INCREASE values. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if DECREASE is specified.

### LPF_BAND

Set this keyword to an integer value of 3 or greater to perform low-pass filtering on the edge-enhanced array. The value of LPF_BAND is used as the width of the smoothing window. This keyword is only effective when the DECREASE or INCREASE keywords are also specified. The default is no smoothing.

### DIAGONAL

Set this keyword to cause SEARCH2D to find cells meeting the search criteria whose surrounding squares share a common corner. Normally, cells are considered adjacent only when squares surrounding the cells share a common edge. Setting this option requires more memory and execution time.

## Examples

Find all the indices corresponding to an object in an image:

```
; Create an image with different valued regions:
img = FLTARR(512, 512)
img[3:503, 9:488] = 0.7
img[37:455, 18:438] = 0.5
img[144:388, 90:400] = 0.7
img[200:301, 1:255] = 1.0
img[155:193, 333:387] = 0.3
TVSCL, img   ;Display the image.

; Search for an object starting at (175, 300) whose data values are
; between (0.6) and (0.8):
region = SEARCH2D(img, 175, 300, 0.6, 0.8, /DIAGONAL)

; Scale the background cells into the range 0 to 127:
img = BYTSCL(img, TOP=127B)

; Highlight the object region by setting it to 255:
img[region] = 255B

; Display the array with the highlighted object in it:
TVSCL, img
```

## Version History

Introduced: Pre 4.0

## See Also

SEARCH3D

# SEARCH3D

The SEARCH3D function finds “objects” or regions of similar data values within a 3-D array of data. Given a starting location and a range of values to search for, SEARCH3D finds all the cells within the volume that are within the specified range of values and have some path of connectivity through these cells to the starting location. In addition to searching for cells within a global range of data values, SEARCH3D can also search for adjacent cells whose values deviate from their neighbors within specified tolerances.

This routine is written in the IDL language. Its source code can be found in the file `search3d.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = SEARCH3D( *Array*, *Xpos*, *Ypos*, *Zpos*, *Min_Val*, *Max_Val* [, /DECREASE, /INCREASE [, LPF_BAND=*integer*{≥3}]] [, /DIAGONAL] )

## Return Value

SEARCH3D returns a longword array that contains a list of the array subscripts that define the selected object or region. The original X and Y indices of the array subscripts returned by SEARCH3D can be found with the following IDL code:

```
S = SIZE(Array)
index_z = Result / (S[1] * S[2])
index_y = (Result - (index_z * S[1] * S[2])) / S[1]
index_x = (Result - (index_z * S[1] * S[2])) - (index_y * S[1])
```

where *Result* is the array returned by SEARCH3D and *Array* is the original input volume. The object within *Array* can be subscripted as `Array[Region]` or `Array[index_x, index_y, index_z]`.

## Arguments

### Array

The three-dimensional array, of any data type except string, to be searched.

### Xpos

The X coordinate (dimension 0 or *Array*) of the starting location.

### Ypos

The Y coordinate (dimension 1 of *Array*) of the starting location.

### Zpos

The Z coordinate (dimension 2 of *Array*) of the starting location.

### Min_Val

The minimum data value for which to search. All array subscripts of all the cells that are connected to the starting cell, and have a value between *Min_Val* and *Max_Val* (inclusive) are returned.

### Max_Val

The maximum data value for which to search.

## Keywords

### DECREASE

This keyword and the INCREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if INCREASE is specified.

### INCREASE

This keyword and the DECREASE keyword allow you to compensate for changing intensities of data values within an object. An edge-enhanced copy of *Array* is made and compared to the orginal array if this keyword is set. When DECREASE or INCREASE is set, any adjacent cells are found if their corresponding data values in the edge enhanced array are greater than DECREASE and less than INCREASE. In any case, the adjacent cells will never be selected if their data values are not between *Min_Val* and *Max_Val*. The default for this keyword is 0.0 if DECREASE is specified.

### LPF_BAND

Set this keyword to an integer value of 3 or greater to perform low-pass filtering on the edge-enhanced array. The value of LPF_BAND is used as the width of the smoothing window. This keyword is only effective when the DECREASE or INCREASE keywords are also specified. The default is no smoothing.

### DIAGONAL

Set this keyword to cause SEARCH3D to find cells meeting the search criteria whose surrounding cubes share a common corner or edge. Normally, cells are considered adjacent only when cubes surrounding the cells share a common edge. Setting this option requires more memory and execution time.

## Examples

Find all the indices corresponding to an object contained in a 3-D array:

```
; Create some data.
vol = RANDOMU(s, 40, 40, 40)
vol[3:13, 1:15, 17:33] = 1.3
vol[15:25, 5:25, 15:25] = 0.2
vol[5:30,17:38,7:28] = 1.3
vol[9:23, 16:27, 7:33] = 1.5

; Search for an object starting at (6, 22, 16) whose data values
; are between (1.2) and (1.4):
region = SEARCH3D(vol, 6, 22, 16, 1.2, 1.4, /DIAGONAL)

; Scale the background cells into the range 0 to 127:
vol = BYTSCL(vol, TOP=127B)

; Highlight the object region by setting it to 255:
vol[Region] = 255B
WINDOW, 0, XSIZE=640, YSIZE=512, RETAIN=2

; Set up a 3-D view:
CREATE_VIEW, XMAX=39, YMAX=39, ZMAX=39, AX=(-30), AZ=30, ZOOM=0.8

; Display the volume with the highlighted object in it:
TVSCL, PROJECT_VOL(vol, 64, 64, 40, DEPTH_Q=0.4)
```

## Version History

Introduced: Pre 4.0

## See Also

SEARCH2D

# SET_PLOT

The SET_PLOT procedure sets the output device used by the IDL graphics procedures. Keyword parameters control how the color tables are transferred to the newly selected graphics device. SET_PLOT performs the following actions:

- It sets the read-only system variable !D to reflect the configuration of the new device.
- It sets the default color !P.COLOR to the maximum color index minus one or, in the case of devices with white backgrounds, such as PostScript, to 0 (black).
- If the COPY keyword is set, the device color tables are copied directly from IDL's internal color tables. If the new device's color tables contain more indices than those of the old device, the new device's tables are not completely filled.
- If the INTERPOLATE keyword is set, the internal color tables are interpolated to fill the range of the new device.
- It sets the clipping rectangle to the entire device surface.

**Warning**

After calling SET_PLOT to change graphics devices, the scaling contained in the axis structures !X, !Y, and !Z is invalid. Any routines that rely on data coordinates should not be called until a new data coordinate system has been established. Be careful when switching devices as the number of color indices frequently differs between devices. When in doubt, reload the color table of the new device explicitly.

## Syntax

SET_PLOT, *Device* [, /COPY] [, /INTERPOLATE]

## Arguments

### Device

A scalar string containing the name of the device to use. The case of *Device* is ignored by IDL. See Appendix A, "IDL Graphics Devices" for a list of device names.

# Keywords

## COPY

Set this keyword to copy the device's color table from the internal color table, preserving the current color mapping. The default is not to load the color table upon selection.

**Warning**

Unless this keyword is set, IDL's internal color tables will incorrectly reflect the state of the device's color tables until they are reloaded by TVLCT or the LOADCT procedure. Assuming that the previously-selected device's color table contains *M* elements, and the new device's color table contains *N* elements, then the minimum of *M* and *N* elements are loaded.

## INTERPOLATE

Set this keyword to indicate that the current contents of the internal color table should be interpolated to cover the range of the newly-selected device. Otherwise, the internal color tables are not changed.

# Examples

Change the IDL graphics device to PostScript by entering:

```
SET_PLOT, 'PS'
```

After changing the plotting device, all graphics commands are sent to that device until changed again by another use of the SET_PLOT routine.

# Version History

Introduced: Original

# SET_SHADING

The SET_SHADING procedure modifies the light source shading parameters that affect the output of SHADE_SURF and POLYSHADE. Parameters can be changed to control the light-source direction, shading method, and the rejection of hidden surfaces. SET_SHADING first resets the shading parameters to their default values. The parameter values specified in the call then overwrite the default values. To reset all parameters to their default values, simply call this procedure with no parameters.

## Syntax

SET_SHADING [, /GOURAUD] [, LIGHT=*[x, y, z]*] [, /REJECT]
[, VALUES=*[darkest, brightest]*]

## Arguments

None.

## Keywords

### GOURAUD

This keyword controls the method of shading the surface polygons by the POLYSHADE procedure. The SHADE_SURF procedure always uses the Gouraud method. Set this keyword to a nonzero value (the default), to use Gouraud shading. Set this keyword to zero to shade each polygon with a constant intensity.

Gouraud shading interpolates intensities from each vertex along each edge. Then, when scan converting the polygons, the shading is interpolated along each scan line from the edge intensities. Gouraud shading is slower than constant shading but usually results in a more realistic appearance.

### LIGHT

A three-element vector that specifies the direction of the light source. The default light source vector is [0,0,1], with the light rays parallel to the Z axis.

### REJECT

Set this keyword (the default) to reject polygons as being hidden if their vertices are ordered in a clockwise direction as seen by the viewer. This keyword should always be set when rendering enclosed solids whose original vertex lists are in

counterclockwise order. When rendering surfaces that are not closed or are not in counterclockwise order this keyword can be set to zero although shading anomalies at boundaries between visible and hidden surfaces may occur.

### VALUES

A two-element array that specifies the range of pixel values (color indices) to use. The first element is the color index for the darkest pixel. The second element is the color index for the brightest pixel. For example, to render a shaded surface with the darkest shade set to pixel value 100 and the brightest value set to 150, use the commands:

```
SET_SHADING, VALUES=[100, 150]
SHADE_SURF, dataset
```

## Examples

Change the light source so that the light rays are parallel to the X axis:

```
SET_SHADING, LIGHT = [1, 0, 0]
```

## Version History

Introduced: Pre 4.0

## See Also

POLYSHADE, SHADE_SURF

# SETENV

The SETENV procedure adds or changes an environment string in the process environment.

## Syntax

SETENV, *Environment_Expression*

## Arguments

### Environment_Expression

A scalar string or string array containing an environment expressions to be added to the environment.

## Keywords

None.

## Examples

Change the current shell variable by entering:

```
SETENV,'SHELL=/bin/sh'
```

Make sure to eliminate any whitespace around the equal sign:

```
; This is an incorrect usage--there are spaces around the equal
; sign:
SETENV, 'VAR = H:\rsi'

; This is correct--VAR is set to H:\rsi:
SETENV, 'VAR=H:\rsi'
```

## Version History

Introduced: Original

## See Also

GETENV

# SETUP_KEYS

The SETUP_KEYS procedure sets function keys for use with UNIX versions of IDL when used with the standard tty command interface.

Under UNIX, the number of function keys, their names, and the escape sequences they send to the host computer vary enough between various keyboards that IDL cannot be written to understand all keyboards. Therefore, IDL provides a very general routine named DEFINE_KEY that allows the user to specify the names and escape sequences of function keys.

SETUP_KEYS provides a convenient interface to DEFINE_KEY, using user input (via the keywords described below), the TERM environment variable and the type of machine the current IDL is running on to determine what kind of keyboard you are using, and then uses DEFINE_KEY to enter the proper definitions for the function keys.

The new mappings for the keys can be viewed using the command

```
HELP, /KEYS.
```

The need for SETUP_KEYS has diminished in recent years because most UNIX terminal emulators have adopted the ANSI standard for function keys, as represented by VT100 terminals and their many derivatives, as well as xterm and the newer CDE based dtterm.

The current version of IDL already knows the function keys of such terminals, so SETUP_KEYS is not required. However, SETUP_KEYS is still needed to define keys on non-ANSI terminals such as the Sun shelltool, SGI Iris-ansi terminal emulator, or IBM’s aixterm.

IDL does not support the function keys from the hpterm terminal emulator supplied on HP systems. Hpterm uses non ANSI-standard escape sequences which IDL cannot parse. RSI recommends the use of the xterm or dtterm terminal emulators instead.

This routine is written in the IDL language. Its source code can be found in the file `setup_keys.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SETUP_KEYS [, /EIGHTBIT] [, /SUN | , /VT200 | , /HP9000 | , /MIPS | , /PSTERM | , /SGI] [, /APP_KEYPAD] [, /NUM_KEYPAD]

# Arguments

None.

# Keywords

**Note**

If no keyword is specified, SETUP_KEYS uses !VERSION to determine the type of machine running IDL. It assumes that the keyboard involved is of the same type (this assumption is correct).

## ANSI

Set this keyword to establish function key definitions for ANSI keyboards.

## EIGHTBIT

Set this keyword to use the 8-bit versions of the escape codes (instead of the default 7-bit) when establishing VT200 function key definitions.

## SUN

Set this keyword to establish function key definitions for a Sun3 keyboard.

## VT200

Set this keyword to establish function key definitions for a DEC VT200 keyboard.

## HP9000

Set this keyword to establish function key definitions for an HP 9000 series 300 keyboard. Although the HP 9000 series 300 supports both xterm and hpterm windows, IDL supports only user-definable key definitions in xterm windows—hpterm windows use non-standard escape sequences which IDL does not attempt to handle.

## IBM

Set this keyword to establish function key definitions for IBM keyboards.

## MIPS

Set this keyword to establish function key definitions for a Mips RS series keyboard.

### SGI

Set this keyword to establish function key definitions for SGI keyboards.

### APP_KEYPAD

Set this keyword to define escape sequences for the group of keys in the numeric keypad, enabling these keys to be programmed within IDL.

### NUM_KEYPAD

Set this keyword to disable programmability of the numeric keypad.

## Version History

Introduced: Pre 4.0

## See Also

DEFINE_KEY

# SFIT

The SFIT function determines a polynomial fit to a surface and returns a fitted array. The function fitted is:

$$f(x, y) = \sum kx_{j,i} \cdot x^i \cdot y^j$$

This routine is written in the IDL language. Its source code can be found in the file `sfit.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = SFIT( *Data*, *Degree* [, KX=*variable*] )

## Arguments

### Data

The two-dimensional array of data to fit. The sizes of the dimensions may be unequal.

### Degree

The maximum degree of fit (in one dimension).

## Keywords

### KX

Set this keyword to a named variable that will contain the array of coefficients for a polynomial function of *x* and *y* to fit data. This parameter is returned as a *Degree*+1 by *Degree*+1 array.

## Examples

```
; Create a grid from zero to six radians in the X and Y directions:
X = (FINDGEN(61)/10) # REPLICATE(1,61)
Y = TRANSPOSE(X)
```

```
; Evaluate a function at each point:
F = -SIN(2*X) + COS(Y/2)

; Compute a sixth-degree polynomial fit to the function data:
result = SFIT(F, 6)

; Display the original function on the left and the fitted function
; on the right, using identical axis scaling:
WINDOW, XSIZE = 800, YSIZE = 400

; Set up side-by-side plots:
!P.MULTI = [0, 2, 1]

; Set background color to white:
!P.BACKGROUND = 255

; Set plot color to black:
!P.COLOR = 0

SURFACE, F, X, Y, ZRANGE = [-3, 3], ZSTYLE = 1
SURFACE, result, X, Y
```

The following figure shows the result of this example:

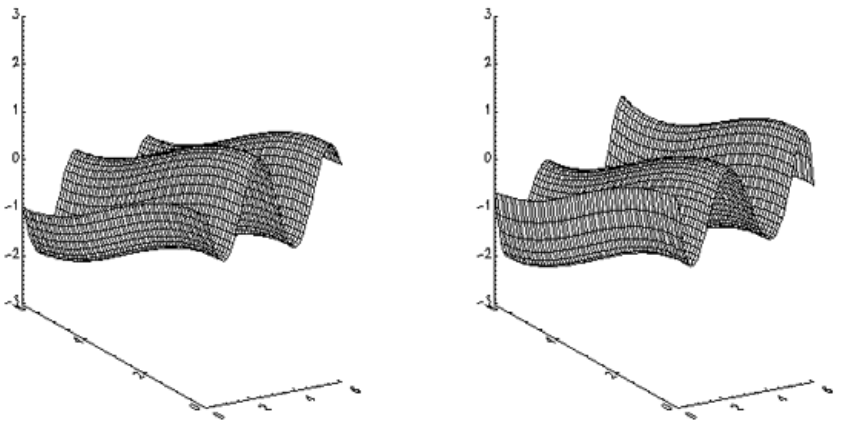


*Figure 19: The Original Function (Left) and the Fitted Function (Right)*

# Version History

Introduced: Pre 4.0

## See Also

CURVEFIT, GAUSSFIT, LINFIT, LMFIT, POLY_FIT, REGRESS, SVDFIT

# SHADE_SURF

The SHADE_SURF procedure creates a shaded-surface representation of a regular or nearly-regular gridded surface with shading from either a light source model or from a user-specified array of intensities. This procedure and its parameters are similar to SURFACE. Given a regular or near-regular grid of elevations it produces a shaded-surface representation of the data with hidden surfaces removed.

The SET_SHADING procedure can be used to control the direction of the light source and other shading parameters.

If the graphics output device has scalable pixels (e.g., PostScript), the output image is scaled so that its largest dimension is less than or equal to 512 (unless the PIXELS keyword is set to some other value). This default resolution may not be high enough for some datasets. If your output looks jagged or “stair-stepped”, try specifying a larger value with the PIXELS keyword.

When outputting to a device that prints black on a white background, (e.g., PostScript), pixels that contain the background color index of 0 are set to white.

### Restrictions

If the *(X, Y)* grid is not regular or nearly regular, errors in hidden line removal will occur. If the T3D keyword is set, the 3-D to 2-D transformation matrix contained in !P.T must project the Z axis to a line parallel to the device Y axis, or errors will occur. The SHADE_SURF_IRR procedure can be used to render many datasets that do not meet these requirements. Irregularly-gridded data can also be made interpolated to a regular grid using the TRIGRID and TRIANGULATE routines.

## Syntax

SHADE_SURF, *Z* [, *X*, *Y*] [, AX=*degrees*] [, AZ=*degrees*] [, IMAGE=*variable*] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, PIXELS=*pixels*] [, /SAVE] [, SHADES=*array*] [, /XLOG] [, /YLOG]

**Graphics Keywords:** [, CHARSIZE=*value*] [, CHARTHICK=*integer*] [, COLOR=*value*][, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*] [, /NODATA] [, POSITION=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, SUBTITLE=*string*] [, /T3D] [, THICK=*value*] [, TICKLEN=*value*] [, TITLE=*string*]
[, {X | Y | Z}CHARSIZE=*value*]
[, {X | Y | Z}GRIDSTYLE=*integer*{0 to 5}]
[, {X | Y | Z}MARGIN=*[left, right]*]
[, {X | Y | Z}MINOR=*integer*]

[, {X | Y | Z}RANGE=*[min, max]*]
[, {X | Y | Z}STYLE=*value*]
[, {X | Y | Z}THICK=*value*]
[, {X | Y | Z}TICKFORMAT=*string*]
[, {X | Y | Z}TICKINTERVAL= *value*]
[, {X | Y | Z}TICKLAYOUT=*scalar*]
[, {X | Y | Z}TICKLEN=*value*]
[, {X | Y | Z}TICKNAME=*string_array*]
[, {X | Y | Z}TICKS=*integer*]
[, {X | Y | Z}TICKUNITS=*string*]
[, {X | Y | Z}TICKV=*array*]
[, {X | Y | Z}TICK_GET=*variable*]
[, {X | Y | Z}TITLE=*string*]
[, ZVALUE=*value*{0 to 1}]

# Arguments

## Z

The two-dimensional array to be displayed. If *X* and *Y* are provided, the surface is plotted as a function of the (*X*, *Y*) locations specified by their contents. Otherwise, the surface is generated as a function of the array index of each element of *Z*.

This argument is converted to double-precision floating-point before plotting. Plots created with SHADE_SURF are limited to the range and precision of double-precision floating-point values.

## X

A vector or two-dimensional array specifying the X coordinates of the grid. If this argument is a vector, each element of *X* specifies the X coordinate for a column of *Z* (e.g., `X[0]` specifies the X coordinate for `Z[0,*]`). If *X* is a two-dimensional array, each element of *X* specifies the X coordinate of the corresponding point in *Z* ($X_{ij}$ specifies the X coordinate for $Z_{ij}$).

This argument is converted to double-precision floating-point before plotting.

## Y

A vector or two-dimensional array specifying the Y coordinates of the grid. If this argument is a vector, each element of *Y* specifies the Y coordinate for a row of *Z* (e.g., `Y[0]` specifies the Y coordinate for `Z[*,0]`). If *Y* is a two-dimensional array, each element of *Y* specifies the Y coordinate of the corresponding point in *Z* ($Y_{ij}$ specifies the Y coordinate for $Z_{ij}$).

This argument is converted to double-precision floating-point before plotting.

# Keywords

## AX

This keyword specifies the angle of rotation, about the X axis, in degrees towards the viewer. This keyword is effective only if !P.T3D and the T3D keyword are not set. If !P.T3D is set, the three-dimensional to two-dimensional transformation used by SURFACE is contained in the 4 by 4 array !P.T.

The surface represented by the two-dimensional array is first rotated, AZ (see below) degrees about the Z axis, then by AX degrees about the X axis, tilting the surface towards the viewer (AX > 0), or away from the viewer.

The AX and AZ keyword parameters default to +30 degrees if omitted.

The three-dimensional to two-dimensional transformation represented by AX and AZ, can be saved in !P.T by including the SAVE keyword.

## AZ

This keyword specifies the counterclockwise angle of rotation about the Z axis. This keyword is effective only if !P.T3D is not set. The order of rotation is AZ first, then AX.

## IMAGE

A named variable into which an image containing the shaded surface is stored. If this keyword is omitted, the image is displayed but not saved.

## MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See “Special Floating-Point Values” in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See “Special Floating-Point

Values” in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## PIXELS

Set this keyword to a scalar value that specifies the maximum size of the image dimensions, in pixels. PIXELS only applies when the output device uses scalable pixels (e.g., the PostScript device). Use this keyword to increase the resolution of the output image if the default looks jagged or “stair-stepped”.

## SAVE

Set this keyword to save the 3-D to 2-D transformation matrix established by SHADE_SURF in the system variable field !P.T. Use this keyword when combining the output of SHADE_SURF with the output of other routines in the same plot.

## SHADES

An array expression, of the same dimensions as *Z*, that contains the color index at each point. The shading of each pixel is interpolated from the surrounding SHADE values. If this parameter is omitted, light-source shading is used. For most displays, this parameter should be scaled into the range of bytes.

**Warning**

When using the SHADES keyword on True Color devices, we recommend that decomposed color support be turned off, by setting DECOMPOSED=0 for DEVICE.

## XLOG

Set this keyword to specify a logarithmic X axis.

## YLOG

Set this keyword to specify a logarithmic Y axis.

## Graphics Keywords Accepted

See Appendix B, “Graphics Keywords”, for the description of graphics and plotting keywords not listed above. CHARSIZE, CHARTHICK, COLOR, DATA, DEVICE, FONT, NODATA, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN,

[XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

## Examples

```
; Create a simple dataset:
D = DIST(40)
; Display the dataset as a light-source shaded surface:
SHADE_SURF, D, TITLE = 'Shaded Surface'
```

Instead of light-source shading, an array of the same size as the elevation dataset can be used to color the surface. This technique creates four-dimensional displays.

```
; Create an array of shades to use:
S = SIN(D)

; Now create a new shaded surface that uses the array of shading
; values instead of the light source:
SHADE_SURF, D, SHADES = BYTSCL(S)
```

Note that the BYTSCL function is used to scale S into the range of bytes.

## Version History

Introduced: Original

## See Also

ISURFACE, POLYSHADE, SET_SHADING, SHADE_VOLUME, SURFACE

# SHADE_SURF_IRR

The SHADE_SURF_IRR procedure creates a shaded surface representation of an irregularly gridded elevation dataset.

The data must be representable as an array of quadrilaterals. This routine should be used when the (*X, Y, Z*) arrays are too irregular to be drawn by SHADE_SURF, but are still semi-regular.

This routine is written in the IDL language. Its source code can be found in the file `shade_surf_irr.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SHADE_SURF_IRR, *Z*, *X*, *Y* [, AX=*degrees*] [, AZ=*degrees*] [, IMAGE=*variable*] [, PLIST=*variable*] [, /T3D]

## Arguments

### Z

An *n* x *m* array of elevations.

### X

An *n* x *m* array containing the *X* location of each *Z* value.

### Y

An *n* x *m* array containing the *Y* location of each *Z* value.

The grid described by *X* and *Y* must consist of quadrilaterals, must be semi-regular, and must be in “clockwise” order. Clockwise ordering means that:

```
;for all j
x[i,j] <= x[i+1, j]
```

and

```
;for all i
y[i,j] <= y[i, j+1]
```

# Keywords

## AX

The angle of rotation about the X axis. The default is 30 degrees.

## AZ

The angle of rotation about the Z axis. The default is 30 degrees.

## IMAGE

Set this keyword to a named variable that will contain the resulting shaded surface image. The variable is returned as a byte array of the same size as the currently selected graphics device.

## PLIST

Set this keyword to a named variable that will contain the polygon list on return. This feature is useful when you want to make a number of images from the same set of vertices and polygons.

## T3D

Set this keyword to indicate that the generalized transformation matrix in !P.T is to be used (in which case the keyword values for AX and AZ are ignored)

# Examples

The following example creates a semi-regular data set in the proper format at displays the resulting irregular surface.

```
; Create some elevation data:
z = DIST(10,10)*100.0
; Create arrays to hold X and Y data:
x = FLTARR(10,10) & y = FLTARR(10,10)
; Ensure that X and Y arrays are in "clockwise" order:
FOR i = 0,9 do x[0:9,i] = FINDGEN(10)
FOR j = 0,9 DO y[j,0:9] = FINDGEN(10)
; Make X and Y arrays irregular:
x = x + RANDOMU(seed,10,10)*0.49
y = y + RANDOMU(seed,10,10)*0.49
; Display the irregular surface:
SHADE_SURF_IRR, z, x, y
```

## Version History

Introduced: Pre 4.0

## See Also

SHADE_SURF, TRIGRID

# SHADE_VOLUME

Given a 3-D volume and a contour value, SHADE_VOLUME produces a list of vertices and polygons describing the contour surface. This surface can then be displayed as a shaded surface by the POLYSHADE procedure. Shading is obtained from either a single light-source model or from user-specified values.

SHADE_VOLUME computes the polygons that describe a three dimensional contour surface. Each volume element (voxel) is visited to find the polygons formed by the intersections of the contour surface and the voxel edges. The method used by SHADE VOLUME is that of Klemp, McIrvin and Boyd, 1990: “PolyPaint—A Three-Dimensional Rendering Package,” *American Meteorology Society Proceedings, Sixth International Conference on Interactive Information and Processing Systems*. This method is similar to the marching cubes algorithm described by Lorenson and Cline, 1987: “Marching Cubes: A High Resolution 3D Surface Construction Algorithm,” *Computer Graphics 21*, 163-169.

This routine is limited to processing datasets that will fit in memory.

## Syntax

SHADE_VOLUME, *Volume*, *Value*, *Vertex*, *Poly* [, /LOW] [, SHADES=*array*] [, /VERBOSE] [, XRANGE=*vector*] [, YRANGE=*vector*] [, ZRANGE=*vector*]

## Arguments

### Volume

A three-dimensional array that contains the dataset to be contoured. If the *Volume* array is dimensioned $(D_0, D_1, D_2)$, the resulting vertex coordinates are as follows:

$$0 < X < D_0 - 1; 0 < Y < D_1 - 1; 0 < Z < D_2 - 1.$$

If floating-point NaN values are present in *Volume*, then SHADE_VOLUME may generate inconsistent surfaces and may return NaN values in the *Vertex* argument. The surfaces generated by SHADE_VOLUME may also vary across platforms if NaN data is present in the *Volume* parameter.

### Value

The scalar contour value. This value specifies the constant-density surface (also called an isosurface) to be rendered.

### Vertex

The name of a variable to receive the vertex array. On output, this variable is set to a (3, *n*) floating-point array, suitable for input to POLYSHADE.

### Poly

A named variable to receive the polygon list, an *n*-element, longword array. This list describes the vertices of each polygon and is suitable for input to POLYSHADE. The vertices of each polygon are listed in counterclockwise order when observed from outside the surface. The vertex description of each polygon is a vector of the form: [*n*, $i_0$, $i_1$, ..., $i_{n-1}$] and the *Poly* array is the concatenation of the lists of each polygon. For example, when rendering a pyramid consisting of four triangles, *Poly* would contain 16 elements, made by concatenating four, four-element vectors of the form [3, $V_0$, $V_1$, $V_2$]. $V_0$, $V_1$, and $V_2$ are the indices of the vertices describing each triangle.

## Keywords

### LOW

Set this keyword to display the low side of the contour surface (i.e., the contour surfaces enclose high data values). If this keyword is omitted or is 0, the high side of the contour surface is displayed and the contour encloses low data values. If this parameter is incorrectly specified, errors in shading will result.

### SHADES

An optional array, converted to byte type before use, that contains the user-specified shading color index for each voxel. This array must have the same dimensions as *Volume*. On exit, this array is replaced by another array, that contains the shading value for each vertex, contained in *Vertex*.

**Warning**

When using the SHADES keyword on True Color devices, we recommend that decomposed color support be turned off, by setting DECOMPOSED=0 for DEVICE.

### VERBOSE

Set this keyword to print a message indicating the number of polygons and vertices that are produced.

### XRANGE

An optional two-element vector that contains the limits, over the first dimension, of the sub-volume to be considered.

### YRANGE

An optional two-element vector that contains the limits, over the second dimension, of the sub-volume to be considered.

### ZRANGE

An optional two-element vector containing the limits, over the third dimension, of the sub-volume to be considered.

## Examples

The following procedure shades a volume passed as a parameter. It uses the SCALE3 procedure to establish the viewing transformation. It then calls SHADE_VOLUME to produce the vertex and polygon lists, and POLYSHADE to draw the contour surface.

```
PRO SHOWVOLUME, vol, thresh, LOW = low
   ; Get the dimensions of the volume:
   s = SIZE(vol)
   ; Error, must be a 3-D array:
   IF s[0] NE 3 THEN MESSAGE, 'Error: vol must be a 3-D array'
   ; Establish the 3-D transformation and coordinate ranges:
   SCALE3, XRANGE=[0, S[1]], YRANGE=[0, S[2]], ZRANGE=[0, S[3]]
   ; Default = view high side of contour surface:
   IF N_ELEMENTS(low) EQ 0 THEN low = 0
   ; Produce vertices and polygons:
   SHADE_VOLUME, vol, thresh, v, p, LOW = low
   ; Produce image of surface and display:
   TV, POLYSHADE(v, p, /T3D)
END
```

## Version History

Introduced: Pre 4.0

## See Also

INTERVAL_VOLUME, IVOLUME, POLYSHADE, SHADE_SURF, XVOLUME

# SHIFT

The SHIFT function shifts elements of vectors or arrays along any dimension by any number of elements. Positive shifts are to the right while left shifts are expressed as a negative number. All shifts are circular.

Elements shifted off one end wrap around and are shifted onto the other end. In the case of vectors the action of SHIFT can be expressed:

$$\text{Result}_{(i + s)\ modulation} = \text{Array}_i \quad \text{for} \quad (0 \le 1 < n)$$

where *s* is the amount of the shift, and *n* is the number of elements in the array.

## Syntax

*Result* = SHIFT(*Array*, $S_1$, ..., $S_n$)

## Return Value

The result is a vector or array of the same structure and type as *Array*.

## Arguments

### Array

The array to be shifted.

### $S_i$

The shift parameters. The $S_i$ arguments can be either a single array containing the shift parameters for each dimension, or a sequence of up to eight scalar shift values. For arrays of more than one dimension, the parameter $S_n$ specifies the shift applied to the *n*-th dimension. $S_1$ specifies the shift along the first dimension and so on. If only one shift parameter is present and the parameter is an array, the array is treated as a vector (i.e., the array is treated as having one-dimensional subscripts).

A shift specification of 0 means that no shift is to be performed along that dimension.

## Keywords

None.

## Examples

The following example demonstrates using SHIFT with a vector. by entering:

```
A = INDGEN(5)

; Print the original vector, the vector shifted one position to the
; right, and the vector shifted one position to the left:
PRINT, A, SHIFT(A, 1), SHIFT(A, -1)
```

IDL prints:

```
  0   1   2   3   4
  4   0   1   2   3
  1   2   3   4   0
```

Notice how elements of the vector that shift off the end wrap around to the other end. This “wrap around” occurs when shifting arrays of any dimension.

## Version History

Introduced: Original

## See Also

ISHFT

# SHMDEBUG

The SHMDEBUG function enables a debugging mode in which IDL prints an informational message (including a traceback) every time a variable created with the SHMVAR function loses its reference to the underlying memory segment created by. There are many reasons why a such a variable might lose its reference; some reasons have to do with the internal implementation of the IDL interpreter and are not obvious or visible to the IDL user.

**Note**

The SHMDEBUG debugging mode should be used for problem solving only, and should not be part of production code.

## Syntax

*Result* = SHMDEBUG(*Enable*)

## Return Value

SHMDEBUG returns the previous setting of the debugging state.

## Arguments

### Enable

Set this argument equal to a non-zero value to enable debugging, or to zero to disable debugging.

## Keywords

None.

## Examples

Create a memory segment, tie a variable to it, enable debugging, and then cause the variable to lose the reference:

```
old_debug = SHMDEBUG(1) ; Enable debug mode
SHMMAP, 'A', 100 ; 100 element floating vector
z = SHMVAR('A') ; Variable tied to segment
z[0] = FINDGEN(100) ; Does not lose reference
```

```
z = FINDGEN(100) ; Loses reference
% Variable released shared memory segment: A
% Released at: $MAIN$
```

The assignment `z[0] = FINDGEN(100)` explicitly uses subscripting to assign the FINDGEN value to the array. Under normal circumstances, using subscripting in this way on the left hand side of an assignment is inefficient and not recommended. In this case, however, it has the desirable side effect of causing the variable Z to maintain its connection to its existing underlying memory. In contrast, the second (normally more desirable) assignment without the subscript causes IDL to allocate different memory for the variable Z, with the side effect of losing the connection to the shared memory segment.

## Version History

Introduced: 5.6

## See Also

SHMMAP, SHMUNMAP, SHMVAR

# SHMMAP

The SHMMAP procedure maps anonymous shared memory, or local disk files, into the memory address space of the currently executing IDL process. Mapped memory segments are associated with an IDL array specified by the user as part of the call to SHMMAP. The type and dimensions of the specified array determine the length of the memory segment.

The array can be of any type except pointer, object reference, or string. (Structure types are allowed as long as they do not contain any pointers, object references, or strings.) By default, the array type is single-precision floating-point; other types can be chosen by specifying the appropriate keyword.

Once such a memory segment exists, it can be tied to an actual IDL variable using the SHMVAR function, or unmapped using SHMUNMAP.

## Why Use Mapped Memory?

- Shared memory is often used for interprocess communication. Any process that has a shared memory segment mapped into its address space is able to “see” any changes made by any other process that has access to the same segment. Shared memory is the default for SHMMAP, unless the FILENAME keyword is specified.
- Memory-mapped files allow you to treat the contents of a local disk file as if it were simple memory. Reads and writes to such memory are automatically written to the file by the operating system using its standard virtual memory mechanisms. Access to mapped files has the potential to be faster than standard Input/Output using Read/Write system calls because it does not go through the expensive system call interface, and because it does not require the operating system to copy data between user and kernel memory buffers when performing the I/O. However, it is not as general or flexible as the standard I/O mechanisms, and is therefore not a replacement for them.

**Warning**

Unlike most IDL functionality, incorrect use of SHMMAP can corrupt or even crash your IDL process. Proper use of these low level operating system features requires systems programming experience, and is not recommended for those without such experience. You should be familiar with the memory and file mapping features of your operating system and the terminology used to describe such features.

SHMMAP uses the facilities of the underlying operating system. Any of several alternatives may be used, as described in "Types Of Memory Segments" on page 1773. SHMMAP uses the following rules, in the specified order, to determine which method to use:

1. If the FILENAME keyword is present, SHMMAP creates a memory mapped file segment.
2. If the SYSV keyword is used under UNIX, a System V shared memory segment is created or attached. Use of the SYSV keyword under Windows will cause an error to be issued.
3. If none of the above options are specified, SHMMAP creates an anonymous shared memory segment. Under UNIX, this is done with Posix shared memory. Under Windows, the `CreateFileMapping()` system call is used.

# Syntax

SHMMAP [, *SegmentName*] [, $D_1$, ..., $D_8$] [, /BYTE] [, /COMPLEX]
[, /DCOMPLEX] [, /DESTROY_SEGMENT] [, DIMENSION=*value*] [, /DOUBLE]
[, FILENAME=*value*] [, /FLOAT] [, GET_NAME=*value*]
[, GET_OS_HANDLE=*value*] [, /INTEGER] [, /L64] [, /LONG] [, OFFSET=*value*]
[, OS_HANDLE=*value*] [, /PRIVATE] [, SIZE=*value*] [, /SYSV]
[, TEMPLATE=*value*] [, TYPE=*value*] [, /UINT] [, /UL64] [, /ULONG]

# Arguments

## SegmentName

A scalar string supplying the name by which IDL will refer to the shared memory segment. This name is only used by IDL, and does not necessarily correspond to the name used for the shared memory segment by the underlying operating system. See the discussion of the OS_HANDLE keyword for more information on the underlying operating system name. If *SegmentName* is not specified, IDL will generate a unique name. The *SegmentName* can be obtained using the GET_NAME keyword.

## Di

The dimensions of the result. The $D_i$ arguments can be either a single array containing the dimensions or a sequence of scalar dimensions. Up to eight dimensions can be specified.

# Keywords

## BYTE

Set this keyword to specify that the memory segment should be treated as a byte array.

## COMPLEX

Set this keyword to specify that the memory segment should be treated as a complex, single-precision floating-point array.

## DCOMPLEX

Set this keyword to specify that the memory segment should be treated as a complex, double-precision floating-point array.

## DESTROY_SEGMENT

The UNIX anonymous shared memory mechanisms (Posix `shm_open()` and System V `shmget()`) create shared memory segments that are not removed from the operating system kernel until explicitly destroyed (or the system is rebooted). At any time, a client program can attach to such an existing segment, read or write to it, and then detach. This can be convenient in situations where the need for the shared memory is long lived, and programs that need it come and go. It also can create a problem, however, in that shared memory segments that are not explicitly destroyed can cause memory leaks in the operating system. Hence, it is important to properly destroy such segments when they are no longer required.

For UNIX anonymous shared memory (Posix or System V), the default behavior is for IDL to destroy any shared memory segments it created when the segments are unmapped, and not to destroy segments it did not create. The DESTROY_SEGMENT keyword is used to override this default: set DESTROY_SEGMENT to 1 (one) to indicate that IDL should destroy the segment when it is unmapped, or 0 (zero) to indicate that it should not destroy it. All such destruction occurs when the segment is unmapped (via the SHMUNMAP procedure) and not during the call to SHMMAP.

The DESTROY_SEGMENT keyword is ignored under the Windows operating system. Under UNIX, it is ignored for mapped files.

## DIMENSION

Set this keyword equal to a vector of 1 to 8 elements specifying the dimensions of the result. Setting this keyword is equivalent to specifying an array via the *D* argument.

## DOUBLE

Set this keyword to specify that the memory segment should be treated as a double-precision floating-point array.

## FILENAME

By default, SHMMAP maps anonymous shared memory. Set the FILENAME keyword equal to a string containing the path name of a file to be mapped to create a memory-mapped file. A shared mapped file can serve as shared memory between unrelated processes. The primary difference between anonymous shared memory and mapped files is that mapped files require a file of the specified size to exist in the filesystem, whereas anonymous shared memory has no user-visible representation in the filesystem.

By default, files are mapped as shared, meaning that all processes that map the file will see any changes made. All changes are written back to the file by the operating system and become permanent. You must have write access to the file in order to map it as shared.

To change the default behavior, set the PRIVATE keyword. When a file is mapped privately, changes made to the file are *not* written back to the file by the operating system, and are not visible to any other processes. You do not need write access to a file in order to map it privately — read access is sufficent.

**Note**

The non-private form of file mapping corresponds to the `MAP_SHARED` flag to the UNIX `mmap()` function, or the `PAGE_READWRITE` to the Windows `CreateFileMapping()` system call.

## FLOAT

Set this keyword to specify that the memory segment should be treated as a single-precision floating-point array.

## GET_NAME

If *SegmentName* is not specified in a call to SHMMAP, IDL automatically generates a name. Set this keyword equal to a named variable that will receive the name assigned by IDL to the memory segment.

## GET_OS_HANDLE

Set this keyword equal to a named variable that will receive the operating system name (or *handle*) for the memory segment. The meaning of the operating system handle depends on both the operating system and the type of memory segment used. See the description of the OS_HANDLE keyword for details.

## INTEGER

Set this keyword to specify that the memory segment should be treated as an integer array.

## L64

Set this keyword to specify that the memory segment should be treated as a 64-bit integer array.

## LONG

Set this keyword to specify that the memory segment should be treated as a longword integer array.

## OFFSET

If present and non-zero, this keyword specifies an offset (in bytes) from the start of the shared memory segment or memory mapped file that will be used as the base address for the IDL array associated with the memory segment.

**Note**

Most computer hardware is not able to access arbitrary data types at arbitrary memory addresses. Data must be properly aligned for its type or the program will crash with an alignment error (often called a *bus error*) when the data is accessed. The specific rules differ between machines, but in many cases the address of a data object must be evenly divisible by the size of that object. IDL will issue an error if you specify an offset that is not valid for the array specified.

**Note**

The actual memory mapping primitives provided by the underlying operating system require such offsets to be integer multiples of the virtual memory pagesize (sometimes called the *allocation granularity*) for the system. This value is typically a power of two such as 8K or 64K. In contrast, IDL allows arbitrary offsets as long as they satisfy the alignment constraints of the data type. This is implemented by mapping the page that contains the specified offset, and then adjusting the memory address to point at the specified byte within that page. In rounding your offset

request back to the nearest page boundary, IDL may map slightly more memory than your request would seem to require, but never more than a single page.

## OS_HANDLE

Set this keyword equal to the name (or *handle*) used by the underlying operating system for the memory segment. If you do not specify the OS_HANDLE keyword, SHMMAP will under some circumstances provide a default value. The specific meaning and syntax of the OS_HANDLE depends on both the operating system and the form of memory used. See the following sections for operating-system specific behavior, and "Types Of Memory Segments" on page 1773 for behavior differences based on the form of memory used.

### Posix (UNIX) Shared Memory

Use the OS_HANDLE keyword to supply a string value containing the system global name of the shared memory segment. Such names are expected to start with a slash (`/`) character, and not to contain any other slash characters. You can think of this as mimicking the syntax for a file in the root directory of the system, although no such file is created. See your system documentation for the `shm_open()` system call for specific details. If you do not supply the OS_HANDLE keyword, SHMMAP will create one for you by prepending a slash character to the value given by the *SegmentName* argument.

### UNIX System V Shared Memory

Use the OS_HANDLE keyword to supply an integer value containing the system global identifier of an existing shared memory segment to attach to the process. If you do not supply the OS_HANDLE keyword, then SHMMAP creates a new memory segment. The identifier for this segment is available via the GET_OS_HANDLE keyword.

### Windows Anonymous Shared Memory

Use the OS_HANDLE keyword to supply a global system name for the mapping object underlying the anonymous shared memory. If the OS_HANDLE keyword is not specified, SHMMAP uses the value of the *SegmentName* argument.

### UNIX Memory Mapped Files

The OS_HANDLE keyword has no meaning for UNIX memory mapped files and is quietly ignored.

### Windows Memory Mapped Files

Use the OS_HANDLE keyword to supply a global system name for the mapping object underlying the mapped file. Use of the OS_HANDLE will ensure that every process accessing the shared file will see a coherent view of its contents, and is thus recommended for Windows memory mapped files. However, if you do not supply the OS_HANDLE handle keyword for a memory mapped file, no global name is passed to the Windows operating system, and a unique mapping object for the file will be created.

## PRIVATE

Set this keyword to specify that a private file mapping is required. In a private file mapping, any changes written to the mapped memory are visible only to the process that makes them, and such changes are not written back to the file. This keyword is ignored unless the FILENAME keyword is also present.

Mapping a file as shared requires that you have write access to the file, but a private mapping requires only read access. Use PRIVATE to map files for which you do not have write access, or when you want to ensure that the original file will not be altered by your process.

**Note**

Due to limitations of the operating system, the PRIVATE keyword is not allowed under the Windows 9x operating systems (Windows 95, Windows 98, Windows ME). Windows NT and related systems do not have this limitation.

**Note**

Under UNIX, the private form of file mapping corresponds to the `MAP_PRIVATE` flag to the `mmap()` system call. Under Windows, the non-private form corresponds to the `PAGE_WRITECOPY` option to the Windows `CreateFileMapping()` system call. When your process alters data within a page of privately mapped memory, the operating system performs a *copy on write* operation in which the contents of that page are copied to a new memory page visible only to your process. This private memory usually comes from anonymous swap space or the system pagefile. Hence, private mapped files require more system resources than shared mappings.

It is possible for some processes to use private mappings to a given file while others use a public mapping to the same file. In such cases, the private mappings will see changes made by the public processes up until the moment the private process itself makes a change to the page. The pagesize granularity and timing issues between

such processes can make such scenarios very difficult to control. RSI does not recommend combining simultaneous shared and private mappings to the same file.

## SIZE

Set this keyword equal to a `size` vector specifying the type and dimensions to be associated with the memory segment. The format of a size vector is given in the description of the SIZE function.

## SYSV

Under UNIX, the default form of anonymous memory is Posix shared memory, (`shm_open()` and `shm_unlink()`). Specify the SYSV keyword to use System V shared memory (`shmget()`, `shmctl()`, and `shmdt()`) instead. On systems where it is available, Posix shared memory is more flexible and has fewer limitations. System V shared memory is available on all UNIX implementations, and serves as an alternative when Posix memory does not exist, or when interfacing to exiting non-IDL software that uses System V shared memory. See “Types Of Memory Segments” on page 1773 for a full discussion.

## TEMPLATE

Set this keyword equal to a variable of the type and dimensions to be associated with the memory segment.

## TYPE

Set this keyword to specify the type code for the memory segment. See the description of the SIZE function for a list of IDL type codes.

## UINT

Set this keyword to specify that the memory segment should be treated as a unsigned integer array.

## ULONG

Set this keyword to specify that the memory segment should be treated as a unsigned longword integer array.

## UL64

Set this keyword to specify that the memory segment should be treated as a unsigned 64-bit integer array.

# Types Of Memory Segments

SHMMAP is a relatively direct interface to the shared memory and file mapping primitives provided by the underlying operating system. The SHMMAP interface attempts to minimize the differences between these primitives, and for simple shared memory use, it may not be necessary to fully understand the underlying mechanisms. For most purposes, however, it is necessary to understand the operating system primitives in order to understand how to use SHMMAP properly.

## UNIX

In modern UNIX systems, the `mmap()` system call forms the primary basis for both file mapping and anonymous shared memory. The existence of System V shared memory, which is an older form of anonymous shared memory, adds some complexity to the situation.

### UNIX Memory Mapped Files

To memory map a file under UNIX, you open the file using the `open()` system call, and then map it using `mmap()`. Once the file is mapped, you can close the file, and the mapping remains in place until explicitly unmapped, or until the process exits or calls `exec()` to run a different program.

If more than one process maps a file at the same time using the `MAP_SHARED` flag to `mmap()`, then those processes will be able to see each others' changes. Hence, memory mapped files are one form of shared memory. Although the requirement for a scratch file large enough to satisfy the mapping is inconvenient, limitations in System V shared memory have led many UNIX programmers to use memory mapped files in this way.

### UNIX System V Shared Memory

Anonymous shared memory has traditionally been implemented via an API commonly referred to as System V IPC. The `shmget()` function is used to create a shared memory segment. The caller does not name the segment. Instead, the operating system assigns each such segment a unique integer ID when it is created. Once a shared memory segment exists, the `shmdt()` function can be used to map it into the address space of any process that knows the identifier. This segment persists in the OS kernel until it is explicitly destroyed via the `shmctl()` function, or until the system is rebooted. This is true even if there are no processes currently mapped to the segment. This can be convenient in situations where the need for the shared memory is long lived, and programs that need it come and go. It also can create a problem, however, since shared memory segments that are not explicitly destroyed

can cause memory leaks in the operating system. Hence, it is important to properly destroy such segments when they are no longer required.

System V shared memory has been part of UNIX for a long time. It is available on all UNIX platforms, and there is a large amount of existing code that uses it. There are, however, some limitations on its utility:

- Many systems place extremely small limits on the size allowed for such memory segments. These limits are often kernel parameters that can be adjusted by the system administrator. The details are highly system dependent. Consult your system documentation for details.
- The caller does not have the option of naming the shared memory segment. Instead, the operating system assigns an arbitrary number, which means that processes that want to map such a segment have to have a mechanism for finding the correct identifier to use before they can proceed. This, in turn, requires some additional form of interprocess communication.

RSI recommends the use of Posix shared memory instead of System V shared memory for those platforms that support it and applications that can use it. Under UNIX, SHMMAP defaults to Posix shared memory to implement anonymous shared memory. To use System V shared memory, you must specify the SYSV keyword. See the Examples section below for an example of using System V shared memory.

### Posix Shared Memory

Posix shared memory is a newer alternative for anonymous shared memory. It is part of the UNIX98 standard, and although not all current UNIX systems support it, it will in time be available on all UNIX systems. Posix shared memory uses the `shm_open()` and `ftruncate()` system calls to create a memory segment that can be accessed via a file descriptor. This descriptor is then used with the `mmap()` system call to map the memory segment in the usual manner. The primary difference between this, and simply using `mmap()` on a scratch file to implement shared memory is that no scratch file is required (the disk space comes from the system swapspace). As with System V shared memory, Posix shared memory segments exist in the operating system until explicitly destroyed (using the `shm_unlink()` system call). Unlike System V shared memory, but like all the other forms, Posix shared memory allows the caller to supply the name of the segment. This simplifies the situation in which multiple processes want to map the same segment. One of them creates it, and the others simply map it, all of them using the same name to reference it.

Posix shared memory is the default for SHMMAP on all UNIX platforms — even those that do not yet support it. (To use System V shared memory instead, you must

specify the SYSV keyword.) There are several reasons for making Posix shared memory the default for all UNIX platforms:

- To remain UNIX compliant, all platforms will have to implement the UNIX98 standard. Most have, and the remainder are currently in the process of doing so. We believe that Posix shared memory will be available on all UNIX systems very soon.
- Having different defaults for different UNIX platforms would cause unnecessary confusion; the confusion would only increase as platforms added support for Posix shared memory, causing the platform's SHMMAP default to change with later IDL releases. Since in most cases you need to know the underlying mechanism in use, the default should be easy to determine, and should not change over time.
- In the long run, it is desirable for the best option to be the default.

### Microsoft Windows

Under Microsoft Windows, the `CreateFileMapping()` system call forms the basis for shared memory as well as memory mapped files. To map a file, you open the file and then pass the handle for that file to `CreateFileMapping()`. To create a region of anonymous mapped memory instead of a mapped file, you pass a special file handle (`0xffffffff`) to `CreateFileMapping()`. In this case, the disk space used to back the shared memory is taken from the system pagefile. `CreateFileMapping()` accepts an optional parameter (`lpname`), which if present, is used to give the resulting memory mapping object a system global name. If you specify such a name, and a mapping object with that name already exists, you will receive a handle to the existing mapping object. Otherwise, `CreateFileMapping()` creates a new mapping object for the file. Hence, to create anonymous (no file) shared memory between unrelated processes, IDL calls `CreateFileMapping()` with the special `0xffffffff` file handle, and specifies a global name for it.

A global name (supplied via the OS_HANDLE keyword) is the only name by which an anonymous shared memory segment can be referenced within the system. Global names are not required for memory mapped files, because each process can create a separate mapping object and use it to refer to the same file. Although this does allow the unrelated processes to see each others' changes, their views of the file will not be *coherent* (that is, identical). With coherent access, all processes see exactly the same memory at exactly the same time because they are all mapping the same physical page of memory. To get coherent access to a memory mapped file, every process should specify the OS_HANDLE keyword to ensure that they use the same mapping object. Coherence is only an issue when the contents of the file are altered; when using read-only access to a mapped file, you need not be concerned with this issue.

The Windows operating system automatically destroys a mapping object when the last process with an open handle to it closes that handle. Destruction of the mapping object may be the result of an explicit call to `CloseHandle()`, or may involve an implicit close that happens when the process exits. This differs from the UNIX behavior for anonymous shared memory, and consequently the benefits and disadvantages are reversed. The advantage is that it is not possible to forget to destroy a mapping object, and end up with the operating system holding memory that is no longer useful, but which cannot be freed. On the other hand, you must ensure that at least one open handle to the object is open at all times, or the system might free an object that you intended to use again.

**Note**

Under Windows, when attaching to an existing memory object by providing the global segment name, IDL is not able to verify that the memory segment returned by the operating system is large enough to satisfy the IDL array specified to SHMMAP for its type and size. If the segment is not large enough, the IDL program will crash with an illegal memory access exception when it attempts to access memory addresses beyond the end of the segment. Hence, the IDL user must ensure that such pre-existing memory segments are long enough for the specified IDL array.

## Reference Counts And Memory Segment Lifecycle

You can see a list of all current memory segments created with SHMMAP by issuing the statement

```
HELP,/SHARED_MEMORY
```

To access a current segment, it must be tied to an IDL variable using the SHMVAR function. IDL maintains a reference count of the number of variables currently accessing each memory segment, and does not allow a memory segment to be removed from the IDL process as long as variables that reference it still exist.

SHMMAP will not allow you to create a new memory segment with the same *SegmentName* as an existing segment. You should therefore be careful to pick unique segment names. One way to ensure that segment names are unique is to not provide the *SegmentName* argument when calling SHMMAP. In this case, SHMMAP will automatically choose a unique name, which can be obtained using the GET_NAME keyword.

The SHMUNMAP procedure is used to remove a memory segment from the IDL session. In addition, it may remove the memory segment from the system. (Whether the memory segment is removed from the system depends on the type of segment,

and on the arguments used with SHMMAP when the segment was initially attached.) If no variables from the current IDL session are accessing the segment (that is, if the IDL-maintained reference count is 0), the segment is removed immediately. If variables in the current IDL session are still referencing the segment, the segment is marked for removal when the last such variable drops its reference. Once SHMMAP is called on a memory segment, no additional calls to SHMVAR are allowed for it within the current IDL session; this means that a segment marked by SHMUNMAP as *UnmapPending* cannot be used for new variables within the current IDL session.

**Note**

IDL has no way to determine whether a process other than itself is accessing a shared memory segment. As a result, it is possible for IDL to destroy a memory segment that is in use by another process. The specific details depend on the type of memory segment, and the options used with SHMMAP when the segment was loaded. When creating applications that use shared memory, you should ensure that all applications that use the segment (be they instances of IDL or any other application) communicate regarding their use of the shared memory and act in a manner that avoids this pitfall.

# Examples

## Example 1

Create a shared memory segment of 1000000 double-precision data elements, and then fill it with a DINDGEN ramp:

```
SHMMAP, 'MYSEG', /DOUBLE, 1000000
z = SHMVAR('MYSEG')
z[0] = DINDGEN(1000000)
```

**Note**

When using shared memory, using the explicit subscript of the variable (z, in this case) maintains the variable's connection with the shared memory segment. When not using shared memory, assignment without subscripting is more efficient and is recommended.

## Example 2

Create the same shared memory segment as the previous example, but let IDL choose the segment name:

```
SHMMAP, /DOUBLE, DIMENSION=[1000000], GET_NAME=segname
z = SHMVAR(segname)
```

```
z[0] = DINDGEN(1000000)
```

## Example 3

Create the same shared memory segment as the previous example, but use a temporary file, mapped into IDL's address space, instead of anonymous shared memory. The file needs to be the correct length for the data we will be mapping onto it. We satisfy this need while simultaneously initializing it with the DINDGEN vector by writing the vector to the file. The use of the OS_HANDLE keyword improves performance and correctness under Windows while being quietly ignored under UNIX:

```
filename = FILEPATH('idl_scratch', /TMP)
OPENW, unit, filename, /GET_LUN
WRITEU, unit, DINDGEN(1000000)
CLOSE, unit
SHMMAP, /DOUBLE, DIMENSION=[1000000], GET_NAME=segname, $
FILENAME=filename, OS_HANDLE='idl_scratch'
z = SHMVAR(segname)
```

## Example 4

Create an anonymous shared memory segment using UNIX System V shared memory. Use of System V shared memory differs from the other methods in two ways:

- The system identifier for the segment is a number chosen by the system instead of a name selected by the user.
- With SYSV memory, you have to explicitly indicate whether the operation is a create operation (no OS_HANDLE keyword) or merely an attach to an existing segment (OS_HANDLE is present). The other methods create the segment as needed, and will automatically attach to a memory segment with the desired operating system handle if it already exists. The SHMMAP call does not explicitly have to specify that the segment should be created.

In this example, we will use the type and size of the existing `myvar` variable to determine the size of the memory:

```
SHMMAP, TEMPLATE=myvar, GET_NAME=segname, /SYSV, $
   GET_OS_HANDLE=oshandle
```

In this case, the SYSV keyword forces the use of System V shared memory. The absence of the OS_HANDLE keyword tells SHMMAP to create the segment, instead of simply mapping an existing one. In a different IDL session running on the same machine, if you knew the proper OS_HANDLE value for this segment, you could attach to the segment created above as follows:

```
SHMMAP, TEMPLATE=myvar, GET_NAME=segname, /SYSV, $
   OS_HANDLE=oshandle
```

In this case, the OS_HANDLE keyword tells SHMMAP the identifier of the memory segment, causing it to attach to the existing segment instead of creating a new one.

## Version History

Introduced: 5.6

## See Also

SHMDEBUG, SHMUNMAP, SHMVAR

# SHMUNMAP

The SHMUNMAP procedure is used to remove a memory segment previously created by SHMMAP from the IDL session. In addition, it may remove the memory segment from the system. (Whether the memory segment is removed from the system depends on the type of segment, and on the arguments used with SHMMAP when the segment was initially attached.) If no variables from the current IDL session are accessing the segment (that is, if the IDL-maintained reference count is 0), the segment is removed immediately. If variables in the current IDL session are still referencing the segment, the segment is marked for removal when the last such variable drops its reference.

During this *UnmapPending* phase:

- The segment still exists in the system, so attempts to use SHMMAP to create a new segment with the same *SegmentName* will fail.
- Additional calls to SHMVAR to attach new variables to this segment will fail.

**Note**

IDL has no way to determine whether a process other than itself is accessing a shared memory segment. As a result, it is possible for IDL to destroy a memory segment that is in use by another process. The specific details depend on the type of memory segment, and the options used with SHMMAP when the segment was loaded. When creating applications that use shared memory, you should ensure that all applications that use the segment (be they instances of IDL or any other application) communicate regarding their use of the shared memory and act in a manner that avoids this pitfall.

## Syntax

SHMUNMAP, *SegmentName*

## Arguments

### SegmentName

A scalar string containing the IDL name for the shared memory segment, as assigned by SHMMAP.

## Keywords

None.

## Examples

To destroy a memory segment previously created by SHMMAP with the segment name `myseg`:

```
SHMUNMAP, 'myseg'
```

## Version History

Introduced: 5.6

## See Also

SHMDEBUG, SHMMAP, SHMVAR

# SHMVAR

The SHMVAR function creates an IDL array variable that uses the memory from a current mapped memory segment created by the SHMMAP procedure. Variables created by SHMVAR are used in much the same way as any other IDL variable, and provide the IDL user with the ability to alter the contents of anonymous shared memory or memory mapped files.

By default, the variable created by SHMVAR is given the type and dimensions that were specified to SHMMAP when the memory segment was created. However, this default can be changed by SHMVAR via a variety of keywords as well as via the $D_i$ arguments. The created array can be of any type except for pointer, object reference, or string. Structure types are allowed as long as they do not contain any pointers, object references, or strings.

## Syntax

*Result* = SHMVAR(*SegmentName* [, $D_1$, ..., $D_8$] [, /BYTE] [, /COMPLEX] [, /DCOMPLEX] [, DIMENSION=*value*] [, /DOUBLE] [, /FLOAT] [, /INTEGER] [, /L64] [, /LONG] [, SIZE=*value*] [, TEMPLATE=*value*] [, TYPE=*value*] [, /UINT] [, /UL64] [, /ULONG] )

## Return Value

An IDL array variable that uses memory from a the specified mapped memory segment.

## Arguments

### SegmentName

A scalar string supplying the IDL name for the shared memory segment, as assigned by SHMMAP.

### $D_i$

The dimensions of the result. The $D_i$ arguments can be either a single array containing the dimensions or a sequence of scalar dimensions. Up to eight dimensions can be specified. If no dimensions are specified, the parameters specified to SHMMAP are used.

# Keywords

## BYTE

Set this keyword to specify that the memory segment should be treated as a byte array.

## COMPLEX

Set this keyword to specify that the memory segment should be treated as a complex, single-precision floating-point array.

## DCOMPLEX

Set this keyword to specify that the memory segment should be treated as a complex, double-precision floating-point array.

## DIMENSION

Set this keyword equal to a vector of 1 to 8 elements specifying the dimensions of the result. This is equivalent to the array form of the $D_i$ plain arguments. If no dimensions are specified, the parameters specified to SHMMAP are used.

## DOUBLE

Set this keyword to specify that the memory segment should be treated as a double-precision floating-point array.

## FLOAT

Set this keyword to specify that the memory segment should be treated as a single-precision floating-point array.

## INTEGER

Set this keyword to specify that the memory segment should be treated as an integer array.

## L64

Set this keyword to specify that the memory segment should be treated as a 64-bit integer array.

### LONG

Set this keyword to specify that the memory segment should be treated as a longword integer array.

### SIZE

Set this keyword equal to a size vector specifying the type and dimensions to be associated with the memory segment. The format of a size vector is given in the description of the SIZE function. If no dimensions are specified, the parameters specified to SHMMAP are used.

### TEMPLATE

Set this keyword equal to a variable of the type and dimensions to be associated with the memory segment. If no dimensions are specified, the parameters specified to SHMMAP are used.

### TYPE

Set this keyword to specify the type code for the memory segment. See the description of the SIZE function for a list of IDL type codes.

### UINT

Set this keyword to specify that the memory segment should be treated as a unsigned integer array.

### ULONG

Set this keyword to specify that the memory segment should be treated as a unsigned longword integer array.

### UL64

Set this keyword to specify that the memory segment should be treated as a unsigned 64-bit integer array.

## Examples

See the examples given for the SHMMAP procedure.

## Version History

Introduced: 5.6

## See Also

SHMDEBUG, SHMMAP, SHMUNMAP

# SHOW3

The SHOW3 procedure combines an image, a surface plot of the image data, and a contour plot of the images data in a single tri-level display.

This routine is written in the IDL language. Its source code can be found in the file `show3.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SHOW3, *Image* [, *X*, *Y*] [, /INTERP] [, E_CONTOUR=*structure*] [, E_SURFACE=*structure*] [, SSCALE=*scale*]

## Arguments

### Image

The two-dimensional array to display.

### X

A vector containing the X values of each column of *Image*. If the *X* argument is omitted, columns have values 0, 1, ..., *n*columns-1.

### Y

A vector containing the Y values of each row of *Image*. If the *Y* argument is omitted, rows have values 0, 1, ..., *n*rows-1.

## Keywords

### INTERP

Set this keyword to use bilinear interpolation on the pixel display. This technique is slightly slower, but for small images, it makes a better display.

### E_CONTOUR

Set this keyword equal to an anonymous structure containing additional keyword parameters that are passed to the CONTOUR procedure. Tag names in the structure should be valid keyword arguments to CONTOUR, and the values associated with each tag should be valid keyword values.

### E_SURFACE

Set this keyword equal to an anonymous structure containing additional keyword parameters that are passed to the SURFACE procedure. Tag names in the structure should be valid keyword arguments to SURFACE, and the values associated with each tag should be valid keyword values.

### SSCALE

Reduction scale for surface. The default is 1. If this keyword is set to a value other than 1, the array size is reduced by this factor for the surface display. That is, the number of points used to draw the wire-mesh surface is reduced. If the array dimensions are not an integral multiple of SSCALE, the image is reduced to the next smaller multiple.

## Examples

```
; Create a dataset:
A = BESELJ(SHIFT(DIST(30,20), 15, 10)/2.,0)

; Show it with default display:
SHOW3, A

; Specify X axis proportional to square root of values:
SHOW3, A, SQRT(FINDGEN(30))

; Label CONTOUR lines with double size characters, and include
;downhill tick marks:
SHOW3, A, E_CONTOUR={C_CHARSIZE:2, DOWN:1}

; Draw a surface with a skirt and scale Z axis from -2 to 2:
SHOW3, A, E_SURFACE={SKIRT:-1, ZRANGE:[-2,2]}
```

## Version History

Introduced: Original

## See Also

CONTOUR, ICONTOUR, ISURFACE, SURFACE

# SHOWFONT

The SHOWFONT procedure displays a TrueType or vector-drawn font (from the file `hersh1.chr`, located in the `resource/fonts` subdirectory of the IDL distribution) on the current graphics device.

This routine is written in the IDL language. Its source code can be found in the file `showfont.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SHOWFONT, *Font*, *Name* [, /ENCAPSULATED] [, /TT_FONT]

## Arguments

### Font

The index number of the font (may range from 3 to 29) or, if the TT_FONT keyword is set, a string that contains the name of the TrueType font to display.

### Name

A string that contains the text of a title to appear at the top of the font display.

## Keywords

### ENCAPSULATED

Set this keyword, if the current graphics device is “PS”, to make encapsulated PostScript output.

### TT_FONT

If this keyword is set, the specified font will be interpreted as a TrueType font.

## Examples

To create a display of the Helvetica italic TrueType font on the screen:

```
SHOWFONT, 'Helvetica Italic', 'Helvetica Italic', /TT_FONT
```

To create a display of Font 3 for PostScript:

```
; Set output to PostScript:
```

```
SET_PLOT, 'PS'

; Specify the output filename. If we didn't specify this, the file
; would be saved as idl.ps by default:
DEVICE, FILENAME='font3.ps'

;Display font 3:
SHOWFONT, 3, 'Simplex Roman'

; Close the new PS file:
DEVICE, /CLOSE
```

## Version History

Introduced: Pre 4.0

## See Also

EFONT, PS_SHOW_FONTS

# SIMPLEX

The SIMPLEX function uses the simplex method to solve linear programming problems. Given a set of *N* independent variables $X_i$, where *i = 0, ..., N*, the simplex method seeks to maximize the following function,

$$Z = a_1X_1 + a_2X_2 + \ldots a_NX_N$$

with the assumption that $X_i \geq 0$. The $X_i$ are further constrained by the following equations:

$$b_{j1}X_1 + b_{j2}X_2 + \ldots b_{jN}X_N \leq c_j \quad j = 1, 2, \ldots, M_1$$

$$b_{j1}X_1 + b_{j2}X_2 + \ldots b_{jN}X_N \geq c_j \quad j = M_1 + 1, M_1 + 2, \ldots, M_1 + M_2$$

$$b_{j1}X_1 + b_{j2}X_2 + \ldots b_{jN}X_N = c_j \quad j = M_1 + M_2 + 1, M_1 + M_2 + 2, \ldots, M$$

where $M = M_1 + M_2 + M_3$ is the total number of equations, and the constraint values $c_j$ must all be positive.

To solve the above problem using the SIMPLEX function, the *Z* equation is rewritten as a vector:

$$Z_{equation} = \left[a_1\ a_2\ \ldots a_N\right]$$

The constraint equations are rewritten as a matrix with *N*+1 columns and *M* rows, where all of the *b* coefficients have had their sign reversed:

$$\text{Constraints} = \begin{bmatrix} c_1 & -b_{11} & -b_{12} \ldots -b_{1N} \\ c_2 & -b_{21} & -b_{22} \ldots -b_{2N} \\ : & : & : \\ : & : & : \\ c_M & -b_{M1} & -b_{M2} \ldots -b_{MN} \end{bmatrix}$$

**Note**

The constraint matrix must be organized so that the coefficients for the less-than (<) equations come first, followed by the coefficients of the greater-than (>) equations, and then the coefficients of the equal (=) equations.

The SIMPLEX function is based on the routine `simplx` described in section 10.8 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

# Syntax

*Result* = SIMPLEX( *Zequation*, *Constraints*, $M_1$, $M_2$, $M_3$
[, *Tableau* [, *Izrov* [, *Iposv*] ] ] [, /DOUBLE] [, EPS = *value*] [, STATUS = *variable*] )

# Return Value

The *Result* is a vector of *N*+1 elements containing the maximum *Z* value and the values of the *N* independent *X* variables (the optimal feasible vector):

$$\text{Result} = \left[ Z_{max}\ X_1\ X_2 \ldots X_N \right]$$

# Arguments

## Zequation

A vector containing the *N* coefficients of the $Z_{equation}$ to be maximized.

## Constraints

An array of *N*+1 columns by *M* rows containing the constraint values and coefficients for the constraint equations.

### M1

An integer giving the number of less-than constraint equations contained in *Constraints*. *M1* may be zero, indicating that there are no less than constraints.

### M2

An integer giving the number of greater-than constraint equations contained in *Constraints*. *M2* may be zero, indicating that there are no greater than constraints.

### M3

An integer giving the number of equal-to constraint equations contained in *Constraints*. *M3* may be zero, indicating that there are no equal to constraints. The total of *M1* + *M2* + *M3* should equal M, the number of constraint equations.

### Tableau

Set this optional argument to a named variable in which to return the output array from the simplex algorithm. For more detailed discussion about this argument, see the write-up in section 10.8 of *Numerical Recipes in C*.

### Izrov

Set this optional argument to a named variable in which to return the output izrov variable from the simplex algorithm. For more detailed discussion about this argument, see the write-up in section 10.8 of *Numerical Recipes in C*.

### Iposv

Set this optional argument to a named variable in which to return the output iposv variable from the simplex algorithm. For more detailed discussion about this argument, see the write-up in section 10.8 of *Numerical Recipes in C*.

## Keywords

### DOUBLE

Set this keyword to use double-precision for computations and to return a double-precision result. Set DOUBLE to 0 to use single-precision for computations and to return a single-precision result. The default is /DOUBLE if any of the inputs are double-precision, otherwise the default is 0.

### EPS

Set this keyword to a number close to machine accuracy, which is used to test for convergence at each iteration. The default is $10^{-6}$.

### STATUS

Set this keyword to a named variable to receive the status of the operation. Possible status values are:

| Value | Description |
|---|---|
| 0 | Successful completion. |
| 1 | The objective function is unbounded. |

*Table 86: SIMPLEX Function Status Values*

| Value | Description |
|---|---|
| 2 | No solution satisfies the given constraints. |
| 3 | The routine did not converge. |

*Table 86: SIMPLEX Function Status Values (Continued)*

# Examples

The following example is taken from *Numerical Recipes in C*.

Find the Z value which maximizes the equation $Z = X_1 + X_2 + 3\ X_3 - 0.5\ X_4$, with the following constraints:

$$X_1 + 2X_3 \leq 740$$
$$2X_2 - 7X_4 \leq 0$$
$$X_2 - X_3 + 2X_4 \geq 0.5$$
$$X_1 + X_2 + X_3 + X_4 = 9$$

To find the solution, enter the following code at the IDL command line:

```
; Set up the Zequation with the X coefficients.
Zequation = [1,1,3,-0.5]
; Set up the Constraints matrix.
Constraints = [ $
   [740, -1,  0, -2,  0], $
   [  0,  0, -2,  0,  7], $
   [0.5,  0, -1,  1, -2], $
   [  9, -1, -1, -1, -1] ]
; Number of less-than constraint equations.
m1 = 2
; Number of greater-than constraint equations.
m2 = 1
; Number of equal constraint equations.
m3 = 1
;
; Call the function.
result = SIMPLEX(Zequation, Constraints, m1, m2, m3)
;
; Print out the results.
PRINT, 'Maximum Z value is: ', result[0]
PRINT, 'X coefficients are: '
PRINT, result[1:*]
```

IDL prints:

```
Maximum Z value is:       17.0250
X coefficients are:
      0.000000      3.32500      4.72500     0.950000
```

Therefore, the optimal feasible vector is $X_1 = 0.0$, $X_2 = 3.325$, $X_3 = 4.725$, and $X_4 = 0.95$.

## Version History

Introduced: 5.5

## See Also

AMOEBA, DFPMIN, POWELL

# SIN

The periodic function SIN returns the trigonometric sine of X.

## Syntax

*Result* = SIN(*X*)

## Return Value

Returns the double-precision floating-point, complex or single-precision floating-point value.

## Arguments

### X

The angle for which the sine is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. When applied to complex numbers:

SIN(*x*) = (EXP(*I**x) + EXP(-*I**x))/(2**I*)

where *I* is defined as COMPLEX(0, 1).

If input argument *X* is an array, the result has the same structure, with each element containing the sine of the corresponding element of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To find the sine of 0.5 radians and print the result, enter:

```
PRINT, SIN(0.5)
```

The following example plots the SIN function between 0 and 2π with 100 intervals:

```
X = 2*!PI/100 * FINDGEN(100)
PLOT, X, SIN(X)
```

**Note**

!PI is a read-only system variable that contains the single-precision value for π.

## Version History

Introduced: Original

## See Also

ASIN, SINH

# SINDGEN

The SINDGEN function returns a string array with the specified dimensions. Each element of the array is set to the string representation of the value of its one-dimensional subscript, using IDL's default formatting rules.

## Syntax

*Result* = SINDGEN($D_1$ [, ..., $D_8$])

## Return Value

Returns a string array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Examples

To create S, a six-element string vector with each element set to the string value of its subscript, enter:

```
S = SINDGEN(6)
```

## Version History

Introduced: Original

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, UINDGEN, UL64INDGEN, ULINDGEN

# SINH

The SINH function returns the hyperbolic sine of X.

## Syntax

*Result* = SINH(*X*)

## Return Value

Returns the double-precision floating-point, complex or single-precision floating-point value.

## Arguments

### X

The angle for which the hyperbolic sine is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. SINH is defined as:

$$\sinh x = (e^{u} - e^{-u}) / 2$$

If *X* is an array, the result has the same structure, with each element containing the hyperbolic sine of the corresponding element of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To find the hyperbolic sine of each element in the array [.5, .2, .4] and print the result, enter:

```
PRINT, SINH([.5, .2, .4])
```

To plot the SINH function between 0 and 2π with 100 intervals, enter:

```
X = 2*!PI/100 * FINDGEN(100)
PLOT, X, SINH(X)
```

**Note**

!PI is a read-only system variable that contains the single-precision value of π.

## Version History

Introduced: Original

## See Also

ASIN, SIN

# SIZE

The SIZE function returns size and type information for its argument if no keywords are set. If a keyword is set, SIZE returns the specified quantity.

## Syntax

*Result* = SIZE( *Expression* [, /L64] [, /DIMENSIONS | , /FILE_LUN | , /N_DIMENSIONS | , /N_ELEMENTS | , /STRUCTURE | , /TNAME | , /TYPE] )

## Return Value

The returned vector is always of integer type. The first element is equal to the number of dimensions of *Expression*. This value is zero if *Expression* is scalar or undefined. The next elements contain the size of each dimension, one element per dimension (none if *Expression* is scalar or undefined). After the dimension sizes, the last two elements contain the type code (zero if undefined) and the number of elements in *Expression*, respectively. The type codes are listed below.

### IDL Type Codes and Names

The following table lists the IDL type codes and type names returned by the SIZE function:

| Type Code | Type Name | Data Type |
|---|---|---|
| 0 | UNDEFINED | Undefined |
| 1 | BYTE | Byte |
| 2 | INT | Integer |
| 3 | LONG | Longword integer |
| 4 | FLOAT | Floating point |
| 5 | DOUBLE | Double-precision floating |
| 6 | COMPLEX | Complex floating |
| 7 | STRING | String |
| 8 | STRUCT | Structure |

*Table 87: IDL Type Codes and Names*

| Type Code | Type Name | Data Type |
|---|---|---|
| 9 | DCOMPLEX | Double-precision complex |
| 10 | POINTER | Pointer |
| 11 | OBJREF | Object reference |
| 12 | UINT | Unsigned Integer |
| 13 | ULONG | Unsigned Longword Integer |
| 14 | LONG64 | 64-bit Integer |
| 15 | ULONG64 | Unsigned 64-bit Integer |

*Table 87: IDL Type Codes and Names (Continued)*

# Arguments

## Expression

The expression for which size information is requested.

# Keywords

With the exception of L64, the following keywords determine the return value of the SIZE function and are mutually exclusive — specify at most one of the following.

## DIMENSIONS

Set this keyword to return the dimensions of *Expression*. If *Expression* is scalar, the result is a scalar containing a 0. For arrays, the result is an array containing the array dimensions. The result is a 32-bit integer when possible, and 64-bit integer if the number of elements in *Expression* requires it. Set L64 to force 64-bit integers to be returned in all cases.If *Expression* is undefined, IDL reports eight dimensions.

## FILE_LUN

Set this keyword to return the file unit to which *Expression* is associated, if it is an IDL file variable, as created with the ASSOC function. If *Expression* is not a file variable, 0 is returned (0 is not a valid file unit for ASSOC).

## L64

By default, the result of SIZE is 32-bit integer when possible, and 64-bit integer if the number of elements in *Expression* requires it. Set L64 to force 64-bit integers to be returned in all cases. In addition to affecting the default result, L64 also affects the output from the DIMENSIONS, N_ELEMENTS, and STRUCTURE keywords.

**Note**

Only 64-bit versions of IDL are capable of creating variables requiring 64-bit SIZE output. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

## N_DIMENSIONS

Set this keyword to return the number of dimension in *Expression*, if it is an array. If *Expression* is scalar or undefined, 0 is returned.

## N_ELEMENTS

Set this keyword to return the number of data elements in *Expression*. Setting this keyword is equivalent to using the N_ELEMENTS function. The result will be 32-bit integer when possible, and 64-bit integer if the number of elements in *Expression* requires it. Set L64 to force 64-bit integers to be returned in all cases. If *Expression* is undefined, 0 is returned.

## STRUCTURE

Set this keyword to return all available information about *Expression* in a structure.

**Note**

Since the structure is a named structure, the size of its fields is fixed. The result is an IDL_SIZE (32-bit) structure when possible, and an IDL_SIZE64 structure otherwise. Set L64 to force an IDL_SIZE64 structure to be returned in all cases.

The following are descriptions of the fields in the returned structure:

| Field | Description |
|---|---|
| TYPE_NAME | Name of IDL type of *Expression.* |
| TYPE | Type code of *Expression.* |

*Table 88: Structure Fields*

| Field | Description |
|---|---|
| FILE_LUN | If *Expression* is an IDL file variable, as created with the ASSOC function, the file unit to which it is associated; otherwise, 0. |
| N_ELEMENTS | Number of data elements in *Expression*. |
| N_DIMENSIONS | If *Expression* is an array, the number of dimensions; otherwise, *Expression* is 0. |
| DIMENSIONS | An 8-element array containing the dimensions of *Expression*. |

*Table 88: Structure Fields (Continued)*

### TNAME

Set this keyword to return the IDL type of *Expression* as a string. See "IDL Type Codes and Names" on page 1800 for details.

### TYPE

Set this keyword to return the IDL type code for *Expression*. See "IDL Type Codes and Names" on page 1800 for details. For an example illustrating how to determine the type code of an expression, see "Determining the Size/Type of an Array" in Chapter 15 of the *Building IDL Applications* manual.

## Examples

Print the size information for a 10 by 20 floating-point array by entering:

```
PRINT, SIZE(FINDGEN(10, 20))
```

IDL prints:

```
      2   10   20   4   200
```

This IDL output indicates the array has 2 dimensions, equal to 10 and 20, a type code of 4, and 200 elements total.

Similarly, to print only the number of dimensions of the same array:

```
PRINT, SIZE(FINDGEN(10, 20), /N_DIMENSIONS)
```

IDL prints:

```
      2
```

## Version History

Introduced: Original

# SKEWNESS

The SKEWNESS function computes the statistical skewness of an *n*-element vector. Skewness determines whether a distribution is symmetric about its maximum. Positive skewness indicates the distribution is skewed to the right, with a longer tail to the right of the distribution maximum. Negative skewness indicates the distribution is skewed to the left, with a longer tail to the left of the distribution maximum.

SKEWNESS calls the IDL function MOMENT.

## Syntax

*Result* = SKEWNESS( *X* [, /DOUBLE] [, /NAN] )

## Return Value

Returns the floating point or double precision statistical skewness. If the variance of the vector is zero, the skewness is not defined, and SKEWNESS returns !VALUES.F_NAN as the result.

## Arguments

### X

A numeric vector.

## Keywords

### DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic.

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## Examples

```
; Define the n-element vector of sample data:
```

```
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]
; Compute the skewness:
result = SKEWNESS(x)
PRINT, 'Skewness = ', result
```

IDL prints:

```
Skewness =    -0.0942851
```

## Version History

Introduced: 5.1

## See Also

KURTOSIS, MEAN, MEANABSDEV, MOMENT, STDDEV, VARIANCE

# SKIP_LUN

The SKIP_LUN procedure reads data in an open file and moves the file pointer. It is useful in situations where it is necessary to skip over a known amount of data in a file without the requirement of having the data available in an IDL variable. SKIP_LUN can skip over a fixed amount of data, specified in bytes or lines of text, or can skip over the remainder of the input file from the current position to end of file. Since SKIP_LUN actually performs an input operation to advance the file pointer, it is not as efficient as POINT_LUN for skipping over a fixed number of bytes in a disk file. For that reason, use of POINT_LUN is preferred when possible. SKIP_LUN is especially useful in situations such as:

- Skipping over a fixed number of lines of text. Since lines of text can have variable length, it can be difficult to use POINT_LUN to skip them.
- Skipping data from a file that is not a regular disk file (for example, data from an internet socket).

## Syntax

SKIP_LUN, *FromUnit*, [, *Num*] [, /EOF] [, /LINES]
[, /TRANSFER_COUNT=*variable*]

## Arguments

### FromUnit

An integer that specifies the file unit for the file in which the file pointer is to be moved. Data in *FromUnit* is skipped, starting at the current position of the file pointer. The file pointer is advanced as data is read and skipped. The file specified by *FromUnit* must be open, and must not have been opened with the RAWIO keyword to OPEN.

### Num

The amount of data to skip. This value is specified in bytes, unless the LINES keyword is specified, in which case it is taken to be the number of text lines. If *Num* is not specified, SKIP_LUN acts as if the EOF keyword has been set, and skips all data in *FromUnit* (the source file) from the current position of the file pointer to the end of the file.

If *Num* is specified and the source file comes to end of file before the specified amount of data is skipped, SKIP_LUN issues an end-of-file error. The EOF keyword alters this behavior.

# Keywords

## EOF

Set this keyword to ignore the value given by *Num* (if present) and instead skip all data from the current position of the file pointer in *FromUnit* and the end of the file.

**Note**

If EOF is set, no end-of-file error is issued even if the amount of data skipped does not match the amount specified by *Num*. The TRANSFER_COUNT keyword can be used with EOF to determine how much data was skipped.

## LINES

Set this keyword to indicate that the *Num* argument specifies the number of lines of text to be skipped. By default, the *Num* argument specifies the number of bytes of data to skip.

## TRANSFER_COUNT

Set this keyword equal to a named variable that will contain the amount of data skipped. If LINES is specified, this value is the number of lines of text. Otherwise, it is the number of bytes. TRANSFER_COUNT is primarily useful in conjunction with the EOF keyword. If EOF is not specified, TRANSFER_COUNT will be the same as the value specified for *Num*.

# Examples

Skip the next 8 lines of text from a file:

```
SKIP_LUN, FromUnit, 8, /LINES
```

Skip the remainder of the data in a file, and use the TRANSFER_COUNT keyword to determine how much data was skipped:

```
SKIP_LUN, FromUnit, /EOF, TRANSFER_COUNT=n
```

Skip the remainder of the text lines in a file, and use the TRANSFER_COUNT keyword to determine how many lines were skipped:

```
SKIP_LUN, FromUnit, /EOF, /LINES, TRANSFER_COUNT=n
```

## Version History

Introduced: 5.6

## See Also

CLOSE, COPY_LUN, EOF, FILE_COPY, FILE_LINK, FILE_MOVE, OPEN, POINT_LUN, READ/READF, WRITEU

# SLICER3

The IDL SLICER3 is a widget-based application to visualize three-dimensional datasets. This program supersedes the SLICER program.

This routine is written in the IDL language. Its source code can be found in the file `slicer3.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

See "The SLICER3 Graphical User Interface" on page 1812 for details on working with volumetric data within this application.

## Syntax

SLICER3 [, *hData3D*] [, DATA_NAMES=*string/string_array*] [, /DETACH] [, GROUP=*widget_id*] [, /MODAL]

## Arguments

### hData3D

A pointer to a three-dimensional data array, or an array of pointers to multiple three-dimensional arrays. If multiple arrays are specified, they all must have the same X, Y, and Z dimensions. If *hData3D* is not specified, SLICER3 creates a 2 x 2 x 2 array of byte data using the IDL BYTARR function. You can also load data interactively via the File menu of the SLICER3 application (see "Examples" on page 1827 for details).

**Note**

If data are loaded in this fashion, any data passed to SLICER3 via a pointer (or pointers) is deleted, and the pointers become invalid.

## Keywords

### DATA_NAMES

Set this keyword equal to a string array of names for the data. The names appear on the droplist widget for the current data. If the number of elements of DATA_NAMES is less than the number of elements in *hData3D* then default names will be generated for the unnamed data.

## DETACH

Set this keyword to place the drawing area in a window that is detached from the SLICER3 control panel. The drawing area can only be detached if SLICER3 is not run as a modal application.

## GROUP

Set this keyword equal to the Widget ID of an existing widget that serves as the "group leader" for the SLICER3 graphical user interface. When a group leader is destroyed, all widgets in the group are also destroyed. If SLICER3 is started from a widget application, then GROUP should *always* be specified.

## MODAL

Set this keyword to block user interaction with all other widgets (and block the command line) until the SLICER3 exits. If SLICER3 is started from some other widget-based application, then it is usually advisable to run SLICER3 with the MODAL keyword set.

**Note**

SLICER3 modifies the current color table, as well as various elements of the plotting system (i.e., the "!X", "!Y", "!Z", and "!P" system variables). If the MODAL keyword is set (recommended), then SLICER3 will, upon exit, restore these system variables (and the color tables) to the values they had when SLICER3 was started.

# The SLICER3 Graphical User Interface

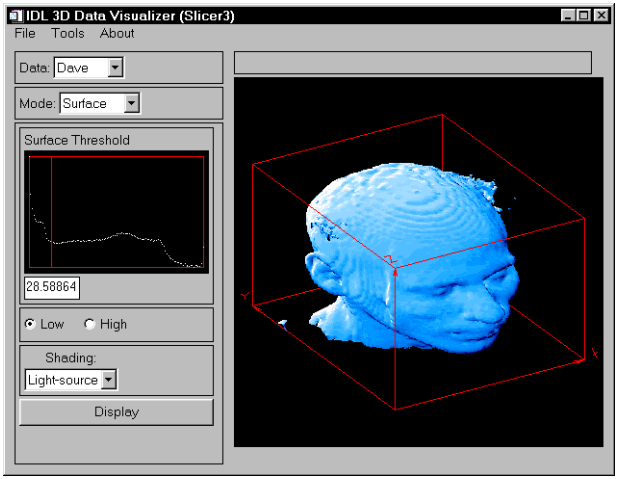



*Figure 20: SLICER3 Graphical User Interface*

The following options are available via SLICER3's graphical user interface.

## File Menu

### Load

Select this menu option to choose a file containing a 3-D array (or arrays) to load into SLICER3. The file must have been written in the format specified in the following table. For each data array in the file, the following values must be included. Note that the first six values are returned by the IDL SIZE function; see "Examples" on page 1827 for an example of how to create a data file suitable for SLICER3 with just a few IDL commands.

| Data item | Data Type | Number of Bytes |
|---|---|---|
| Number of dimension in array.<br>**Note -** This is always 3 for valid SLICER3 data.) | long | 4 |

*Table 89: SLICER3 Data File Structure*

| Data item | Data Type | Number of Bytes |
|---|---|---|
| Size of first dimension. | long | 4 |
| Size of second dimension. | long | 4 |
| Size of third dimension. | long | 4 |
| Data type (Must be type 1 through 5. See “SIZE” on page 1800 for a list of data types.) | long | 4 |
| Total number of elements (dimX, dimY, dimZ). | long | 4 |
| Number of characters in data name. (See “STRLEN” on page 1905 for the easiest way to determine this number.) | long | 4 |
| Data name | byte | strlen() |
| 3-D data array. | varies | varies |

*Table 89: SLICER3 Data File Structure (Continued)*

If multiple arrays are present in the file, they must all have the same dimensions.

**Note**

Files saved by the “Save Subset” operation (see below) are suitable for input via the “Load” operation.

Data files that are moved from one platform to another may not load as expected, due to byte ordering differences. See the BYTEORDER and SWAP_ENDIAN for details.

### Save/Save Subset

SLICER3 must be in BLOCK mode to for this option to be available.

Select this menu option to save a subset of the 3-D data enclosed in the current block to the specified file. Subsets saved in this fashion are suitable for loading via the “Load” menu option. If multiple 3-D arrays are available when this option is selected, multiple subsets are saved to the file.

### Save/Save Tiff Image

Select this menu option to save the contents of the current SLICER3 image window as a TIFF image in the specified file. When running in 8-bit mode, a “Class P” palette color TIFF file is created. In 24-bit mode, a “Class R” (interleaved by image) TIFF file is created.

### Quit

Select this menu option to exit SLICER3.

## Tools Menu

### Erase

Select this menu option to erase the display window and delete all the objects in the display list.

### Delete/...

As graphical objects are created, they are added to the display list. Select this menu option to delete a specific object from the list. When an object is deleted, the screen is redrawn with the remaining objects.

### Colors/Reset Colors

Select this menu option to restore the original color scheme.

### Colors/Differential Shading

Use this menu option to change the percentage of differential shading applied to the X, Y, and Z slices.

### Colors/Slice/Block

Use this menu option to launch the XLOADCT application to modify the colors used for slices and blocks

### Colors/Surface

Use this menu option to launch the XLOADCT application to modify the colors used for isosurfaces.

### Colors/Projection

Use this menu option to launch the XLOADCT application to modify the colors used for projections.

**Note**

On some platforms, the selected colors may not become visible until after you exit the “XLOADCT” application.

### Options

Select this menu option to display a panel that allows you to set:

- The axis visibility.
- The wire-frame cube visibility.
- The display window size.

## Main Draw Window

Operations available in the Main Draw Window are dependent on the mode selected in the Mode pulldown menu. In general, when coordinate input is required from the user, it is performed by clicking a mouse button on the “surface” of the wire-frame cube that surrounds the data. This 3-D location is then used as the basis for whatever input is needed. In most cases, the “front” side of the cube is used. In a few cases, the coordinate input is on the “back” side of the cube.

## Data Pulldown Menu

If multiple datasets are currently available in SLICER3, this menu allows you to select which data will be displayed in the Main Draw Window. Slices, blocks, iso-surfaces, etc. are created from the currently selected data. If only one dataset is loaded, this menu is inactive.

## Mode Pulldown Menu

This menu is used to select the current mode of operation.

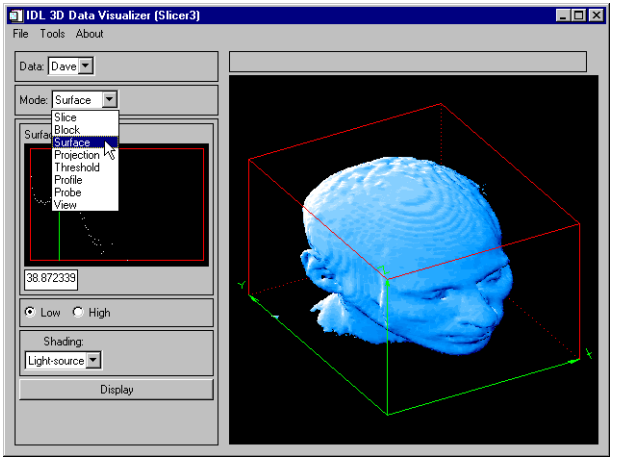



*Figure 21: Mode Pulldown Menu*

### Slice Mode

To display a slice, click and drag the left mouse button on the wire-frame cube. When the button is released, a slice through the data will be drawn at that location.

## Draw Radio Button

When in Draw mode, new slices will be merged into the current Z-buffer contents.

## Expose Radio Button

When in Expose mode, new slices will be drawn in front of everything else.

## Orthogonal Radio Button

When in Orthogonal mode, use the left mouse button in the main draw window to position and draw an orthogonal slicing plane. Clicking the right mouse button in the main draw window (or any mouse button in the small window) will toggle the slicing plane orientation.

## X/Y/Z Radio Buttons

- X: This sets the orthogonal slicing plane orientation to be perpendicular to the X axis.
- Y: This sets the orthogonal slicing plane orientation to be perpendicular to the Y axis.
- Z: This sets the orthogonal slicing plane orientation to be perpendicular to the Z axis.

## Oblique Radio Button

Clicking any mouse button in the small window will reset the oblique slicing plane to its default orientation.

## Normal Radio Button

When in this mode, click and drag the left mouse button in the big window to set the surface normal for the oblique slicing plane.

## Center Radio Button

When in this mode, click and drag the left mouse button in the big window to set the center point for the surface normal.

## Display Button

Clicking this button will cause an oblique slicing plane to be drawn.

## Block Mode

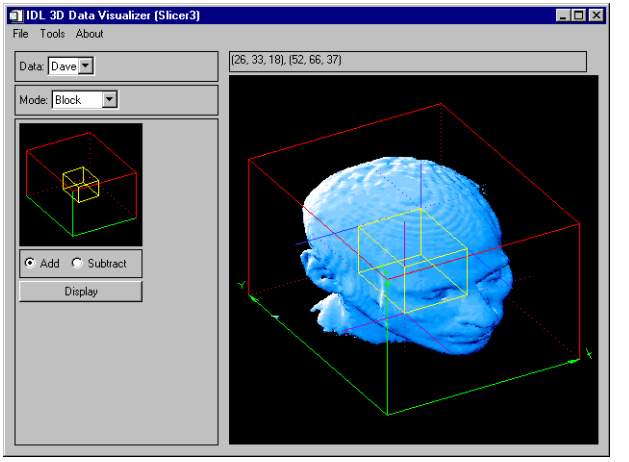



*Figure 22: Block Mode*

When in Block mode, use the left mouse button in the main draw window to set the location for the “purple” corner of the block. Use the right mouse button to locate the opposite “blue” corner of the block. When in Block mode, the “Save Subset” operation under the main “File” menu is available.

### Add

When in this mode, the block will be “added” to the current Z-buffer contents.

### Subtract

When in this mode, the block will be “subtracted” from the current Z-buffer contents. Subtract mode is only effective when the block intersects some other object in the display (such as an iso-surface).

### Display Button

Clicking this button will cause the block to be drawn.

## Surface Mode

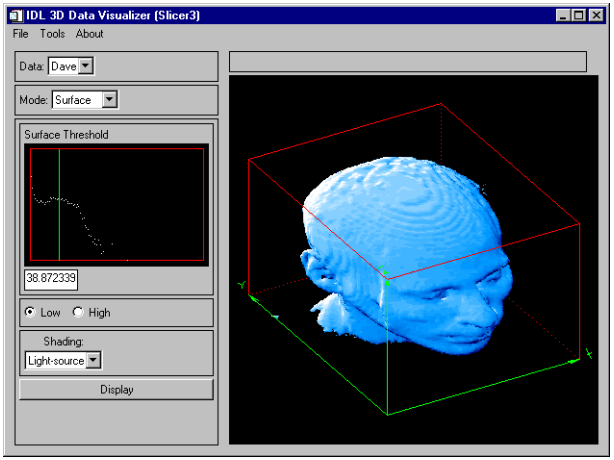



*Figure 23: Surface Mode*

An iso-surface is like a contour line on a contour map. On one side of the line, the elevation is higher than the contour level, and on the other side of the line, the elevation is lower than the contour level. An iso-surface, however, is a 3-D surface that passes through the data such that the data values on one side of the surface are higher than the threshold value, and on the other side of the surface, the data values are lower than the threshold value.

When in Surface mode, a logarithmic histogram plot of the data is displayed in the small draw window. Click and drag a mouse button on this plot to set the iso-surface threshold value. This value is also shown in the text widget below the plot. The threshold value may also be set by typing a new value in this text widget. The histogram plot is affected by the current threshold settings. (See Threshold mode, below).

### Low

Selecting this mode will cause the iso-surface polygon facing to face towards the lower data values. Usually, this is the mode to use when the iso-surface is desired to surround high data values.

### High

Selecting this mode will cause the iso-surface polygon facing to face towards the higher data values. Usually, this is the mode to use when the iso-surface is desired to surround low data values.

### Shading pulldown menu

Iso-surfaces are normally rendered with light-source shading. If multiple datasets are currently loaded, then this menu allows the selection of a different 3-D array for the source of the iso-surface shading values. If only one dataset is currently loaded, then this menu is inactive.

### Display Button

Clicking this button will cause the iso-surface to be created and drawn. Iso-surfaces often consist of tens of thousands of polygons, and can sometimes take considerable time to create and render.

## Projection Mode

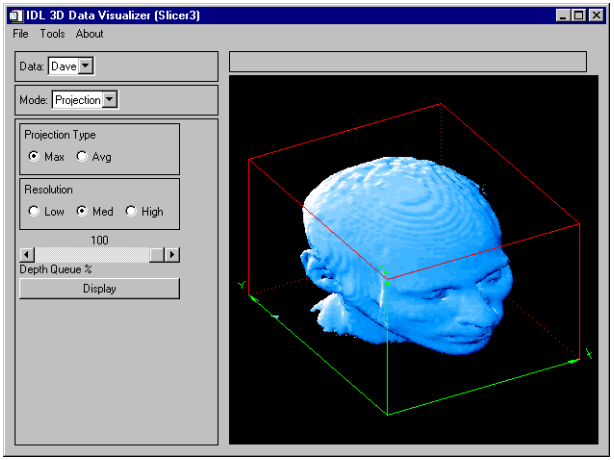



*Figure 24: Projection Mode*

A “voxel” projection of a 3-D array is the projection of the data values within that array onto a viewing plane. This is similar to taking an X-ray image of a 3-D object.

### Max

Select this mode for a Maximum intensity projection.

### Avg

Select this mode for an Average intensity projection.

### Low

Select this mode for a Low resolution projection.

### Med

Select this mode for a Medium resolution projection.

### High

Select this mode for a High resolution projection.

### Depth Queue % Slider

Use the slider to set the depth queue percent. A value of 50, for example, indicates that the farthest part of the projection will be 50% as bright as the closest part of the projection.

### Display Button

Clicking this button will cause the projection to be calculated and drawn. Projections can sometimes take considerable time to display. Higher resolution projections take more computation time.

## Threshold Mode

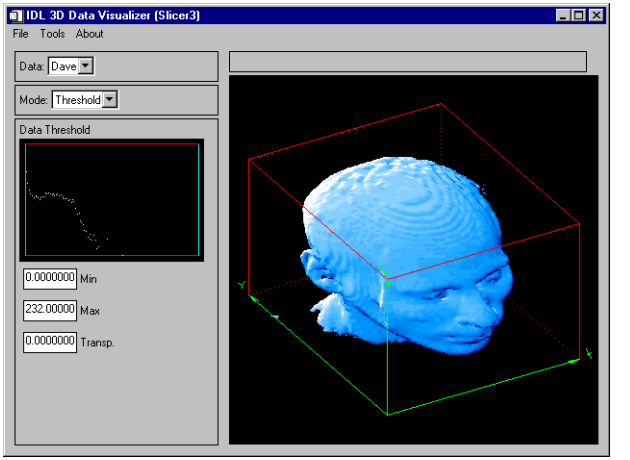



*Figure 25: Threshold Mode*

When in Threshold mode, a logarithmic histogram plot of the data is displayed in the small draw window. Click and drag the left mouse button on this plot to set the minimum and maximum threshold values. To expand a narrow range of data values into the full range of available colors, set the threshold range before displaying slices, blocks, or projections. The threshold settings also affect the histogram plot in "Surface" mode. The minimum and maximum threshold values are also shown in the text widgets below the histogram plot.

Click and drag the right mouse button on the histogram plot to set the transparency threshold. Portions of any slice, block, or projection that are less than the transparency value are not drawn (clear). Iso-surfaces are not affected by the transparency threshold. The transparency threshold value is also shown in a text widget below the histogram plot.

### Min

In this text widget, a minimum threshold value can be entered.

### Max

In this text widget, a maximum threshold value can be entered.

### Transp.

In this text widget, a transparency threshold value can be entered.

## Profile Mode

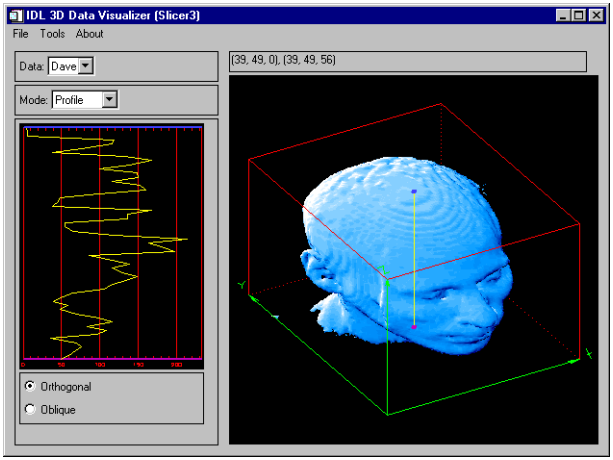



*Figure 26: Profile Mode*

In Profile mode, a plot is displayed showing the data values along a line. This line is also shown superimposed on the data in the main draw window. The bottom of the plot corresponds to the “purple” end of the line, and the top of the plot corresponds to the “blue” end of the line.

### Orthogonal

Click and drag the left mouse button to position the profile line, based upon a point on the “front” faces of the wire-frame cube. Click and drag the right mouse button to position the profile line, based upon a point on the “back” faces of the wire-frame cube. As the profile line is moved, The profile plot is dynamically updated.

### Oblique

Click and drag the left mouse button to position the “purple” end of the profile line on one of the “front” faces of the wire-frame cube. Click and drag the right mouse button to position the “blue” end of the profile line on one of the “back” faces of the wire-frame cube. As the profile line is moved, The profile plot is dynamically updated.

## Probe Mode

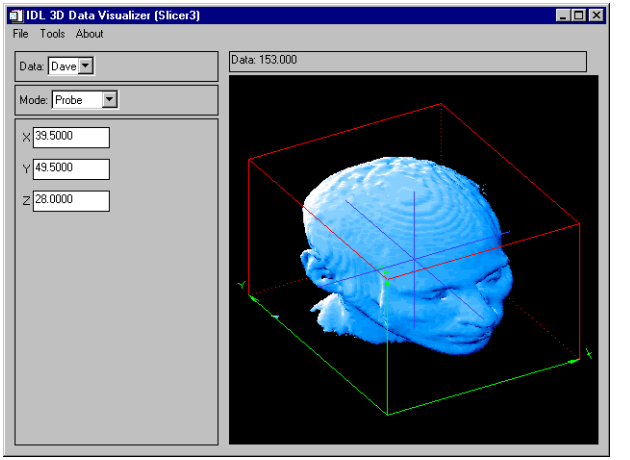



*Figure 27: Probe Mode*

In Probe mode, click and drag a mouse button over an object in the main draw window. The actual X-Y-Z location within the data volume is displayed in the three text widgets. Also, the data value at that 3-D location is displayed in the status window, above the main draw window. If the cursor is inside the wire-frame cube, but not on any object, then the status window displays “No data value”, and the three text widgets are empty. If the cursor is outside the wire-frame cube, then the status window and text widgets are empty.

**X**

Use this text widget to enter the X coordinate for the probe.

**Y**

Use this text widget to enter the Y coordinate for the probe.

**Z**

Use this text widget to enter the Z coordinate for the probe.

## View Mode

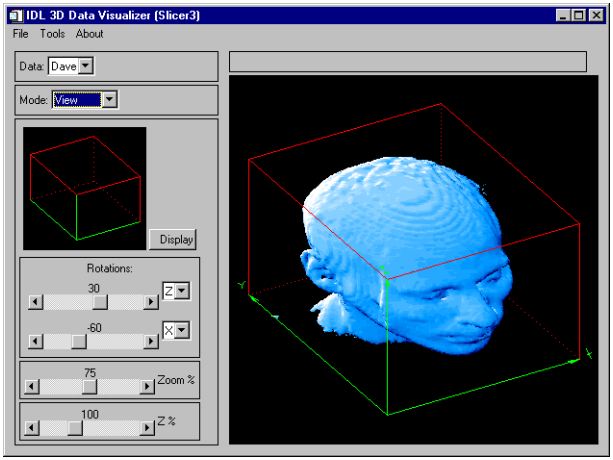



*Figure 28: View Mode*

In view mode, a small window shows the orientation of the data cube in the current view. As view parameters are changed, this window is dynamically updated. The main draw window is then updated when the user clicks on “Display”, or exits View mode.

### Display

Clicking on this button will cause the objects in the main view window to be drawn in the new view. If any view parameters have been changed since the last time the main view was updated, the main view will be automatically redrawn when the user exits View mode.

### 1st Rotation

Use this slider to set the angle of the first view rotation (in degrees). The droplist widget adjacent to the slider indicates which axis this rotation is about.

### 2nd Rotation

Use this slider to set the angle of the second view rotation (in degrees). The droplist widget adjacent to the slider indicates which axis this rotation is about.

### Zoom % Slider

Use this slider to set the zoom factor percent. Depending upon the view rotations, SLICER3 may override this setting to ensure that all eight corners of the data cube are within the window.

### Z % Slider

Use this slider to set a scale factor for the Z axis (to compensate for the data's aspect ratio).

## Operational Details

The SLICER3 procedure has the following side effects:

- SLICER3 sets the position for the light source and enables back-facing polygons to be drawn (see the IDL "SET_SHADING" command).
- SLICER3 overwrites the existing contents of the Z-buffer. Upon exiting SLICER3, the Z-buffer contents are the same as what was last displayed by SLICER3.
- On 24-bit displays, SLICER3 sets the device to non-decomposed color mode (DEVICE, DECOMPOSED=0).
- SLICER3 breaks the color table into 6 "bands", based upon the number of available colors (where `max_color=!D.N_COLORS` on 8-bit displays, and `max_color=256` on 24-bit displays and `nColor = (max_color - 9) / 5`):

| Band Start index | Band End index | Used For |
|---|---|---|
| 0 | nColor-1 | X Slices. |
| nColor | (2*nColor)-1 | Y Slices. |
| 2*nColor | (3*nColor)-1 | Z Slices. |
| 3*nColor | (4*nColor)-1 | Iso-surfaces |
| 4*nColor | (5*nColor)-1 | Projections |

*Table 90: SLICER3 Band Start/End*

Annotation colors are the last “band”, and they are set up as shown in the table:

| Color index | Color |
|---|---|
| max_color - 1 | White |
| max_color - 2 | Yellow |
| max_color - 3 | Cyan |
| max_color - 4 | Purple |
| max_color - 5 | Red |
| max_color - 6 | Green |
| max_color - 7 | Blue |
| max_color - 8 | Black |

*Table 91: SLICER3 Color Bands*

On 24-bit displays, you can often improve performance by running SLICER3 in 8-bit mode. This can be accomplished (on some platforms) by entering the following command at the start of the IDL session (before any windows are created):

```
Device, Pseudo_Color=8
```

# Examples

The following IDL commands open a data file from the IDL distribution and load it into SLICER3:

```
; Choose a data file:
file=FILEPATH('head.dat', SUBDIR=['examples', 'data'])

; Open the data file:
OPENR, UNIT, file, /GET_LUN

; Create an array to hold the data:
data = BYTARR(80, 100, 57, /NOZERO)

; Read the data into the array:
READU, UNIT, data

; Close the data file:
CLOSE, UNIT
```

```
; Create a pointer to the data array:
hData = PTR_NEW(data, /NO_COPY)

; Load the data into SLICER3:
SLICER3, hdata, DATA_NAMES='Dave'
```

**Note**

If data are loaded via the File menu after SLICER3 is launched with a pointer argument (as shown above), the pointer becomes invalid. You can use an IDL statement like the following to “clean up” after calling SLICER3 in this fashion:

```
if PTR_VALID(hdata) then PTR_FREE, hdata
```

Because we did not launch SLICER3 with the MODAL keyword, the last contents of the main draw window still reside in IDL’s Z-buffer. To retrieve this image after exiting SLICER3, use the following IDL statements:

```
; Save the current graphics device:
current_device = !D.Name

; Change to the Z-buffer device:
SET_PLOT, 'Z'

; Read the image from the Z-buffer:
image_buffer = TVRD()

; Return to the original graphics device:
SET_PLOT, current_device

; Display the image:
TV, image_buffer
```

The following IDL commands manually create a data save file suitable for dynamic loading into SLICER3. Note that if you load data into SLICER3 as shown above, you can also create save files by switching to BLOCK mode and using the Save Subset menu option.

```
; Store some 3-D data in a variable called data_1:
data_1 = INDGEN(20,30,40)

; Store some 3-D data in a variable called data_2:
data_2 = FINDGEN(20,30,40)

; Define the names for the datasets. Their names will appear in the
; "Data" pulldown menu in SLICER3:
data_1_name ='Test Data 1'
data_2_name ='Data 2'
```

```
; Select a data file name:
dataFile = PICKFILE()

; Write the file:
GET_LUN, lun
OPENW, lun, dataFile
WRITEU, lun, SIZE(data_1)
WRITEU, lun, STRLEN(data_1_name)
WRITEU, lun, BYTE(data_1_name)
WRITEU, lun, data_1
WRITEU, lun, SIZE(data_2)
WRITEU, lun, STRLEN(data_2_name)
WRITEU, lun, BYTE(data_2_name)
WRITEU, lun, data_2
CLOSE, lun
FREE_LUN, lun
```

## Version History

Introduced: 5.0

## See Also

GRID3, EXTRACT_SLICE, IVOLUME, SHADE_VOLUME, XVOLUME

# SLIDE_IMAGE

The SLIDE_IMAGE procedure creates a scrolling graphics window for examining large images. By default, 2 draw widgets are used. The draw widget on the left shows a reduced version of the complete image, while the draw widget on the right displays the actual image with scrollbars that allow sliding the visible window.

This routine is written in the IDL language. Its source code can be found in the file `slide_image.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SLIDE_IMAGE [, *Image*] [, /BLOCK] [, CONGRID=0]
[, FULL_WINDOW=*variable*] [, GROUP=*widget_id*] [, /ORDER] [, /REGISTER]
[, RETAIN={0 | 1 | 2}] [, SLIDE_WINDOW=*variable*] [, SHOW_FULL=0]
[, TITLE=*string*] [, TOP_ID=*variable*] [, XSIZE=*width*] [, XVISIBLE=*width*]
[, YSIZE=*height*] [, YVISIBLE=*height*]

## Arguments

### Image

A 2-D image array to be displayed. If this argument is not specified, no image is displayed. The FULL_WINDOW and SCROLL_WINDOW keywords can be used to obtain the window numbers of the two draw widgets so they can be drawn into at a later time.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have SLIDE_IMAGE block, any earlier calls to XMANAGER must have been called

with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## CONGRID

Normally, the image is processed with the CONGRID procedure before it is written to the fully visible window on the left. Specifying CONGIRD=0 will force the image to be drawn as is.

## FULL_WINDOW

Set this keyword to a named variable that will contain the IDL window number of the fully visible window. This window number can be used with the WSET procedure to draw to the scrolling window at a later point.

## GROUP

Set this keyword to the widget ID of the widget that calls SLIDE_IMAGE. If set, the death of the caller results in the death of SLIDE_IMAGE.

## ORDER

This keyword is passed directly to the TV procedure to control the order in which the images are drawn. Usually, images are drawn from the bottom up. Set this keyword to a non-zero value to draw images from the top down.

## REGISTER

Set this keyword to create a “Done” button for SLIDE_IMAGE and register the widgets with the XMANAGER procedure.

The basic widgets used in this procedure do not generate widget events, so it is not necessary to process events in an event loop. The default is therefore to simply create the widgets and return. Hence, when REGISTER is not set, SLIDE_IMAGE can be displayed and the user can still type commands at the IDL command prompt.

## RETAIN

This keyword is passed directly to the WIDGET_DRAW function. RETAIN specifies how backing store should be handled for the window. Valid values are:

- 0 — Specifies no backing store. In this case, it is recommended that the REGISTER keyword be set so that expose and scroll events are handled.

- 1 — Requests that the server or window system provide backing store. This is the default if RETAIN is not specified.
- 2 — Specifies that IDL provide backing store directly.

See “Backing Store” on page 3824 for details.

## SLIDE_WINDOW

Set this keyword to a named variable that will contain the IDL window number of the sliding window. This window number can be used with the WSET procedure to draw to the scrolling window at a later time.

## SHOW_FULL

Set this keyword to zero to show the entire image at full resolution in one scrolling graphics window. By default, SHOW_FULL is set, displaying two draw widgets.

**Note**

On Windows platforms only, using TVRD to return the array size of the displayed image will cause the returned array to be off by the size of the frame (one pixel per side). To return the dimensions of the original image, you must modify the `slide_image.pro` library routine so that the FRAME keyword is not used with SHOW_FULL.

## TITLE

Set this keyword to the title to be used for the SLIDE_IMAGE widget. If this keyword is not specified, “Slide Image” is used.

## TOP_ID

Set this keyword to a named variable that will contain the top widget ID of the SLIDE_IMAGE hierarchy. This ID can be used to kill the hierarchy as shown below:

```
SLIDE_IMAGE, TOP_ID=base, ...
WIDGET_CONTROL, /DESTROY, base
```

## XSIZE

Set this keyword to the maximum width of the image that can be displayed by the scrolling window. This keyword should not be confused with the visible size of the image, controlled by the XVISIBLE keyword. If XSIZE is not specified, the width of *Image* is used. If *Image* is not specified, 256 is used.

### XVISIBLE

Set this keyword to the width of the viewport on the scrolling window. If this keyword is not specified, 256 is used.

### YSIZE

Set this keyword to the maximum height of the image that can be displayed by the scrolling window. This keyword should not be confused with the visible size of the image, controlled by the YVISIBLE keyword. If YSIZE is not present the height of *Image* is used. If *Image* is not specified, 256 is used.

### YVISIBLE

Set this keyword to the height of the viewport on the scrolling window. If this keyword is not present, 256 is used.

## Examples

Open an image from the IDL distribution and load it into SLIDE_IMAGE:

```
; Create a variable to hold the image:
image = BYTARR(768,512)

OPENR, unit, FILEPATH('nyny.dat', SUBDIR=['examples','data']),
/GET_LUN
READU, unit, image
CLOSE, unit

; Scale the image into byte range of the display:
image = BYTSCL(image)

; Display the image:
SLIDE_IMAGE, image
```

## Version History

Introduced: Pre 4.0

## See Also

IIMAGE, TV, TVSCL, WIDGET_DRAW, WINDOW

# SMOOTH

The SMOOTH function returns a copy of *Array* smoothed with a boxcar average of the specified width. The result has the same type and dimensions as *Array*. The algorithm used by SMOOTH is:

$$R_i = \begin{cases} \frac{1}{w}\sum_{j=0}^{w-1} A_{i+j-w/2}, & i = \frac{(w-1)}{2}, \ldots, N - \frac{(w+1)}{2} \\ A_i, \text{ otherwise} & \end{cases}$$

where *N* is the number of elements in A.

## Syntax

*Result* = SMOOTH( *Array*, *Width* [, /EDGE_TRUNCATE] [, MISSING=*value*] [, /NAN] )

## Return Value

Returns the smoothed array, which has the same dimensions as the input array.

## Arguments

### Array

The array to be smoothed. *Array* can have any number of dimensions.

### Width

The width of the smoothing window. *Width* can either be a scalar or a vector with length equal to the number of dimensions of *Array*. If *Width* is a scalar then the same width is applied for each dimension that has length greater than 1 (dimensions of length 1 are skipped). If *Width* is a vector, then each element of *Width* is used to specify the smoothing width for each dimension of *Array*. Values for *Width* must be smaller than the corresponding *Array* dimension. If a *Width* value is even, then *Width*+1 will be used instead. The value of *Width* does not affect the running time of SMOOTH to a great extent.

**Note**

A Width value of zero or 1 implies no smoothing. However, if the NAN keyword is set, then any NaN values within the Array will be treated as missing data and will be replaced.

**Tip**

For a multi-dimensional array, set widths to 1 within the Width vector for dimensions that you don't want smoothed.

# Keywords

## EDGE_TRUNCATE

Set this keyword to apply the smoothing function to all points. If the neighborhood around a point includes a point outside the array, the nearest edge point is used to compute the smoothed result. If EDGE_TRUNCATE is not set, the end points are copied from the original array to the result with no smoothing.

For example, when smoothing an *n*-element vector with a three point wide smoothing window, the first point of the result $R_0$ is equal to $A_0$ if EDGE_TRUNCATE is not set, but is equal to $(A_0+A_0+A_1)/3$ if the keyword is set. In the same manner, point $R_{n-1}$ is set to $A_{n-1}$ if EDGE_TRUNCATE is not set, or to $(A_{n-2}+A_{n-1}+A_{n-1})/3$ if it is.

Points not within a distance of *Width*/2 from an edge are not affected by this keyword.

**Note**

Normally, two-dimensional floating-point arrays are smoothed in one pass. If both the EDGE_TRUNCATE and NAN keywords are specified for a two-dimensional array, the result is obtained in two passes, one for each dimension. Therefore, the results may differ slightly when both the EDGE_TRUNCATE and NAN keywords are set.

## MISSING

The value to return for elements that contain no valid points within the kernel. The default is the IEEE floating-point value NaN. This keyword is only used if the NAN keyword is set.

## NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. (See “Special Floating-Point Values” in Chapter 18

of the *Building IDL Applications* manual for more information on IEEE floating-point values.) Elements with the value NaN are treated as missing data, and are ignored when computing the smooth value for neighboring elements. In the *Result*, missing elements are replaced by the smoothed value of all other valid points within the smoothing window. If all points within the window are missing, then the result at that point is given by the MISSING keyword.

**Note**

SMOOTH should never be called without the NAN keyword if the input array may possibly contain NaN values.

## Examples

Create and display a simple image by entering:

```
WINDOW, XSIZE=800, YSIZE=400
D = SIN(DIST(256)/3)
TVSCL, D
```

Now display the same dataset smoothed with a width of 9 in each dimension by entering:

```
TVSCL, SMOOTH(D, 9), 256, 0
```

Now smooth only in the vertical direction with a width of 15:

```
TVSCL, SMOOTH(D, [1, 15]), 512, 0
```

## Version History

Introduced: Original

## See Also

DIGITAL_FILTER, LEEFILT, MEDIAN, TS_DIFF, TS_FCAST, TS_SMOOTH

# SOBEL

The SOBEL function returns an approximation to the Sobel edge enhancement operator for images,

$$G_{jk} = |G_x| + |G_y|$$

$$G_Y = F_{j-1,\,k-1} + 2F_{j,\,k-1} + F_{j+1,\,k-1} - (F_{j-1,\,k+1} + 2F_{j,\,k+1} + F_{j+1,\,k+1})$$

$$G_X = F_{j+1,\,k+1} + 2F_{j+1,\,k} + F_{j+1,\,k-1} - (F_{j-1,\,k+1} + 2F_{j-1,\,k} + F_{j-1,\,k-1})$$

where (*j*, *k*) are the coordinates of each pixel $F_{jk}$ in the *Image*. This is equivalent to a convolution using the masks,

$$\text{X mask} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad \text{Y mask} = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

All of the edge points in the result are set to zero.

## Syntax

*Result* = SOBEL(*Image*)

## Return Value

SOBEL returns a two-dimensional array of the same size as *Image*. If *Image* is of type byte or integer then the result is of integer type, otherwise the result is of the same type as *Image*.

**Note**

To avoid overflow for integer types, the computation is done using the next larger signed type and the result is transformed back to the correct type. Values larger than the maximum for that integer type are truncated. For example, for integers the

function is computed using type long, and on output, values larger than 32767 are set equal to 32767.

## Arguments

### Image

The two-dimensional array containing the image to which edge enhancement is applied.

## Keywords

None.

## Examples

If the variable `myimage` contains a two-dimensional image array, a Sobel sharpened version of `myimage` can be displayed with the command:

```
TVSCL, SOBEL(myimage)
```

## Version History

Introduced: Original

## See Also

ROBERTS

# SOCKET

The SOCKET procedure, supported on UNIX and Microsoft Windows platforms, opens a client-side TCP/IP Internet socket as an IDL file unit. Such files can be used in the standard manner with any of IDL's Input/Output routines.

**Tip**

RSI recommends that you don't use the EOF procedure as a way to check to see if a socket is empty. It is recommended that you structure your communication across the socket so that using EOF is not necessary to know when the communication is complete.

## Syntax

SOCKET, *Unit*, *Host*, *Port* [, CONNECT_TIMEOUT=*value*] [, ERROR=*variable*] [, /GET_LUN] [, /RAWIO] [, READ_TIMEOUT=*value*] [, /SWAP_ENDIAN] [, /SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN] [, WIDTH=*value*] [, WRITE_TIMEOUT=*value*]

**UNIX-Only Keywords:** [, /STDIO]

## Arguments

### Unit

The unit number to associate with the opened socket.

### Host

The name of the host to which the socket is connected. This can be either a standard Internet host name (e.g. `ftp.RSInc.com`) or a dot-separated numeric address (e.g. `192.5.156.21`).

### Port

The port to which the socket is connected on the remote machine. If this is a well-known port (as contained in the `/etc/services` file on a UNIX host), then you can specify its name (e.g. daytime); otherwise, specify a number.

# Keywords

## CONNECT_TIMEOUT

Set this keyword to the number of seconds to wait before giving up and issuing an error to shorten the connect timeout from the system-supplied default. Most experts recommend that you not specify an explicit timeout, and instead use your operating system defaults.

**Note**

Although you can use CONNECT_TIMEOUT to shorten the timeout, you cannot increase it past the system-supplied default.

## ERROR

A named variable in which to place the error status. If an error occurs in the attempt to open File, IDL normally takes the error handling action defined by the ON_ERROR and/or ON_IOERROR procedures. SOCKET always returns to the caller without generating an error message when ERROR is present. A nonzero error status indicates that an error occurred. The error message can then be found in the system variable !ERROR_STATE.MSG.

## GET_LUN

Set this keyword to use the GET_LUN procedure to set the value of *Unit* before the file is opened. Instead of using the two statements:

```
GET_LUN, Unit
OPENR, Unit, 'data.dat'
```

you can use the single statement:

```
OPENR, Unit, 'data.dat', /GET LUN
```

## RAWIO

Set this keyword to disable all use of the standard operating system I/O for the file, in favor of direct calls to the operating system. This allows direct access to devices, such as tape drives, that are difficult or impossible to use effectively through the standard I/O. Using this keyword has the following implications:

- No formatted or associated (ASSOC) I/O is allowed on the file. Only READU and WRITEU are allowed.

- Normally, attempting to read more data than is available from a file causes the unfilled space to be set to zero and an error to be issued. This does not happen with files opened with RAWIO. When using RAWIO, the programmer must check the transfer count, either via the TRANSFER_COUNT keywords to READU and WRITEU, or the FSTAT function.
- The EOF and POINT_LUN functions cannot be used with a file opened with RAWIO.
- Each call to READU or WRITEU maps directly to UNIX read(2) and write(2) system calls. The programmer must read the UNIX system documentation for these calls and documentation on the target device to determine if there are any special rules for I/O to that device. For example, the size of data that can be transferred to many cartridge tape drives is often forced to be a multiple of 512 bytes.

## READ_TIMEOUT

Set this keyword to the number of seconds to wait for data to arrive before giving up and issuing an error. By default, IDL blocks indefinitely until the data arrives. Typically, this option is unnecessary on a local network, but it is useful with networks that are slow or unreliable.

## STDIO (UNIX Only)

Under UNIX, forces the file to be opened via the standard C I/O library (stdio) rather than any other more native OS API that might usually be used. This is primarily of interest to those who intend to access the file from external code, and is not necessary for most uses.

**Note**

Under Windows, the STDIO feature is not possible. Requesting it causes IDL to throw an error.

## SWAP_ENDIAN

Set this keyword to swap byte ordering for multi-byte data when performing binary I/O on the specified file. This is useful when accessing files also used by another system with byte ordering different than that of the current host.

### SWAP_IF_BIG_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has big endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

### SWAP_IF_LITTLE_ENDIAN

Setting this keyword is equivalent to setting SWAP_ENDIAN; it only takes effect if the current system has little endian byte ordering. This keyword does not refer to the byte ordering of the input data, but to the computer hardware.

### WIDTH

The desired output width. When using the defaults for formatted output, IDL uses the following rules to determine where to break lines:

- If the output file is a terminal, the terminal width is used.
- Otherwise, a default of 80 columns is used.

The WIDTH keyword allows the user to override this default.

### WRITE_TIMEOUT

Set this keyword to the number of seconds to wait to send data before giving up and issuing an error. By default, IDL blocks indefinitely until it is possible to send the data. Typically, this option is unnecessary on a local network, but it is useful with networks that are slow or unreliable.

## Examples

Most UNIX systems maintain a daytime server on the daytime port (port 13). These servers send a 1 line response when connected to, containing the current time of day.

```
; To obtain the current time from the host bullwinkle:
SOCKET, 1, 'bullwinkle','daytime'
date=''
READF, 1, date
CLOSE, 1
PRINT, date
```

IDL prints:

```
Wed Sep 15 17:20:27 1999
```

## Version History

Introduced: 5.3

SWAP_IF_BIG_ENDIAN, SWAP_IF_LITTLE_ENDIAN keywords added: 5.6

# SORT

The SORT function returns a vector of subscripts that allow access to the elements of *Array* in ascending order.

## Syntax

*Result* = SORT(*Array* [, /L64] )

## Return Value

The result is always a vector of integer type with the same number of elements as *Array.*

## Arguments

### Array

The array to be sorted. *Array* can be any basic type of vector or array. String arrays are sorted using the ASCII collating sequence. Complex arrays are sorted by their magnitude. Array values which are Not A Number (NaN) are moved to the end of the resulting array.

## Keywords

### L64

By default, the result of SORT is 32-bit integer when possible, and 64-bit integer if the number of elements being sorted requires it. Set L64 to force 64-bit integers to be returned in all cases.

**Note**

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit sort. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

## Examples

### Example 1

```
A = [4, 3, 7, 1, 2]
PRINT, 'SORT(A) = ', SORT(A)
```

```
; Display the elements of A in sorted order:
PRINT, 'Elements of A in sorted order: ', A[SORT(A)]

; Display the elements of A in descending order:
PRINT, 'Elements of A in descending order: ', A[REVERSE(SORT(A))]
```

IDL prints:

```
SORT(A) =   3   4   1   0   2
Elements of A in sorted order:   1   2   3   4   7
Elements of A in descending order:   7   4   3   2   1
```

SORT(A) returns “`3 4 1 0 2`” because:

A[3] < A[4] < A[1] < A[0] < A[2]

### Example 2

#### Sorting NaN Values

When sorting data including Not A Number (NaN) values, the NaN entries are moved to the end of the resulting array. For example:

```
values = [ 500, !VALUES.F_NAN, -500 ]
PRINT, SORT(values)
```

IDL prints:

```
2           0           1
```

## Version History

Introduced: Original

## See Also

REVERSE, UNIQ, WHERE

# SPAWN

The SPAWN procedure spawns a child process to execute a command or series of commands. The result of calling SPAWN depends on the platform on which it is being used:

- Under UNIX, the shell used (if any) is obtained from the SHELL environment variable. The NOSHELL keyword can be used to execute a command directly as a child process without starting a shell process.
- Under Windows, a Command Shell is opened. The NOSHELL keyword can be used to execute the specified command directly without starting an intermediate command interpreter shell.

**Note**

See "Using SPAWN Without a Shell Under UNIX" on page 1851 for notes on executing commands without using a shell process under UNIX. See "Execution Directory under Microsoft Windows" on page 1851 for a caution regarding Windows network paths.

If SPAWN is called without arguments, an interactive command interpreter process is started, in which you can enter one or more operating system commands.

By default, IDL waits for the child process started by SPAWN to finish before it continues. It is possible to have IDL instead continue execution in parallel with the child process. The syntax for this depends on the operating system on your system:

- Under UNIX, include an ampersand (&) at the end of your shell command.
- Under Windows, specify the NOWAIT keyword to SPAWN.

**Note**

For more information on using SPAWN, see the *External Development Guide*.

## Syntax

SPAWN [, *Command* [, *Result*] [, *ErrResult*] ]

**Keywords (all platforms):** [, COUNT=*variable*] [, EXIT_STATUS=*variable*] [ ,/NOSHELL] [, /NULL_STDIN] [, PID=*variable*] [, /STDERR]

**UNIX-Only Keywords:** [, /NOTTYRESET] [, /SH] [, /UNIT=*variable* {*Command* required, *Result* not allowed}]

**Windows-Only Keywords:** [, /HIDE] [, /LOG_OUTPUT] [, /NOWAIT]

# Arguments

## Command

A string containing the commands to be executed.

If *Command* is present, it must be specified as follows:

- On UNIX, *Command* is expected to be scalar unless used in conjunction with the NOSHELL keyword, in which case *Command* is expected to be a string array where each element is passed to the child process as a separate argument.
- On Windows, *Command* can be a scalar string or string array. If it is a string array, SPAWN glues together each element of the string array, with each element separated by whitespace.

If *Command* is not present, SPAWN starts an interactive command interpreter process, which you can use to enter one or more operating system commands. While you use the command interpreter process, IDL is suspended. Under Windows, an interactive command shell window is created for this purpose. UNIX spawn does not create a separate window, but simply runs on the user's current tty, using the default shell (as specified by the SHELL environment variable). The SH keyword can be used to force use of the Bourne shell (`/bin/sh`).

**Note**

Using SPAWN in this manner is equivalent to using the IDL $ command. The difference between these two is that $ can only be used interactively while SPAWN can be used interactively or in IDL programs

## Result

A named variable in which to place the output from the child process. Each line of output becomes a single array element. If *Result* is not present, the output from the child shell process goes to the standard output (usually the terminal).

## ErrResult

A named variable in which to place the error output (stderr) from the child process. Each line of output becomes a single array element. If *ErrResult* is not present, the error output from the child shell process goes to the standard error file.

**Note**

See the STDERR keyword for another error stream option.

# Keywords

## COUNT

If *Result* is present and this keyword is also specified, COUNT specifies a named variable into which the number of lines of output is placed. This value gives the number of elements placed into *Result*.

## EXIT_STATUS

Set this keyword to a named variable in which the exit status for the child process is returned. The meaning of this value is operating system dependent:

- Under UNIX, it is the value passed by the child to exit(2), and is analogous to the value returned by $? under most UNIX shells. If the UNIT keyword is used, this keyword always returns 0. In this case, use the EXIT_STATUS keyword to FREE_LUN or CLOSE to determine the final exit status of the process.
- Under Windows, it is the value returned by the Win32 GetExitCodeProcess() system function. If the NOWAIT keyword is set, EXIT_STATUS returns 0.

## HIDE (WINDOWS Only)

If HIDE is set, the command interpreter shell window is minimized to prevent the user from seeing it.

## LOG_OUTPUT (WINDOWS Only)

Normally, IDL starts a command interpreter shell, and output from the child process is displayed in the command interpreter's window. If LOG_OUTPUT is set, the command interpreter window is minimized (as with HIDE) and all output is diverted to the IDLDE log window. If the *Result* or *ErrResult* arguments are present, they take precedence over LOG_OUTPUT.

## NOSHELL

Set this keyword to specify that *Command* should execute directly as a child process without an intervening shell process.

- UNIX – When using the NOSHELL keyword under UNIX, you must specify *Command* as a string array in which the first element is the name of the command to execute and the following arguments are the arguments to be passed to the command. See "Using SPAWN Without a Shell Under UNIX" on page 1851 for notes on executing commands without using a shell process.
- Windows – Use this keyword to start the specified *Command* directly, without the use of an intervening command shell. This is useful for Windows programs that do not require a console, such as Notepad.

  Many common DOS commands (e.g. DIR) are not distinct programs, and are instead implemented as part of the command interpreter. Specifying NOSHELL with such commands results in the command not being found. In such cases, the HIDE keyword might be useful.

## NOTTYRESET (UNIX Only)

Some UNIX systems drop characters when the tty mode is switched between normal and raw modes. IDL switches between these modes when reading command input and when using the GET_KBRD function. On such systems, IDL avoids losing characters by delaying the switch back to normal mode until it is truly needed. This method has the benefit of avoiding the large number of mode changes that would otherwise be necessary. Routines that cause output to be sent to the standard output (e.g., I/O operations, user interaction and SPAWN) ensure that the tty is in its normal mode before performing their operations.

If the NOTTYRESET keyword is set, SPAWN does not switch the tty back to normal mode before launching the child process assuming instead that the child will not send output to the tty. Use this keyword to avoid characters being dropped in a loop of the form:

```
WHILE (GET_KBRD(0) NE 'q') SPAWN, command
```

This keyword has no effect on systems that don't suffer from dropped characters.

## NOWAIT (WINDOWS Only)

If this keyword is set, the IDL process continues executing in parallel with the subprocess. Normally, the IDL process suspends execution until the subprocess completes.

## NULL_STDIN

If set, the null device is connected to the standard input of the child process. The null device is either `/dev/null` (under UNIX) or NUL (under Windows).

## PID

A named variable into which the Process Identification number of the child process is stored.

## SH (UNIX Only)

Set this keyword to force the use of the Bourne shell (`/bin/sh`). Usually, the shell used is determined by the SHELL environment variable.

## STDERR

If set, the child's error output (stderr) is combined with the standard output and returned in *Result*. STDERR and the *ErrResult* argument are mutually exclusive. You should use one or the other, but not both.

## UNIT (UNIX Only)

If UNIT is present, SPAWN creates a child process in the usual manner, but instead of waiting for the specified command to finish, it attaches a bidirectional pipe between the child process and IDL. From the IDL session, the pipe appears as a logical file unit. The other end of the pipe is attached to the child process standard input and output. The UNIT keyword specifies a named variable into which the number of the file unit is stored.

Once the child process is started, the IDL session can communicate with it through the usual input/output facilities. After the child process has done its task, the CLOSE procedure can be used to kill the process and close the pipe. Since SPAWN uses GET_LUN to allocate the file unit, FREE_LUN should be used to free the unit.

If UNIT is present, *Command* must be present, and *Result* is not allowed.

## Obsolete Keywords

The following keywords are obsolete:

- FORCE
- MACCREATOR
- NOCLISYM
- NOLOGNAM
- NOTIFY

For information on obsolete keywords, See Appendix I, "Obsolete Features".

## Using SPAWN Without a Shell Under UNIX

When a Unix program is run, its name and arguments are provided to it as an array of strings, one string per argument. The first string is the name of the program, and the remainder (if any) are the arguments. C programmers will recognize this as the standard (argc, argv) arguments passed to the main() function when the program is run. When you execute a command via a Unix shell, one of the operations that the shell carries out for you is to split the command and arguments apart on whitespace boundaries (blanks and tabs) to create this array of arguments. It then runs the program for you, using one of the Unix system exec() functions.

By default, SPAWN creates a shell process and passes the command to this shell instead of simply creating a child process to directly execute the command. Use of a shell is the default because the shell provides useful facilities such as wildcard expansion and argument processing (described above). Although this is usually desirable, it has the drawback of being slower than necessary, and of using an additional process for the shell.

When SPAWN is called with the NOSHELL keyword set, the command is executed as a direct child process, avoiding the extra overhead of starting a shell. This is faster, but since there is no shell, you must specify the arguments in the standard form required by Unix programs. When you specify the NOSHELL keyword, the Command argument should be a string array. The first element of the array is the name of the command to use, and the following elements contain the arguments.

For example, consider the command,

```
SPAWN, 'ps ax'
```

that uses the UNIX *ps* command to show running processes on the computer. To issue this command without a shell, you would write it as follows:

```
SPAWN, ['ps', 'ax'], /NOSHELL
```

## Execution Directory under Microsoft Windows

SPAWN attempts to use IDL's current working directory as the current directory for the spawned process. However, Microsoft Windows does not support the specification of a UNC path as the current directory for a Command Shell. Issuing a SPAWN command when IDL's current working directory is set to a UNC path will cause Windows to generate an error that looks something like:

```
CMD.EXE was started with '\\host\dir' as the current directory
path. UNC paths are not supported.  Defaulting to Windows
directory.
```

If your application requires that you be able to use SPAWN when IDL's current working directory is set to a directory on a Windows network, consider mapping the UNC path to a Windows drive letter and setting that to be IDL's working directory.

# Examples

## Example 1: Interactive use of SPAWN

To simply spawn a shell process from within IDL, enter the command:

```
SPAWN
```

To execute the UNIX `ls` command and return to the IDL prompt, enter:

```
SPAWN, 'ls'
```

To execute the UNIX `ls` command and store the result in the IDL string variable `listing`, enter:

```
SPAWN, 'ls', listing
```

## Example 2: Noninteractive use of SPAWN

It is sometimes useful to create a temporary scratch file, removing the file when it is no longer needed. SPAWN could be used as shown below to manage the removal of the scratch file.

```
OPENW, UNIT, 'scratch.dat', /GET_LUN

;...IDL commands go here.

;Deallocate the file unit and close the file.
FREE_LUN, UNIT

;Use the !VERSION system variable to determine the proper file
;deletion command for the current operating system.
CASE !VERSION.OS OF
  'Windows': CMD = 'DEL'
  ELSE: CMD = 'rm'
ENDCASE

;Delete the file using SPAWN.
SPAWN, CMD + ' scratch.dat'

END
```

**Note**

The DELETE keyword to the OPEN procedure or the FILE_DELETE procedure more efficiently handles this job. The above example should serve only to demonstrate use of the SPAWN procedure.

## Version History

Introduced: Original

## See Also

"Dollar Sign ($)" on page 3945, Chapter 2, "Using SPAWN and UNIX Pipes" in the *External Development Guide* manual

# SPH_4PNT

Given four 3-dimensional points, the SPH_4PNT procedure returns the center and radius necessary to define the unique sphere passing through those points.

This routine is written in the IDL language. Its source code can be found in the file `sph_4pnt.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SPH_4PNT, *X*, *Y*, *Z*, *Xc*, *Yc*, *Zc*, *R* [, /DOUBLE]

## Arguments

### X, Y, Z

4-element floating-point or double-precision vectors containing the X, Y, and Z coordinates of the points.

### Xc, Yc, Zc

Named variables that will contain the sphere's center X, Y, and Z coordinates.

### R

A named variable that will contain the sphere's radius.

## Keywords

### DOUBLE

Set this keyword to force computations to be done in double-precision arithmetic.

## Examples

Find the center and radius of the unique sphere passing through the points: (1, 1, 0), (2, 1, 2), (1, 0, 3), (1, 0, 1):

```
; Define the floating-point vectors containing the x, y and z
; coordinates of the points:
X = [1, 2, 1, 1] + 0.0
Y = [1, 1, 0, 0] + 0.0
Z = [0, 2, 3, 1] + 0.0
```

```
; Compute sphere’s center and radius:
SPH_4PNT, X, Y, Z, Xc, Yc, Zc, R

; Print the results:
PRINT, Xc, Yc, Zc, R
```

IDL prints:

```
-0.500000      2.00000      2.00000      2.69258
```

## Version History

Introduced: Pre 4.0

## See Also

CIR_3PNT, PNT_LINE

# SPH_SCAT

The SPH_SCAT function performs spherical gridding. Scattered samples on the surface of a sphere are interpolated to a regular grid. This routine is a convenient interface to the spherical gridding and interpolation provided by TRIANGULATE and TRIGRID.

This routine is written in the IDL language. Its source code can be found in the file `sph_scat.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = SPH_SCAT( *Lon*, *Lat*, *F* [, BOUNDS=*[lonmin, latmin, lonmax, latmax]*] [, BOUT=*variable*] [, GOUT=*variable*] [, GS=*[lonspacing, latspacing]*] [, NLON=*value*] [, NLAT=*value*] )

## Return Value

Returns a regularly-interpolated grid of the function.

## Arguments

### Lon

A vector of sample longitudes, in degrees.

**Note**

*Lon*, *Lat*, and *F* must all have the same number of points.

### Lat

A vector of sample latitudes, in degrees.

### F

A vector of data values which are functions of Lon and Lat. $F_i$ represents a value at ($Lon_i$, $Lat_i$).

# Keywords

## BOUNDS

Set this keyword to a four-element vector containing the grid limits in longitude and latitude of the output grid. The four elements are: [$Lon_{min}$, $Lat_{min}$, $Lon_{max}$, $Lat_{max}$]. If this keyword is not set, the grid limits are set to the extent of *Lon* and *Lat*.

**Note**

To cover all longitudes, you must explicitly specify the values for the BOUNDS keyword.

## BOUT

Set this keyword to a named variable that, on return, contains a four-element vector (similar to BOUNDS) that describes the actual extent of the regular grid.

## GOUT

Set this keyword to a named variable that, on return, contains a two-element vector (similar to GS) that describes the actual grid spacing.

## GS

Set this keyword to a two-element vector that specifies the spacing between grid points in longitude (the first element) and latitude (the second element).

If this keyword is not set, the default value is based on the extents of *Lon* and *Lat*. The default longitude spacing is ($Lon_{max}$ - $Lon_{min}$)/(NLON-1). The default latitude spacing is ($Lat_{max}$ - $Lat_{min}$)/(NLAT-1). If NLON and NLAT are not set, the default grid size of 26 by 26 is used for NLON and NLAT.

## NLON

The output grid size in the longitude direction. The default value is 26.

**Note**

NLON need not be specified if the size can be inferred from GS and BOUNDS.

## NLAT

The output grid size in the latitude direction. The default value is 26.

**Note**

NLAT need not be specified if the size can be inferred from GS and BOUNDS.

## Examples

```
; Create some random longitude points:
lon = RANDOMU(seed, 50) * 360. -180.

; Create some random latitude points:
lat = RANDOMU(seed, 50) * 180. -90.

; Make a function to fit:
z = SIN(lat*!DTOR)
c = COS(lat*!DTOR)
x = COS(lon*!DTOR) * c
y = SIN(lon*!DTOR) * c

; The finished dependent variable:
f = SIN(x+y) * SIN(x*z)
; Interpolate the data and return the result in variable r:
r = SPH_SCAT(lon, lat, f, BOUNDS=[0, -90, 350, 85], GS=[10,5])
```

## Version History

Introduced: 4.0

## See Also

TRIANGULATE, TRIGRID

# SPHER_HARM

The SPHER_HARM function returns the value of the spherical harmonic $Y_{lm}(\theta,\phi)$, $-l \le m \le l$, $l \ge 0$, which is a function of two coordinates on a spherical surface.

The spherical harmonics are related to the associated Legendre polynomial by:

$$Y_{lm}(\theta,\phi) = \sqrt{\frac{2l+1}{4\pi}\frac{(l-m)!}{(l+m)!}}P_l^m(\cos\theta)e^{im\phi}$$

For negative *m* the following relation is used:

$$Y_{1,-m}(\theta,\phi) = (-1)^m Y_{lm}^*(\theta,\phi)$$

where * represents the complex conjugate.

This routine is written in the IDL language. Its source code can be found in the file `spher_harm.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = SPHER_HARM( *Theta*, *Phi*, *L*, *M*, [, /DOUBLE] )

## Return Value

SPHER_HARM returns a complex scalar or array containing the value of the spherical harmonic function. The return value has the same dimensions as the input arguments *Theta* and *Phi*. If one argument (*Theta* or *Phi*) is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If either *Theta* or *Phi* are double-precision or if the DOUBLE keyword is set, the result is double-precision complex, otherwise the result is single-precision complex.

## Arguments

### Theta

The value of the polar (colatitudinal) coordinate $\theta$ at which $Y_{lm}(\theta,\phi)$ is evaluated. *Theta* can be either a scalar or an array.

### Phi

The value of the azimuthal (longitudinal) coordinate ϕ at which $Y_{lm}(\theta,\phi)$ is evaluated. *Phi* can be either a scalar or an array.

### L

A scalar integer, $L \geq 0$, specifying the order *l* of $Y_{lm}(\theta,\phi)$. If *L* is of type float, it will be truncated.

### M

A scalar integer, $-L \leq M \leq L$, specifying the azimuthal order *m* of $Y_{lm}(\theta,\phi)$. If *M* is of type float, it will be truncated.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

This example visualizes the electron probability density for the hydrogen atom in state 3d0. (Feynman, Leighton, and Sands, 1965: The Feynman Lectures on Physics, Calif. Inst. Tech, Ch. 19):

```
; Define a data cube (N x N x N)
n = 41L
a = 60*FINDGEN(n)/(n-1) - 29.999  ; [-1,+1]
x = REBIN(a, n, n, n)              ; X-coordinates of cube
y = REBIN(REFORM(a,1,n), n, n, n)  ; Y-coordinates
z = REBIN(REFORM(a,1,1,n), n, n, n); Z-coordinates

; Convert from rectangular (x,y,z) to spherical (phi, theta, r)
spherCoord = CV_COORD(FROM_RECT= $
 TRANSPOSE([[x[*]],[y[*]],[z[*]]]), /TO_SPHERE)
phi = REFORM(spherCoord[0,*], n, n, n)
theta = REFORM(!PI/2 - spherCoord[1,*], n, n, n)
r = REFORM(spherCoord[2,*], n, n, n)

; Find electron probability density for hydrogen atom in state 3d0
; Angular component
L = 2   ; state "d" is electron spin L=2
M = 0   ; Z-component of spin is zero
angularState = SPHER_HARM(theta, phi, L, M)
```

```
; Radial component for state n=3, L=2
radialFunction = EXP(-r/2)*(r^2)
waveFunction = angularState*radialFunction
probabilityDensity = ABS(waveFunction)^2

SHADE_VOLUME, probabilityDensity, $
 0.1*MEAN(probabilityDensity), vertex, poly
oPolygon = OBJ_NEW('IDLgrPolygon', vertex, $
 POLYGON=poly, COLOR=[180,180,180])
XOBJVIEW, oPolygon
```

The results are shown in the following figure (rotated in XOBJVIEW for clarity):

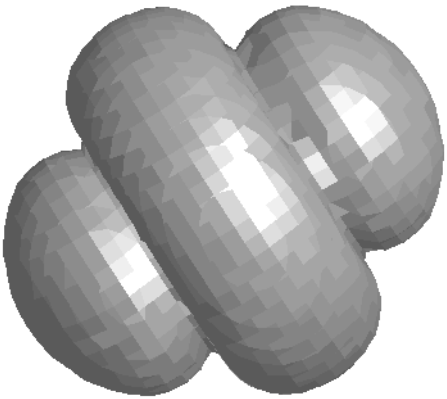


*Figure 29: SPHER_HARM Example of Hydrogen Atom (object rotated in XOBJVIEW for clarity)*

## Version History

Introduced: 5.4

## See Also

LEGENDRE, LAGUERRE

# SPL_INIT

The SPL_INIT function is called to establish the type of interpolating spline for a tabulated set of functional values $X_i$, $Y_i = F(X_i)$.

It is important to realize that SPL_INIT should be called only *once* to process an entire tabulated function in arrays *X* and *Y*. Once this has been done, values of the interpolated function for any value of *X* can be obtained by calls (as many as desired) to the separate function SPL_INTERP.

SPL_INIT is based on the routine spline described in section 3.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = SPL_INIT( *X*, *Y* [, /DOUBLE] [, YP0=*value*] [, YPN_1=*value*] )

## Return Value

Returns the values of the 2nd derivative of the interpolating function at the points $X_i$.

## Arguments

### X

An *n*-element input vector that specifies the tabulate points in ascending order.

### Y

An *n*-element input vector that specifies the values of the tabulated function $F(X_i)$ corresponding to $X_i$.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### YP0

The first derivative of the interpolating function at the point $X_0$. If YP0 is omitted, the second derivative at the boundary is set to zero, resulting in a “natural spline.”

### YPN_1

The first derivative of the interpolating function at the point $X_{n-1}$. If YPN_1 is omitted, the second derivative at the boundary is set to zero, resulting in a “natural spline.”

## Examples

### Example 1

```
X = (FINDGEN(21)/20.) * 2.0*!PI
Y = SIN(X)
PRINT, SPL_INIT(X, Y, YP0 = -1.1, YPN_1 = 0.0)
```

IDL Prints:

```
23.1552    -6.51599    1.06983   -1.26115  -0.839544    -1.04023
-0.950336  -0.817987  -0.592022  -0.311726  2.31192e-05  0.311634
 0.592347   0.816783   0.954825   1.02348   0.902068     1.02781
-0.198994   3.26597  -11.0260
```

### Example 2

```
PRINT, SPL_INIT(X, Y, YP0 = -1.1)
```

IDL prints:

```
23.1552    -6.51599    1.06983   -1.26115  -0.839544    -1.04023
-0.950336  -0.817988  -0.592020  -0.311732  4.41521e-05  0.311555
 0.592640   0.815690   0.958905   1.00825   0.958905     0.815692
 0.592635   0.311567   0.00000
```

## Version History

Introduced: 4.0

## See Also

SPL_INTERP, SPLINE, SPLINE_P

# SPL_INTERP

Given the arrays *X* and *Y*, which tabulate a function (with the $X_i$ in ascending order), and given the array $Y_2$, which is the output from SPL_INIT, and given an input value of $X_2$, the SPL_INTERP function returns a cubic-spline interpolated value for the given value of $X_I$.

SPL_INTERP is based on the routine `splint` described in section 3.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = SPL_INTERP( *X*, *Y*, *Y2*, *X2* [, /DOUBLE] )

## Return Value

Returns either single- or double-precision floating result of the same structure as $X_2$.

## Arguments

### X

An input array that specifies the tabulated points in ascending order.

### Y

An input array that specifies the values of the tabulate function corresponding to $X_i$.

### Y2

The output from SPL_INIT for the specified *X* and *Y*.

### X2

The input value for which an interpolated value is desired. *X* can be scalar or an array of values. The result of SPL_INTERP will have the same structure.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

To create a spline interpolation over a tabulated set of data, [$X_i$, $Y_i$], first create the tabulated data. In this example, $X_i$ will be in the range [0.0, $2\pi$] and $Y_i$ in the range [sin(0.0), sin($2\pi$)].

```
X = (FINDGEN(21)/20.0) * 2.0 * !PI
Y = SIN(X)

; Calculate interpolating cubic spline:
Y2 = SPL_INIT(X, Y)

; Define the X values P at which we desire interpolated Y values:
X2= FINDGEN(11)/11.0 * !PI

; Calculate the interpolated Y values corresponding to X2[i]:
result = SPL_INTERP(X, Y, Y2, X2)

PRINT, result
```

IDL prints:

```
 0.00000  0.281733  0.540638  0.755739  0.909613  0.989796
 0.989796  0.909613  0.755739  0.540638  0.281733
```

The exact solution vector is sin($X_2$).

To interpolate a line in the XY plane, see SPLINE_P.

# Version History

Introduced: 4.0

# See Also

SPL_INIT, SPLINE, SPLINE_P

# SPLINE

The SPLINE function performs cubic spline interpolation.

This routine is written in the IDL language. Its source code can be found in the file `spline.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = SPLINE( *X*, *Y*, *T* [, *Sigma*] )

## Return Value

Returns the result of the cubic spline interpolation.

## Arguments

### X

The abscissa vector. Values *must* be monotonically increasing.

### Y

The vector of ordinate values corresponding to *X*.

### T

The vector of abscissa values for which the ordinate is desired. The values of *T must* be monotonically increasing.

### Sigma

The amount of “tension” that is applied to the curve. The default value is 1.0. If sigma is close to 0, (e.g., .01), then effectively there is a cubic spline fit. If sigma is large, (e.g., greater than 10), then the fit will be like a polynomial interpolation.

## Keywords

None.

## Examples

The commands below show a typical use of SPLINE:

```
; X values of original function:
X = [2.,3.,4.]

; Make a quadratic
Y = (X-3)^2
;Values for interpolated points:
T = FINDGEN(20)/10.+2

; Do the interpolation:
Z = SPLINE(X,Y,T)
```

## Version History

Introduced: Original

## See Also

SPL_INIT, SPLINE_P

# SPLINE_P

The SPLINE_P procedure performs parametric cubic spline interpolation with relaxed or clamped end conditions.

This routine is both more general and faster than the SPLINE function. One call to SPLINE_P is equivalent to two calls to SPLINE, as both the X and Y are interpolated with splines. It is suited for interpolating between randomly placed points, and the abscissa values need not be monotonic. In addition, the end conditions may be optionally specified via tangents.

This routine is written in the IDL language. Its source code can be found in the file `spline_p.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SPLINE_P, *X*, *Y*, *Xr*, *Yr* [, INTERVAL=*value*] [, TAN0=*[$X_0$, $Y_0$]*] [, TAN1=*[$X_{n-1}$, $Y_{n-1}$]*]

## Arguments

### X

The abscissa vector. *X* should be floating-point or double-precision.

### Y

The vector of ordinate values corresponding to X. *Y* should be floating-point or double-precision.

Neither X or Y need be monotonic.

### Xr

A named variable that will contain the abscissa values of the interpolated function.

### Yr

A named variable that will contain the ordinate values of the interpolated function.

# Keywords

## INTERVAL

Set this keyword equal to the desired interval in XY space between interpolants. If omitted, approximately 8 interpolants per XY segment will result.

## TAN0

The tangent to the spline curve at X[0], Y[0]. If omitted, the tangent is calculated to make the curvature of the result zero at the beginning. TAN0 is a two element vector, containing the X and Y components of the tangent.

## TAN1

The tangent to the spline curve at X[*n*-1], Y[*n*-1]. If omitted, the tangent is calculated to make the curvature of the result zero at the end. TAN1 is a two element vector, containing the X and Y components of the tangent.

# Examples

The commands below show a typical use of SPLINE_P:

```
; Abscissas for square with a vertical diagonal:
X = [0.,1,0,-1,0]

; Ordinates:
Y = [0.,1,2,1,0]

; Interpolate with relaxed end conditions:
SPLINE_P, X, Y, XR, YR

; Show it:
PLOT, XR, YR
```

As above, but with setting both the beginning and end tangents:

```
SPLINE_P, X, Y, XR, YR, TAN0=[1,0], TAN1=[1,0]
```

This yields approximately 32 interpolants.

As above, but with setting the interval to 0.05, making more interpolants, closer together:

```
SPLINE_P, X, Y, XR, YR, TAN0=[1,0], TAN1=[1,0], INTERVAL=0.05
```

This yields 116 interpolants and looks close to a circle.

## Version History

Introduced: Pre 4.0

## See Also

SPL_INIT, SPLINE

# SPRSAB

The SPRSAB function performs matrix multiplication on two row-indexed sparse arrays created by SPRSIN. The routine computes all components of the matrix products, but only stores those values whose absolute magnitude exceeds the threshold value.

SPRSAB is based on the routine `sprstm` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission. The difference between the two routines is that SPRSAB performs the matrix multiplication A∗B rather than $A*B^T$.

## Syntax

*Result* = SPRSAB( *A*, *B* [, /DOUBLE] [, THRESHOLD=*value*] )

## Return Value

The result is a row-indexed sparse array.

## Arguments

### A, B

Row-indexed sparse arrays created by the SPRSIN function.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### THRESHOLD

Use this keyword to set the criterion for deciding the absolute magnitude of the elements to be retained in sparse storage mode. For single-precision calculations, the default value is $1.0 \times 10^{-7}$. For double-precision calculations, the default is $1.0 \times 10^{-14}$.

## Examples

```
; Begin by creating two arrays:
A = [[ 5.0,  0.0, 0.0,  1.0], $
     [ 3.0, -2.0, 0.0,  1.0], $
     [ 4.0, -1.0, 0.0,  2.0], $
     [ 0.0,  3.0, 3.0,  1.0]]
B = [[ 1.0,  2.0, 3.0,  1.0], $
     [ 3.0, -3.0, 0.0,  1.0], $
     [-1.0,  3.0, 1.0,  2.0], $
     [ 0.0,  3.0, 3.0,  1.0]]

; Convert the arrays to sparse array format before multiplying.
; The variable SPARSE holds the result in sparse array form:
sparse = SPRSAB(SPRSIN(A), SPRSIN(B))

; Restore the sparse array structure to full storage mode:
result = FULSTR(sparse)

; Print the result:
PRINT, 'result:'
PRINT, result

; Check this result by multiplying the original arrays:
exact = B # A
PRINT, 'exact:'
PRINT, exact
```

IDL prints:

```
result:
 5.00000      13.0000      18.0000       6.00000
-3.00000      15.0000      12.0000       2.00000
 1.00000      17.0000      18.0000       5.00000
 6.00000       3.00000      6.00000      10.0000
exact:
 5.00000      13.0000      18.0000       6.00000
-3.00000      15.0000      12.0000       2.00000
 1.00000      17.0000      18.0000       5.00000
 6.00000       3.00000      6.00000      10.0000
```

## Version History

Introduced: 4.0

## See Also

FULSTR, LINBCG, SPRSAX, SPRSIN, SPRSTP, READ_SPR, WRITE_SPR

# SPRSAX

The SPRSAX function takes a row-indexed sparse array created by the SPRSIN function and multiplies it by an *n*-element vector to its right.

SPRSAX is based on the routine `sprsax` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = SPRSAX( *A*, *X* [, /DOUBLE] )

## Return Value

Returns a *n*-element vector.

## Arguments

### A

A row-indexed sparse array created by the SPRSIN function.

### X

An *n*-element right hand vector.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

```
; Begin by creating an array A:
A = [[ 5.0,  0.0, 0.0], $
     [ 3.0, -2.0, 0.0], $
     [ 4.0, -1.0, 0.0]]

; Define the right-hand vector:
X = [1.0, 2.0, -1.0]
```

```
; Convert to sparse format, then multiply by X:
result = SPRSAX(SPRSIN(A),X)

; Print the result:
PRINT, result
```

IDL prints:

```
5.00000     -1.00000      2.00000
```

## Version History

Introduced: 4.0

## See Also

FULSTR, LINBCG, SPRSAB, SPRSIN, SPRSTP, READ_SPR, WRITE_SPR

# SPRSIN

The SPRSIN function converts an array, or list of subscripts and values, into a row-index sparse storage mode, retaining only elements with an absolute magnitude greater than or equal to the specified threshold. The list form is much more efficient than the array form if the density of the matrix is low.

SPRSIN is based on the routine `sprsin` described in section 2.7 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = SPRSIN( *A* [, /COLUMN] [, /DOUBLE] [, THRESHOLD=*value*] )

or

*Result* = SPRSIN(*Columns*, *Rows*, *Values*, *N* [, /DOUBLE] [, THRESHOLD=*value*])

## Return Value

The result is a row-indexed sparse array contained in structure form. The structure consists of two linear sparse storage vectors: SA, a vector of array values, and IJA, a vector of subscripts to the SA vector. The length of these vectors is equal to 1 plus the number of diagonal elements of the array, plus the number of off-diagonal elements with an absolute magnitude greater that or equal to the threshold value. Diagonal elements of the array are always retained even if their absolute magnitude is less than the specified threshold.

## Arguments

### A

An *n* by *n* array of any type except string or complex.

### Columns

A vector containing the column subscripts of the non-zero elements. Values must be in the range of 0 to (N-1).

### Rows

A vector, of the same length as Column, containing the row subscripts of the non-zero elements. Values must be in the range of 0 to (N-1).

### Values

A vector, of the same length as Column, containing the values of the non-zero elements.

### N

The size of the resulting sparse matrix.

## Keywords

### COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors). This keyword is not allowed in the list form of the call.

### DOUBLE

Set this keyword to convert the sparse array to double-precision.

### THRESHOLD

Use this keyword to set the criterion for deciding the absolute magnitude of the elements to be retained in sparse storage mode. For single-precision calculations, the default value is $1.0 \times 10^{-7}$. For double-precision values, the default is $1.0 \times 10^{-14}$.

## Examples

### Example1

Suppose we wish to convert the following array to sparse storage format:

```
A = [[ 5.0, -0.2, 0.1], $
     [ 3.0, -2.0, 0.3], $
     [ 4.0, -1.0, 0.0]]

; Convert to sparse storage mode. All elements of the array A that
; have absolute values less than THRESH are set to zero.
sparse = SPRSIN(A, THRESH = 0.5)
```

The variable SPARSE now contains a representation of A in structure form. See the description of FULSTR for an example that restores such a structure to full storage mode.

### Example2

This example demonstrates how to use the list form of the call to SPRSIN. The following line of code creates a sparse matrix, equivalent to a 100 by 100 identity matrix, i.e. all diagonal elements are set to 1, all other elements are zero:

```
I100 = SPRSIN(LINDGEN(100), LINDGEN(100), REPLICATE(1.0,100), 100)
```

## Version History

Introduced: 4.0

## See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSTP, READ_SPR, WRITE_SPR

# SPRSTP

The SPRSTP function constructs the transpose of a sparse matrix.

## Syntax

*Result* = SPRSTP(*A*)

## Return Value

Returns the sparse matrix of the given sparse array.

## Arguments

### A

A row-indexed sparse array created by the SPRSIN function.

## Keywords

None

## Examples

This example creates a 100 by 100 pseudo-random sparse matrix, with 1000 non-zero elements, and then computes the product of the matrix and its transpose:

```
n = 100                    ;Dimensions of matrix
m = 1000                   ;Number of non-zero elements
a = SPRSIN(RANDOMU(seed, m)*n, RANDOMU(seed, m)*n, $
    RANDOMU(seed, m),n)
b = SPRSAB(a, SPRSTP(a))  ;Transpose and create the product
```

## Version History

Introduced: 4.0

## See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSIN, READ_SPR, WRITE_SPR

# SQRT

The SQRT function computes the square root of *X*.

## Syntax

*Result* = SQRT(*X*)

## Return Value

Returns the square root of *X*.

## Arguments

### X

The value for which the square root is desired. If *X* is double-precision floating-point or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. When applied to complex numbers, $z = x+iy$:

$$z^{1/2} = \left[\frac{1}{2}(r + x)\right]^{1/2} \pm i\left[\frac{1}{2}(r - x)\right]^{1/2}$$

$$r = \sqrt{x^2 + y^2}$$

The ambiguous sign is taken to be the same as the sign of *y*. The result has the same structure as *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To find the square root of 145 and store the result in variable S, enter:

```
S = SQRT(145)
```

## Version History

Introduced: Original

## See Also

"Exponentiation" in Chapter 2 of the *Building IDL Applications* manual.

# STANDARDIZE

The STANDARDIZE function computes standardized variables from an array of *m* variables (columns) and *n* observations (rows).

This routine is written in the IDL language. Its source code can be found in the file `standardize.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = STANDARDIZE( *A* [, /DOUBLE] )

## Return Value

The result is an *m*-column, *n*-row array where all columns have a mean of zero and a variance of one.

## Arguments

### A

An *m*-column, *n*-row single- or double-precision floating-point array.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

```
; Define an array with 4 variables and 20 observations:
array = $
          [[19.5, 43.1, 29.1, 11.9], $
           [24.7, 49.8, 28.2, 22.8], $
           [30.7, 51.9, 37.0, 18.7], $
           [29.8, 54.3, 31.1, 20.1], $
           [19.1, 42.2, 30.9, 12.9], $
           [25.6, 53.9, 23.7, 21.7], $
           [31.4, 58.5, 27.6, 27.1], $
           [27.9, 52.1, 30.6, 25.4], $
           [22.1, 49.9, 23.2, 21.3], $
           [25.5, 53.5, 24.8, 19.3], $
```

```
                [31.1, 56.6, 30.0, 25.4], $
                [30.4, 56.7, 28.3, 27.2], $
                [18.7, 46.5, 23.0, 11.7], $
                [19.7, 44.2, 28.6, 17.8], $
                [14.6, 42.7, 21.3, 12.8], $
                [29.5, 54.4, 30.1, 23.9], $
                [27.7, 55.3, 25.7, 22.6], $
                [30.2, 58.6, 24.6, 25.4], $
                [22.7, 48.2, 27.1, 14.8], $
                [25.2, 51.0, 27.5, 21.1]]

; Compute the mean and variance of each variable using the MOMENT
; function. The skewness and kurtosis are also computed:
FOR K = 0, 3 DO PRINT, MOMENT(array[K,*])

; Compute the standardized variables:
result = STANDARDIZE(array)

; Compute the mean and variance of each standardized variable using
; the MOMENT function. The skewness and kurtosis are also computed:
FOR K = 0, 3 DO PRINT, MOMENT(result[K,*])
```

IDL prints:

```
25.3050      25.2331    -0.454763     -1.10028
51.1700      27.4012    -0.356958     -1.19516
27.6200      13.3017     0.420289     0.104912
20.1950      26.0731    -0.363277     -1.24886

-7.67130e-07      1.00000    -0.454761    -1.10028
-3.65451e-07      1.00000    -0.356958    -1.19516
-1.66707e-07      1.00000     0.420290     0.104913
 4.21703e-07      1.00000    -0.363278    -1.24886
```

## Version History

Introduced: 5.0

## See Also

MOMENT

# STDDEV

The STDDEV function computes the standard deviation of an *n*-element vector.

## Syntax

*Result* = STDDEV( *X* [, /DOUBLE] [, /NAN] )

## Return Value

The result is the standard deviation of the given vector.

## Arguments

### X

A numeric vector.

## Keywords

### DOUBLE

If this keyword is set, computations are performed in double precision arithmetic.

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## Examples

```
; Define the n-element vector of sample data:
x = [65, 63, 67, 64, 68, 62, 70, 66, 68, 67, 69, 71, 66, 65, 70]

; Compute the standard deviation:
result = STDDEV(x)

PRINT, result
```

IDL prints:

```
2.65832
```

## Version History

Introduced: 5.1

## See Also

KURTOSIS, MEAN, MEANABSDEV, MOMENT, SKEWNESS, VARIANCE

# STOP

The STOP procedure stops the execution of a running program or batch file. Control reverts to the interactive mode.

## Syntax

STOP [, *Expr*$_1$, ..., *Expr*$_n$]

## Arguments

### Expr$_i$

One or more expressions whose value is printed. If no parameters are present, a brief message describing where the STOP was encountered is printed.

## Keywords

None.

## Examples

Suppose that you want to stop the execution of a procedure and print the values of the variables A, B, C and NUM. At the appropriate location in your procedure include the command:

```
STOP, A, B, C, NUM
```

To continue execution of the procedure (if possible) enter the IDL executive command:

```
.CONT
```

## Version History

Introduced: Original

## See Also

BREAKPOINT, EXIT, WAIT

# STRARR

The STRARR function returns a string array containing zero-length strings.

## Syntax

*Result* = STRARR($D_1$ [, ..., $D_8$])

## Return Value

The result is a string array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Examples

To create S, a 20-element string vector, enter:

```
S = STRARR(20)
```

## Version History

Introduced: Original

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, UINTARR, ULON64ARR, ULONARR

# STRCMP

The STRCMP function performs string comparisons between its two String arguments, returning True (1) for those that match and False (0) for those that do not. Normally, the IDL equality operator (EQ) is used for such comparisons, but STRCMP can optionally perform case-insensitive comparisons and can be limited to compare only the first N characters of the two strings, both of which require extra steps using the EQ operator.

## Syntax

*Result* = STRCMP( *String1*, *String2* [, *N*] [, /FOLD_CASE] )

## Return Value

If all of the arguments are scalar, the result is scalar. If one of the arguments is an array, the result is an integer with the same structure. If more than one argument is an array, the result has the structure of the smallest array. Each element of the result contains True (1) if the corresponding elements of String1 and String2 are the same, and False (0) otherwise.

## Arguments

### String1, String2

The strings to be compared.

### N

Normally String1 and String2 are compared in their entirety. If N is specified, the comparison is made on at most the first N characters of each string.

## Keywords

### FOLD_CASE

String comparison is normally a case sensitive operation. Set FOLD_CASE to perform case insensitive comparisons instead.

## Examples

Compare two strings in a case-insensitive manner, considering only the first 3 characters:

```
Result = STRCMP('Moose', 'moo', 3, /FOLD_CASE)
PRINT, Result
```

IDL prints:

```
       1
```

## Version History

Introduced: 5.3

## See Also

STREGEX, STRJOIN, STRMATCH, STRMID, STRPOS, STRSPLIT

# STRCOMPRESS

The STRCOMPRESS function returns a copy of *String* with all whitespace (blanks and tabs) compressed to a single space or completely removed.

## Syntax

*Result* = STRCOMPRESS( *String* [, /REMOVE_ALL] )

## Return Value

The result is a compressed string.

## Arguments

### String

The string to be compressed. If not of type string, it is converted using IDL's default formatting rules. If *String* is an array, the result is an array with the same structure—each element contains a compressed copy of the corresponding element of *String*.

## Keywords

### REMOVE_ALL

Set this keyword to remove *all* whitespace. Normally, all whitespace is compressed to a *single* space.

## Examples

```
; Create a string variable S:
S = 'This is a string with spaces in it.'

; Print S with all of the whitespace removed:
PRINT, STRCOMPRESS(S, /REMOVE_ALL)
```

### IDL Output

```
Thisisastringwithspacesinit.
```

## Version History

Introduced: Original

## See Also

STRTRIM

# STREAMLINE

The STREAMLINE procedure generates the visualization graphics from a path. The output is a polygonal ribbon which is tangent to a vector field along its length. The ribbon is generated by placing a line at each vertex in the direction specified by each normal value multiplied by the anisotropy factor. The input normal array is not normalized before use, making it possible to vary the ribbon width as well.

## Syntax

STREAMLINE, *Verts*, *Conn*, *Normals*, *Outverts*, *Outconn* [, ANISOTROPY=*array*] [, SIZE=*vector*] [, PROFILE=*array*]

## Arguments

### Verts

Input array of path vertices ([3, *n*] array).

### Conn

Input path connectivity array in IDLgrPolyline POLYLINES keyword format. There is one set of line segments in this array for each streamline.

### Normals

Normal estimate at each input vertex ([3, *n*] array).

### Outverts

Output vertices ([3xn] float array). Useful if the routine is to be used with Direct Graphics or the user wants to manipulate the data directly.

### Outconn

Output polygonal connectivity array to match the output vertices.

## Keywords

### ANISOTROPY

Set this input keyword to a three-element array describing the distance between grid points in each dimension. The default value is [1.0, 1.0, 1.0]

### SIZE

Set this keyword to a vector of values (one for each path point). These values are used to specify the width of the ribbon or the size of profile at each point along its path. This keyword is generally used to convey additional data parameters along the streamline.

### PROFILE

Set this keyword to an array of two-dimensional points which are treated as the cross section of the ribbon instead of a line segment. If the first and last points in the array are the same, a closed profile is generated. The profile is placed at each path vertex in the plane perpendicular to the line connecting each path vertex with the vertex normal defining the up direction. This allows for the generation of streamtubes and other geometries.

## Version History

Introduced: 5.3

# STREGEX

The STREGEX function performs regular expression matching against the strings contained in StringExpression. STREGEX can perform either a simple boolean True/False evaluation of whether a match occurred, or it can return the position and offset within the strings for each match. The regular expressions accepted by this routine, which correspond to “Posix Extended Regular Expressions”, are similar to those used by such UNIX tools as egrep, lex, awk, and Perl.

For more information about regular expressions, see “Learning About Regular Expressions” in Chapter 5 of the *Building IDL Applications* manual.

STREGEX is based on the regex package written by Henry Spencer, modified by RSI only to the extent required to integrate it into IDL. This package is freely available at `ftp://zoo.toronto.edu/pub/regex.shar`.

## Syntax

*Result* = STREGEX( *StringExpression*, *RegularExpression* [, /BOOLEAN | , /EXTRACT | , LENGTH=*variable* [, /SUBEXPR]] [, /FOLD_CASE] )

## Return Value

By default, STREGEX returns the position and length of the matched string within StringExpression. If no match is found, -1 is returned for both of these. Optionally, it can return a Boolean True/False result of the match, or the matched strings.

## Arguments

### StringExpression

String to be matched.

### RegularExpression

A scalar string containing the regular expression to match. See “Learning About Regular Expressions” in Chapter 5 of the *Building IDL Applications* manual for a description of the meta characters that can be used in a regular expression.

# Keywords

## BOOLEAN

Normally, STREGEX returns the position of the first character in StringExpression that matches RegularExpression. Setting BOOLEAN modifies this behavior to simply return a True/False value indicating if a match occurred or not.

## EXTRACT

Normally, STREGEX returns the position of the first character in StringExpression that matches RegularExpression. Setting EXTRACT modifies this behavior to simply return the matched substrings. The EXTRACT keyword cannot be used with either BOOLEAN or LENGTH.

## FOLD_CASE

Regular expression matching is normally a case-sensitive operation. Set FOLD_CASE to perform case-insensitive matching instead.

## LENGTH

If present, specifies a variable to receive the lengths of the matches. Together with this result of this function, which contains the starting points of the matches in StringExpression, LENGTH can be used with the STRMID function to extract the matched substrings. The LENGTH keyword cannot be used with either BOOLEAN or EXTRACT.

## SUBEXPR

By default, STREGEX only reports the overall match. Setting SUBEXPR causes it to report the overall match as well as any subexpression matches. A subexpression is any part of a regular expression written within parentheses. For example, the regular expression ‘(a)(b)(c+)’ has 3 subexpressions, whereas the functionally equivalent 'abc+' has none. The SUBEXPR keyword cannot be used with BOOLEAN.

If a subexpression participated in the match several times, the reported substring is the last one it matched. Note, as an example in particular, that when the regular expression ‘(b*)+’ matches ‘bbb’, the parenthesized subexpression matches the three 'b's and then an infinite number of empty strings following the last ‘b’, so the reported substring is one of the empties. This occurs because the ‘*’ matches *zero or more* instances of the character that precedes it.

In order to return multiple positions and lengths for each input, the result from SUBEXPR has a new first dimension added compared to StringExpression.

# Examples

## Example 1

To match a string starting with an “a”, followed by a “b”, followed by 1 or more “c”:

```
pos = STREGEX('aaabccc', 'abc+', length=len)
PRINT, STRMID('aaabccc', pos, len)
```

IDL Prints:

```
abccc
```

To perform the same match, and also find the locations of the three parts:

```
pos = STREGEX('aaabccc', '(a)(b)(c+)', length=len, /SUBEXPR)
print, STRMID('aaabccc', pos, len)
```

IDL Prints:

```
abccc a b ccc
```

Or more simply:

```
print,STREGEX('aaabccc','(a)(b)(c+)',/SUBEXPR,/EXTRACT)
```

IDL Prints:

```
abccc a b ccc
```

## Example 2

This example searches a string array for words of any length beginning with “f” and ending with “t” without the letter “o” in between:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'affluent']
PRINT, STREGEX(str, '^f[^o]*t$', /EXTRACT, /FOLD_CASE)
```

This statement results in:

```
Feet FAST ferret
```

Note the following about this example:

- Unlike the * wildcard character used by STRMATCH, the * meta character used by STREGEX applies to the item directly on its left, which in this case is [^o], meaning “any character except the letter ‘o’ ”. Therefore, [^o]* means “zero or more characters that are not ‘o’ ”, whereas the following statement would find only words whose second character is not “o”:

```
PRINT, str[WHERE(STRMATCH(str, 'f[!o]*t', /FOLD_CASE) EQ 1)]
```

- The anchors (^ and $) tell STREGEX to find only words that begin with “f” and end with “t”. If we left out the ^ anchor in the above example, STREGEX would also return “ffluent” (a substring of “affluent”). Similarly, if we left out the $ anchor, STREGEX would also return “fat” (a substring of “fate”).

## Version History

Introduced: 5.3

## See Also

STRCMP, STRJOIN, STRMATCH, STRMID, STRPOS, STRSPLIT

# STRETCH

The STRETCH procedure stretches the image display color tables so the full range runs from one color index to another. The modified colortable is loaded, but the COLORS common block is not changed. The original colortable can be restored by calling STRETCH with no arguments. A colortable must be loaded before STRETCH can be called.

This routine is written in the IDL language. Its source code can be found in the file `stretch.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

STRETCH [, *Low*, *High* [, *Gamma*]] [, /CHOP]

## Arguments

### Low

The lowest pixel value to use. If this parameter is omitted, 0 is assumed. Appropriate values range from 0 to the number of available colors-1. If no parameters are supplied, the original color tables are restored.

### High

The highest pixel value to use. If this parameter is omitted, the number of colors-1 is assumed. Appropriate values range from 0 to the number of available colors-1.

### Gamma

An optional Gamma correction factor. If this value is omitted, 1.0 is assumed. Gamma correction works by raising the color indices to the *Gamma* power, assuming they are scaled into the range 0 to 1.

## Keywords

### CHOP

Set this keyword to set color indices above the upper threshold to color index 0. Normally, values above the upper threshold are set to the maximum color index.

## Examples

Load the STD GAMMA-II color table by entering:

```
LOADCT, 5
```

Create and display and image by entering:

```
TVSCL, DIST(300)
```

Now adjust the color table with STRETCH. Make the entire color table fit in the range 0 to 70 by entering:

```
STRETCH, 0, 70
```

Notice that pixel values above 70 are now colored white. Restore the original color table by entering:

```
STRETCH
```

## Version History

Introduced: Original

## See Also

GAMMA_CT, H_EQ_CT, MULTI, XLOADCT

# STRING

The STRING function returns its arguments converted to string type. It is similar to the PRINT procedure, except that its output is placed in a string rather than being output to the terminal. The case in which a single expression of type byte is specified without the FORMAT keyword is special—see the “Differences Between STRING and PRINT” on page 1901 for details.

**Note**

Applying the STRING function to a byte array containing a null (zero) value will result in the resulting string being truncated at that position.

## Syntax

*Result* = STRING( *Expression*$_1$, ..., *Expression*$_n$ [, AM_PM=*[string, string]*] [, DAYS_OF_WEEK=*string_array*{7 names}] [, FORMAT=*value*] [, MONTHS=*string_array*{12 names}] [, /PRINT] )

## Return Value

Returns a string containing the specified expression.

## Arguments

### Expression$_n$

The expressions to be converted to string type.

**Note**

If you supply a comma-separated list of expressions without specifying a FORMAT, and the combined length of the expressions is greater than the current width of your tty or command log window, STRING will create a string array with one element for each expression, rather than concatenating all expressions into a single string. In this case, you can either specify a FORMAT, or use the string concatenation operator, “+”.

# Keywords

## AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

## DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

## FORMAT

A format string to be used in formatting the expressions. See "Using Explicitly Formatted Input/Output" in Chapter 10 of the *Building IDL Applications* manual.

## MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

## PRINT

Set this keyword to specify that any special case processing should be ignored and that STRING should behave exactly as the PRINT procedure would.

# Differences Between STRING and PRINT

The behavior of STRING differs from the behavior of the PRINT procedure in the following ways (unless the PRINT keyword is set):

- When called with a single non-byte argument and no format specification, STRING returns a result that has the same dimensions as the original argument. For example, the statement:

  ```
  HELP, STRING(INDGEN(5))
  ```

  gives the result:

  ```
  <Expression> STRING = Array[5]
  ```

while:

```
HELP, STRING(INDGEN(5), /PRINT)
```

results in:

```
<Expression> STRING =' 0 1 2 3 4'
```

- If called with a single argument of byte type and the FORMAT keyword is not used, STRING simply stores the unmodified values of each byte element in the result. This result is a string containing the byte values from the original argument. Thus, the result has one less dimension than the original argument. For example, a 2-dimensional byte array becomes a vector of strings, a byte vector becomes a scalar string. However, a byte scalar also becomes a string scalar. For example, the statement:

  ```
  PRINT, STRING([72B, 101B, 108B, 108B, 111B])
  ```

  produces the output:

  ```
  Hello
  ```

  because the argument to STRING, is a byte vector. Its first element is a 72B which is the ASCII code for “H”, the second is 101B which is an ASCII “e”, and so forth.

- If both the FORMAT and PRINT keywords are not present and STRING is called with more than one argument, and the last argument is a scalar string starting with the characters “$(” or “(”, this final argument is taken to be the format specification, just as if it had been specified via the FORMAT keyword. This feature is maintained for compatibility with version 1 of VMS IDL.

## Examples

To convert the contents of variable A to string type and store the result in the variable B, enter:

```
B = STRING(A)
```

## Version History

Introduced: Original

## See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, UINT, ULONG, ULONG64

# STRJOIN

The STRJOIN function collapses a string scalar or array into merged strings. This function reduces the rank of its input array by one dimension. The strings in the removed first dimension are concatenated into a single string using the string in *Delimiter* to separate them.

## Syntax

*Result* = STRJOIN( *String* [, *Delimiter*] [, /SINGLE] )

## Return Value

Returns the merged strings.

## Arguments

### String

A string scalar or array to be collapsed into merged strings.

### Delimiter

The separator string to use between the joined strings. If Delimiter is not specified, an empty string is used.

## Keywords

### SINGLE

If SINGLE is set, the entire String is joined into a single scalar string result.

## Examples

Replace all the blanks in a sentence with colons:

```
str = 'Out, damned spot! Out I say!'
print, (STRJOIN(STRSPLIT(str, /EXTRACT), ':'))
```

IDL prints:

```
Out,:damned:spot!:Out:I:say!
```

## Version History

Introduced: 5.3

## See Also

STRCMP, STREGEX, STRMATCH, STRMID, STRPOS, STRSPLIT

# STRLEN

The STRLEN function returns the length of its string-type argument. If the argument is not a string, it is first converted to string type.

## Syntax

*Result* = STRLEN(*Expression*)

## Return Value0

Returns the string length.

## Arguments

### Expression

The expression for which the string length is desired. If this parameter is not a string, it is converted using IDL's default formatting rules in order to determine the length. The result is a long integer. If *Expression* is an array, the result is a long integer array with the same structure, where each element contains the length of the corresponding *Expression* element.

## Keywords

None.

## Examples

To find the length of the string "IDL is fun" and print the result, enter:

```
PRINT, STRLEN('IDL is fun')
```

IDL prints:

```
      10
```

## Version History

Introduced: Original

# STRLOWCASE

The STRLOWCASE function returns a copy of *String* converted to lowercase characters. Only uppercase characters are modified—lowercase and non-alphabetic characters are copied without change.

## Syntax

*Result* = STRLOWCASE(*String*)

## Return Value

Returns a string composed of lowercase characters.

## Arguments

### String

The string to be converted. If this argument is not a string, it is converted using IDL's default formatting rules. If *String* is an array, the result is an array with the same structure—each element contains a lower case copy of the corresponding element of *String*.

## Keywords

None.

## Examples

To convert the string "IDL is fun" to all lowercase characters and print the result, enter:

```
PRINT, STRLOWCASE('IDL is fun')
```

IDL prints:

```
idl is fun
```

## Version History

Introduced: Original

## See Also

STRUPCASE

# STRMATCH

The STRMATCH function compares its search string, which can contain wildcard characters, against the input string expression. The result is an array with the same structure as the input string expression. Those elements that match the corresponding input string are set to True (1), and those that do not match are set to False (0).

The wildcards understood by STRMATCH are similar to those used by the standard UNIX shell:

| Wildcard Character | Description |
|---|---|
| * | Matches any string, including the null string. |
| ? | Matches any single character. |
| [...] | Matches any one of the enclosed characters. A pair of characters separated by "-" matches any character lexically between the pair, inclusive. If the first character following the opening [ is a !, any character not enclosed is matched. To prevent one of these characters from acting as a wildcard, it can be quoted by preceding it with a backslash character (e.g. "*" matches the asterisk character). Quoting any other character (including \ itself) is equivalent to the character (e.g. "\a" is the same as "a"). |

*Table 92: Wildcard Characters used by STRMATCH*

## Syntax

*Result* = STRMATCH( *String*, *SearchString* [, /FOLD_CASE] )

## Return Value

Returns 1 if the pattern specified by *SearchString* exists in *String*, or 0 otherwise. If the *String* argument contains an array of strings, the result is an array of 1s and 0s with the same number of elements as *String*, indicating which elements contain *SearchString*.

# Arguments

## String

A scalar string or string array to be searched.

## SearchString

A scalar string containing the pattern to search for in *String*. The pattern string can contain wildcard characters as discussed above.

# Keywords

## FOLD_CASE

The comparison is usually case sensitive. Setting the FOLD_CASE keyword causes a case insensitive match to be done instead.

# Examples

## Example 1

Find all 4-letter words in a string array that begin with “f” or “F” and end with “t” or “T”:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f??t', /FOLD_CASE) EQ 1)]
```

This results in:

```
foot Feet FAST fort
```

## Example 2

Find words of any length that begin with “f” and end with “t”:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f*t', /FOLD_CASE) EQ 1)]
```

This results in:

```
foot Feet FAST ferret fort
```

### Example 3

Find 4-letter words beginning with “f” and ending with “t”, with any combination of “o” and “e” in between:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f[eo][eo]t', /FOLD_CASE) EQ 1)]
```

This results in:

```
foot Feet
```

### Example 4

Find all words beginning with “f” and ending with “t” whose second character is not the letter “o”:

```
str = ['foot', 'Feet', 'fate', 'FAST', 'ferret', 'fort']
PRINT, str[WHERE(STRMATCH(str, 'f[!o]*t', /FOLD_CASE) EQ 1)]
```

This results in:

```
Feet FAST ferret
```

## Version History

Introduced: 5.3

## See Also

STRCMP, STRJOIN, STREGEX, STRMID, STRPOS, STRSPLIT

# STRMESSAGE

The STRMESSAGE function returns the text of the error message specified by *Err*. This function is especially useful in conjunction with the CODE field of the !ERROR_STATE system variable which always contains the error number of the last error. The MSG field of the !ERROR_STATE system variable contains the text of the last error message.

## Syntax

*Result* = STRMESSAGE( *Err* [, /BLOCK | , /CODE | , /NAME] )

## Return Value

Returns the error message text.

## Arguments

### Err

The error number or text. Programs must not make the assumption that certain error numbers are always related to certain error messages—the actual correspondence changes over time as IDL is modified.

## Keywords

### BLOCK

Set this keyword to return the name of the message block that defines *Err*. If this keyword is specified, *Err* must be an error code.

### CODE

Set this keyword to return the error code for the error message specified in *Err*. If this keyword is specified, *Err* must be an error name.

### NAME

Set this keyword to return a string containing the error message that goes with *Err*. If this keyword is specified, *Err* must be an error code.

## Examples

Print the error message associated with error number 4 by entering:

```
PRINT, STRMESSAGE(4)
```

## Version History

Introduced: Original

## See Also

MESSAGE

# STRMID

The STRMID function extracts one or more substring from a string expression. Each extracted string is the result of removing characters.

## Syntax

*Result* = STRMID(*Expression*, *First_Character* [, *Length*] [, /REVERSE_OFFSET])

## Return Value

The result of the function is a string of *Length* characters taken from *Expression*, starting at character position *First_Character*.

The form of *First_Character* and *Length* control how they are applied to *Expression*. Either argument can be a scalar or an array:

- If a scalar value is supplied for *First_Character* and *Length*, then those values are applied to all elements of *Expression*. The result has the same structure and number of elements as *Expression*.

If *First_Character* or *Length* is an array, the size of their first dimension determines how many substrings are extracted from each element of *Expression*. We call this the “stride”. If both are arrays, they must have the same stride. If *First_Character* or *Length* do not contain enough elements to process *Expression*, STRMID automatically loops back to the beginning as necessary. Excess values are ignored. If the stride is 1, the result will have the same structure and number of elements as *Expression*. If it is greater than 1, the result will have an additional dimension, with the new first dimension having the same size as the stride.

## Arguments

### Expression

The expression from which the substrings are to be extracted. If this argument is not a string, it is converted using IDL's default formatting rules.

### First_Character

The starting position within *Expression* at which the substring starts. The first character position is 0.

### Length

The length of the substring. If there are not enough characters left in the main string to obtain *Length* characters, the substring is truncated. If *Length* is not supplied, STRMID extracts all characters from the specified start position to the end of the string.

## Keywords

### REVERSE_OFFSET

Specifies that *First_Character* should be counted from the end of the string backwards. This allows simple extraction of strings from the end.

## Examples

If the variable B contains the string “IDL is fun”, the substring “is” can be extracted and stored in the variable C with the command:

```
C = STRMID(B, 4, 2)
```

## Version History

Introduced: Original

## See Also

STRPOS, STRPUT, STRTRIM

# STRPOS

The STRPOS function finds the first occurrence of a substring within an object string.

## Syntax

*Result* = STRPOS( *Expression*, *Search String* [, *Pos*] [, /REVERSE_OFFSET] [, /REVERSE_SEARCH] )

## Return Value

If *Search_String* occurs in *Expression*, STRPOS returns the character position of the match, otherwise it returns -1.

## Arguments

### Expression

The expression in which to search for the substring. If this argument is not a string, it is converted using IDL's default formatting rules. If *Expression* is an array, the result is an array with the same structure, where each element contains the position of the substring within the corresponding element *Expression*. If *Expression* is the null string, STRPOS returns the value -1.

### Search_String

The substring to be searched for within *Expression*. If this argument is not a string, it is converted using IDL's default formatting rules. If *Search_String* is the null string, STRPOS returns the smaller of *Pos* or one less than the length of *Expression*.

### Pos

The character position at which the search is begun. If *Pos* is omitted and the REVERSE_SEARCH keyword is not set, the search begins at the first character (character position 0). If REVERSE_SEARCH is set, the default is to start at the last character in the string. If *Pos* is less than zero, zero is used for the starting position.

# Keywords

## REVERSE_OFFSET

Normally, the value of *Pos* is used as an offset from the beginning of the expression towards the end. Set REVERSE_OFFSET to use it as an offset from the last character of the string moving towards the beginning. This keyword makes it easy to position the starting point of the search at a fixed offset from the end of the string.

## REVERSE_SEARCH

STRPOS usually starts at *Pos* and moves toward the end of the string looking for a match. If REVERSE_SEARCH is set, the search instead moves towards the beginning of the string.

# Examples

## Example 1

Find the position of the string “fun” within the string “IDL is fun” and print the result by entering:

```
PRINT, STRPOS('IDL is fun', 'fun')
```

IDL prints:

```
      7
```

## Example 2

The REVERSE_SEARCH keyword to the STRPOS function makes it easy to find the last occurrence of a substring within a string. In the following example, we search for the last occurrence of the letter “I” (or “i”) in a sentence:

```
sentence = 'IDL is fun.'
sentence = STRUPCASE(sentence)
lasti = STRPOS(sentence, 'I', /REVERSE_SEARCH)
PRINT, lasti
```

This results in:

```
4
```

Note that although REVERSE_SEARCH tells STRPOS to begin searching from the end of the string, the STRPOS function still returns the position of the search string from the beginning of the string (where 0 is the position of the first character).

## Version History

Introduced: Original

## See Also

STRMID, STRPUT, STRTRIM

# STRPUT

The STRPUT procedure inserts the contents of one string into another. The source string, *Source*, is inserted into the destination string, *Destination*, starting at the given position, *Position*. Characters in *Destination* before the starting position and after the starting position plus the length of *Source* remain unchanged. The length of the destination string is not changed. If the insertion extends past the end of the destination, it is clipped at the end.

## Syntax

STRPUT, *Destination*, *Source* [, *Position*]

## Arguments

### Destination

The named string variable into which *Source* is inserted. *Destination* must be a named variable of type string. If it is an array, *Source* is inserted into every element of the array.

### Source

A scalar string to be inserted into *Destination*. If this argument is not a string, it is converted using IDL's default formatting rules.

### Position

The character position at which the insertion is begun. If *Position* is omitted, the insertion begins at the first character (character position 0). If *Position* is less than zero, zero is used for the initial position.

## Keywords

None.

## Examples

If the variable A contains the string "IBM is fun", the substring "IBM" can be overwritten with the string "IDL" by entering:

```
STRPUT, A, 'IDL', 0
```

The following commands demonstrate the clipping of output that extends past the end of the destination string:

```
STRPUT, A, 'FUNNY', 7
PRINT, A
```

IDL prints:

```
IDL is FUN
```

## Version History

Introduced: Original

## See Also

STRMID, STRPOS, STRTRIM

# STRSPLIT

The STRSPLIT function splits its input *String* argument into separate substrings, according to the specified delimiter or regular expression. By default, the position of the substrings is returned. The EXTRACT keyword can be used to cause STRSPLIT to return an array containing the substrings.

## Syntax

*Result* = STRSPLIT( *String* [, *Pattern*] [, COUNT=*variable*] [, ESCAPE=*string* | , /REGEX [, /FOLD_CASE]] [, /EXTRACT | , LENGTH=*variable*] [, /PRESERVE_NULL] )

## Return Value

Returns an array containing either the positions of the substrings or the substrings themselves (if the EXTRACT keyword is specified).

## Arguments

### String

A scalar string to be split into substrings.

### Pattern

Pattern can contain one of two types of information:

- A string containing the character codes that are considered to be separators. In this case, IDL performs a simple string search for those characters. This method is simple and fast.
- A regular expression, as implemented by the STREGEX function, which is used by IDL to match the separators. This method is slower and more complex, but can handle extremely complicated input strings.

*Pattern* is an optional argument. If it is not specified, STRSPLIT defaults to splitting on spans of whitespace (space or tab characters) in *String*.

# Keywords

## COUNT

Set this keyword to a named variable that will contain the number of matched substrings returned by STRSPLIT. This value will be 0 if either of the *String* or *Pattern* arguments is null. Otherwise, it will cointain the number of elements in the *Result* array.

## ESCAPE

When doing simple pattern matching, the ESCAPE keyword can be used to specify any characters that should be considered to be “escape” characters. Preceding any character with an escape character prevents STRSPLIT from treating it as a separator character even if it is found in *Pattern*.

Note that if the EXTRACT keyword is set, STRSPLIT will automatically remove the escape characters from the resulting substrings. If EXTRACT is not specified, STRSPLIT cannot perform this editing, and the returned position and offsets will include the escape characters.

For example:

```
print, STRSPLIT('a\,b', ',', ESCAPE='\', /EXTRACT)
```

IDL prints:

```
a,b
```

ESCAPE cannot be specified with the FOLD_CASE or REGEX keywords.

## EXTRACT

By default, STRSPLIT returns an array of character offsets into *String* that indicate where the substrings are located. These offsets, along with the lengths available from the LENGTH keyword can be used later with STRMID to extract the substrings. Set EXTRACT to bypass this step, and cause STRSPLIT to return the substrings. EXTRACT cannot be specified with the LENGTH keyword.

## FOLD_CASE

Indicates that the regular expression matching should be done in a case-insensitive fashion. FOLD_CASE can only be specified if the REGEX keyword is set, and cannot be used with the ESCAPE keyword.

### LENGTH

Set this keyword to a named variable to receive the lengths of the substrings. Together with this result of this function, LENGTH can be used with the STRMID function to extract the matched substrings. The LENGTH keyword cannot be used with the EXTRACT keyword.

### PRESERVE_NULL

Normally, STRSPLIT will not return null length substrings unless there are no non-null values to report, in which case STRSPLIT will return a single null string. Set PRESERVE_NULL to cause all null substrings to be returned.

### REGEX

For complex splitting tasks, the REGEX keyword can be specified. In this case, *Pattern* is taken to be a regular expression to be matched against *String* to locate the separators. If REGEX is specified and *Pattern* is not, the default *Pattern* is the regular expression:

```
'[ ' + STRING(9B) + ']+'
```

which means “any series of one or more space or tab characters” (9B is the byte value of the ASCII TAB character).

Note that the default *Pattern* contains a space after the [ character.

The REGEX keyword cannot be used with the ESCAPE keyword.

**Note**

You must call the STRSPLIT procedure with the /REGEX keyword when the target string is more than one character.

## Examples

### Example 1

To split a string on spans of whitespace and replace them with hyphens:

```
Str = 'STRSPLIT chops up strings.'
print, STRJOIN(STRSPLIT(Str, /EXTRACT), '-')
```

IDL prints:

```
STRSPLIT-chops-up-strings.
```

## Example 2

As an example of a more complex splitting task that can be handled with the simple character-matching mode of STRSPLIT, consider a sentence describing different colored ampersand characters. For unknown reasons, the author used commas to separate all the words, and used ampersands or backslashes to escape the commas that actually appear in the sentence (which therefore should not be treated as separators). The unprocessed string looks like:

```
Str = 'There,was,a,red,&&&,,a,yellow,&&\,,and,a,blue,\&.'
```

We use STRSPLIT to break this line apart, and STRJOIN to reassemble it as a standard blank-separated sentence:

```
S = STRSPLIT(Str, ',', ESCAPE='&\', /EXTRACT)
PRINT, STRJOIN(S, ' ')
```

IDL prints:

```
There was a red &, a yellow &, and a blue &.
```

## Example 3

Strings separated by multi-character delimiters cannot be split using the simple character matching mode of STRSPLIT. Such delimiters require the use of a regular expression. For instance, consider splitting the following string on double ampersand boundaries.

```
str = ‘red&&blue&&yellow&&odds&ends’
```

The desired result of such splitting would be four strings, with the values ‘red’, ‘blue’, ‘yellow’, and ‘odds&ends’. You might be tempted to use STRSPLIT as follows:

```
PRINT, STRSPLIT(str,’&&’,/EXTRACT)
```

which causes IDL to print:

```
red blue yellow odds ends
```

IDL split the string on single ampersand boundaries, yielding 5 strings instead of the desired 4. When using the simple character matching mode of STRSPLIT, the characters in the Pattern argument specify a set of possible single character delimiters. The order of these characters is unimportant, and specifying a character more than once has no effect (the extras are ignored).

To properly split the above string using a regular expression:

```
print, strsplit(str,’&&’,/EXTRACT, /REGEX)
```

producing the desired IDL output:

```
red blue yellow odds&ends
```

## Example 4

Finally, suppose you had a complicated string, in which every token was preceded by the count of characters in that token, with the count enclosed in angle brackets:

```
str = '<4>What<1>a<7>tangled<3>web<2>we<6>weave.'
```

This is too complex to handle with simple character matching, but can be easily handled using the regular expression '<[0-9]+>' to match the separators. This regular expression can be read as “an opening angle bracket, followed by one or more

numeric characters between 0 and 9, followed by a closing angle bracket.” The STRJOIN function is used to glue the resulting substrings back together:

```
S = STRSPLIT(str,'<[0-9]+>',/EXTRACT,/REGEX)
PRINT, STRJOIN(S, ' ')
```

IDL prints:

```
What a tangled web we weave.
```

## Version History

Introduced: 5.3

## See Also

STRCMP, STRJOIN, STRMATCH, STREGEX, STRMID, STRPOS

# STRTRIM

The STRTRIM function removes leading and/or trailing blank from the input *String*.

## Syntax

*Result* = STRTRIM( *String* [, *Flag*] )

## Return Value

Returns a copy of string with the specified blank spaces removed.

## Arguments

### String

The string to have leading and/or trailing blanks removed. If this argument is not a string, it is converted using IDL's default formatting rules. If it is an array, the result is an array with the same structure where each element contains a trimmed copy of the corresponding element of *String*.

### Flag

A value that controls the action of STRTRIM. If *Flag* is zero or not present, trailing blanks are removed. Leading blanks are removed if it is equal to 1. Both are removed if it is equal to 2.

## Examples

Converting variables to string type often results in undesirable leading blanks. For example, the following command converts the integer 56 to string type:

```
C = STRING(56)
```

Entering the command:

```
HELP, C
```

IDL prints:

```
C         STRING = '      56'
```

which shows that there are six leading spaces before the characters 5 and 6. To remove these leading blanks, enter the command:

```
C = STRTRIM(C, 1)
```

To confirm that the blanks were removed, enter:

```
HELP, C
```

IDL prints:

```
C         STRING = '56'
```

## Version History

Introduced: Original

## See Also

STRMID, STRPOS, STRPUT, STRSPLIT

# STRUCT_ASSIGN

The IDL “=” operator is unable to assign a structure value to a structure of a different type. The STRUCT_ASSIGN procedure performs “relaxed structure assignment,” which is a field-by-field copy of a structure to another structure. Fields are copied according to the following rules:

1. Any fields found in the destination structure that are not found in the source structure are “zeroed” (set to zero, the empty string, or a null pointer or object reference depending on the type of field).
2. Any fields in the source structure that are not found in the destination structure are quietly ignored.
3. Any fields that are found in both the source and destination structures are copied one at a time. If necessary, type conversion is done to make their types agree. If a field in the source structure has fewer data elements than the corresponding field in the destination structure, then the “extra” elements in the field in the destination structure are zeroed. If a field in the source structure has more elements than the corresponding field in the destination structure, the extra elements are quietly ignored.

Relaxed structure assignment is especially useful when restoring structures from disk files into an environment where the structure definition has changed. See the description o f the RELAXED_STRUCTURE_ASSIGNMENT keyword to the RESTORE procedure for additional details. “Relaxed Structure Assignment” in Chapter 7 of the *Building IDL Applications* manual provides a more in-depth discussion of the structure-definition process.

## Syntax

STRUCT_ASSIGN, *Source*, *Destination* [, /NOZERO] [, /VERBOSE]

## Arguments

### Source

A named variable or element of an array containing a structure, the contents of which will be assigned to the structure specified by the *Destination* argument. *Source* can be an object reference if STRUCT_ASSIGN is called inside an object method.

### Destination

A named variable containing a structure into which the contents of the structure specified by the *Source* argument will be inserted. *Destination* can be an object reference if STRUCT_ASSIGN is called inside an object method.

## Keywords

### NOZERO

Normally, any fields found in the destination structure that are not found in the source structure are zeroed. Set NOZERO to prevent this action and leave the original contents of such fields unchanged.

### VERBOSE

Set this keyword to cause STRUCT_ASSIGN to issue informational messages about any incompatibilities that prevent data from being copied.

## Examples

The following example creates two anonymous structures, then uses STRUCT_ASSIGN to insert the contents of the first into the second:

```
source = { a:FINDGEN(4), b:12 }
dest = { a:INDGEN(2), c:20 }
STRUCT_ASSIGN, /VERBOSE, source, dest
```

IDL prints:

```
% STRUCT_ASSIGN: <Anonymous> tag A is longer than destination.
                 The end will be clipped.
% STRUCT_ASSIGN: Destination lacks <Anonymous> tag B. Not copied.
```

After assignment, `dest` contains a two-element integer array [0, 1] in its field A and the integer 0 in its field C. Since `dest` does not have a field B, field B from `source` is not copied.

## Version History

Introduced: 5.1

# STRUCT_HIDE

The IDL HELP procedure displays information on all known structures or object classes when used with the STRUCTURES or OBJECTS keywords. Although this is usually the desired behavior, authors of large vertical applications or library routines may wish to prevent IDL from displaying information on structures or objects that are not part of their public interface, but which exist solely in support of the internal implementation. The STRUCT_HIDE procedure is used to mark such structures or objects as hidden. Items so marked are not displayed by `HELP, /STRUCTURE` unless the user sets the FULL keyword, but are otherwise unaltered.

**Note**

STRUCT_HIDE is primarily intended for use with named structures or objects. Although it can be safely used with anonymous structures, there is no visible benefit to doing so as anonymous structures are hidden by default.

**Tip**

Authors of objects will often place a call to STRUCT_HIDE in the _ _DEFINE procedure that defines the structure.

## Syntax

STRUCT_HIDE, $Arg_1$ [, $Arg_2$, ..., $Arg_n$]

## Arguments

### $Arg_1$, ..., $Arg_n$

If an argument is a variable of one of the following types, its underlying structure and/or object definition is marked as being hidden from the HELP procedure's default output:

- Structure
- Pointer that refers to a heap variable of structure type
- Object Reference

Any arguments that are not one of these types are quietly ignored. No change is made to the value of any argument.

## Keywords

None

## Examples

This example shows how a structure can be hidden if an application designer doesn't want end-users to be able to see it, but variables are not hidden. To create a named structure called `bullwinkle` and prevent it from appearing in the HELP procedure's default output, do the following.

```
; Define a variable containing the named structure:
tmp = { bullwinkle, moose:1, squirrel:0 }
; IDL returns BULLWINKLE in addition to the other system variables.
HELP, /STRUCTURE, /BRIEF
; Next, specifically hide the structure using
; the STRUCT_HIDE procedure.
STRUCT_HIDE, tmp
; This time IDL returns the system variables but
; not the BULLWINKLE structure.
HELP, /STRUCTURE, /BRIEF
; IDL returns the variable tmp showing that it is
; a named structure called BULLWINKLE.
HELP, tmp
```

## Version History

Introduced: 5.3

## See Also

COMPILE_OPT

# STRUPCASE

The STRUPCASE function returns a copy of *String* converted to upper case. Only lowercase characters are modified—uppercase and non-alphabetic characters are copied without change.

## Syntax

*Result* = STRUPCASE(*String*)

## Return Value

Returns a string composed of uppercase characters.

## Arguments

### String

The string to be converted. If this argument is not a string, it is converted using IDL's default formatting rules. If it is an array, the result is an array with the same structure where each element contains an uppercase copy of the corresponding element of *String*.

## Keywords

None.

## Examples

To print an uppercase version of the string "IDL is fun", enter:

```
PRINT, STRUPCASE('IDL is fun')
```

IDL prints:

```
IDL IS FUN
```

## Version History

Introduced: Original

## See Also

STRLOWCASE

# SURFACE

The SURFACE procedure draws a wire-mesh representation of a two-dimensional array projected into two dimensions, with hidden lines removed.

### Restrictions

If the *(X, Y)* grid is not regular or nearly regular, errors in hidden line removal occur. The TRIGRID and TRIANGULATE routines can be used to interpolate irregularly-gridded data points to a regular grid before plotting.

If the T3D keyword is set, the 3-D to 2-D transformation matrix contained in !P.T must project the Z axis to a line parallel to the device Y axis, or errors will occur.

The surface lines may blend together when drawing large arrays, especially on low or medium resolution displays. Use the REBIN or CONGRID procedure to resample the array to a lower resolution before plotting.

## Syntax

SURFACE, *Z* [, *X*, *Y*] [, AX=*degrees*] [, AZ=*degrees*] [, BOTTOM=*index*] [, /HORIZONTAL] [, /LEGO] [, /LOWER_ONLY | , /UPPER_ONLY] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, /SAVE] [, SHADES=*array*] [, SKIRT=*value*] [, /XLOG] [, /YLOG] [, ZAXIS={1 | 2 | 3 | 4}] [, /ZLOG]

**Graphics Keywords:** Accepts all graphics keywords accepted by PLOT except for: PSYM, SYMSIZE. See “Graphics Keywords Accepted” on page 1938.

## Arguments

### Z

The two-dimensional array to be displayed. If *X* and *Y* are provided, the surface is plotted as a function of the (*X*, *Y*) locations specified by their contents. Otherwise, the surface is generated as a function of the array index of each element of *Z*.

This argument is converted to double-precision floating-point before plotting. Plots created with SURFACE are limited to the range and precision of double-precision floating-point values.

### X

A vector or two-dimensional array specifying the X coordinates of the grid. If this argument is a vector, each element of *X* specifies the X coordinate for a column of *Z*

(e.g., `X[0]` specifies the X coordinate for `Z[0,*]`). If *X* is a two-dimensional array, each element of *X* specifies the X coordinate of the corresponding point in *Z* ($X_{ij}$ specifies the X coordinate for $Z_{ij}$).

This argument is converted to double-precision floating-point before plotting.

### Y

A vector or two-dimensional array specifying the Y coordinates of the grid. If this argument is a vector, each element of *Y* specifies the Y coordinate for a row of *Z* (e.g., `Y[0]` specifies the Y coordinate for `Z[*,0]`). If *Y* is a two-dimensional array, each element of *Y* specifies the Y coordinate of the corresponding point in *Z* ($Y_{ij}$ specifies the Y coordinate for $Z_{ij}$).

This argument is converted to double-precision floating-point before plotting.

## Keywords

### AX

This keyword specifies the angle of rotation, about the X axis, in degrees towards the viewer. This keyword is effective only if !P.T3D is not set. If !P.T3D is set, the three-dimensional to two-dimensional transformation used by SURFACE is taken from the 4 by 4 array !P.T.

The surface represented by the two-dimensional array is first rotated, AZ (see below) degrees about the Z axis, then by AX degrees about the X axis, tilting the surface towards the viewer (AX > 0), or away from the viewer.

The AX and AZ keyword parameters default to +30 degrees if omitted and !P.T3D is 0.

The three-dimensional to two-dimensional transformation represented by AX and AZ, can be saved in !P.T by including the SAVE keyword.

### AZ

This keyword specifies the counterclockwise angle of rotation about the Z axis. This keyword is effective only if !P.T3D is not set. The order of rotation is AZ first, then AX.

### BOTTOM

The color index used to draw the bottom surface. If not specified, the bottom is drawn with the same color as the top.

## HORIZONTAL

A keyword flag which if set causes SURFACE to only draw lines across the plot perpendicular to the line of sight. The default is for SURFACE to draw both across the plot and from front to back.

## LEGO

Set this keyword to produce stacked histogram-style plots. Each data value is rendered as a box covering the XY extent of the cell and with a height proportional to the Z value.

If the *X* and *Y* arguments are specified, only $N_x$-1 columns and $N_y$-1 rows are drawn. (This means that the last row and column of array data are not displayed.) The rectangular area covered by *Z*[*i, j*] is given by *X*[*i*], *X*[*i*+1], *Y*[*j*], and *Y*[*j*+1].

## LOWER_ONLY

Set this keyword to draw only the lower surface of the object. By default, both surfaces are drawn.

## MAX_VALUE

The maximum value to be plotted. If this keyword is present, data values greater than the value of MAX_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## MIN_VALUE

The minimum value to be plotted. If this keyword is present, data values less than the value of MIN_VALUE are treated as missing and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## SAVE

Set this keyword to save the 3-D to 2-D transformation matrix established by SURFACE in the system variable field !P.T. Use this keyword when combining the output of SURFACE with additional output from other routines in the same plot.

When used with AXIS, the SAVE keyword parameter saves the scaling parameters established by the call in the appropriate axis system variable, !X, !Y, or !Z. This causes subsequent overplots to be scaled to the new axis.

For example, to display a two-dimensional array using SURFACE, and to then superimpose contours over the surface (this example assumes that !P.T3D is zero, its default value.), enter the following commands:

```
; Make a surface plot and save the transformation:
SURFACE, Z, /SAVE

; Make contours, don't erase, use the 3-D to 2-D transform placed
; in !P.T by SURFACE:
CONTOUR, Z, /NOERASE, /T3D
```

To display a surface and to then display a flat contour plot, registered above the surface:

```
; Make the surface, save transform:
SURFACE, Z, /SAVE

; Now display a flat contour plot, at the maximum Z value
; (normalized coordinates):
CONTOUR, Z, /NOERASE, /T3D, ZVALUE=1.0
```

You can display the contour plot below the surface with by using a ZVALUE of 0.0.

## SHADES

This keyword allows user-specified coloring of the mesh surfaces. Set this keyword to an array that specifies the color index of the lines emanating from each data point toward the top and right.

**Warning**

When using the SHADES keyword on True Color devices, we recommend that decomposed color support be turned off, by setting `DEVICE, DECOMPOSED=0`. See "DEVICE" on page 488 and "DECOMPOSED" on page 3795.

## SKIRT

This keyword represents a Z-value at which to draw a skirt around the array. The Z value is expressed in data units. The default is no skirt.

If the skirt is drawn, each point on the four edges of the surface is connected to a point on the skirt which has the given Z value, and the same X and Y values as the edge point. In addition, each point on the skirt is connected to its neighbor.

### UPPER_ONLY

Set this keyword to draw only the upper surface of the object. By default, both surfaces are drawn.

### XLOG

Set this keyword to specify a logarithmic X axis.

### YLOG

Set this keyword to specify a logarithmic Y axis.

### ZAXIS

This keyword specifies the placement of the Z axis for the SURFACE plot.

By default, SURFACE draws the Z axis at the upper left corner of the axis box. To suppress the Z axis, use `ZAXIS=-1` in the call. The position of the Z axis is determined from the value of ZAXIS as follows: 1 = lower right, 2 = lower left, 3 = upper left, and 4 = upper right.

### ZLOG

Set this keyword to specify a logarithmic Z axis.

### Graphics Keywords Accepted

See Appendix B, “Graphics Keywords”, for the description of graphics and plotting keywords not listed above. BACKGROUND, CHARSIZE, CHARTHICK, CLIP, COLOR, DATA, DEVICE, FONT, LINESTYLE, NOCLIP, NODATA, NOERASE, NORMAL, POSITION, SUBTITLE, T3D, THICK, TICKLEN, TITLE, [XYZ]CHARSIZE, [XYZ]GRIDSTYLE, [XYZ]MARGIN, [XYZ]MINOR, [XYZ]RANGE, [XYZ]STYLE, [XYZ]THICK, [XYZ]TICKFORMAT, [XYZ]TICKINTERVAL, [XYZ]TICKLAYOUT, [XYZ]TICKLEN, [XYZ]TICKNAME, [XYZ]TICKS, [XYZ]TICKUNITS, [XYZ]TICKV, [XYZ]TICK_GET, [XYZ]TITLE, ZVALUE.

## Examples

```
; Create a simple dataset to display:
D = DIST(30)

; Plot a simple wire-mesh surface representation of D:
SURFACE, D
```

```
; Create a wire-mesh plot of D with a title and a "skirt" around
; the edges of the dataset at Z=0:
SURFACE, D, SKIRT=0.0, TITLE = 'Surface Plot', CHARSIZE = 2
```

## Version History

Introduced: Original

## See Also

CONTOUR, ISURFACE, SHADE_SURF

# SURFR

The SURFR procedure sets up 3-D transformations. This procedure duplicates the rotation, translation, and scaling features of the SURFACE routine, but does not display any data. The resulting transformations are stored in the !P.T system variable.

This routine is written in the IDL language. Its source code can be found in the file `surfr.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SURFR [, AX=*degrees*] [, AZ=*degrees*]

## Arguments

None.

## Keywords

### AX

Angle of rotation about the X axis. The default is 30 degrees.

### AZ

Angle of rotation about the Z axis. The default is 30 degrees.

## Version History

Introduced: Original

## See Also

SCALE3, SCALE3D, T3D

# SVDC

The SVDC procedure computes the Singular Value Decomposition (SVD) of a square (*n* x *n*) or non-square (*n* x *m*) array as the product of orthogonal and diagonal arrays. SVD is a very powerful tool for the solution of linear systems, and is often used when a solution cannot be determined by other numerical algorithms.

The SVD of an (*n* x *m*) non-square array *A* is computed as the product of an (*n* x *m*) column orthogonal array *U*, an (*n* x *n*) diagonal array *SV*, composed of the singular values, and the transpose of an (*n* x *n*) orthogonal array V: A = U SV $V^T$

SVDC is based on the routine `svdcmp` described in section 2.6 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_SVD procedure.

## Syntax

SVDC, *A*, *W*, *U*, *V* [, /COLUMN] [, /DOUBLE] [, ITMAX=*value*]

## Arguments

### A

The square (*n* x *n*) or non-square (*n* x *m*) single- or double-precision floating-point array to decompose.

### W

On output, *W* is an *n*-element output vector containing the “singular values.”

### U

On output, *U* is an *n*-column, *m*-row orthogonal array used in the decomposition of *A*.

### V

On output, *V* is an *n*-column, *n*-row orthogonal array used in the decomposition of *A*.

# Keywords

## COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## ITMAX

Set this keyword to specify the maximum number of iterations. The default value is 30.

# Examples

To find the singular values of an array A:

```
; Define the array A:
A = [[1.0, 2.0, -1.0, 2.5], $
     [1.5, 3.3, -0.5, 2.0], $
     [3.1, 0.7,  2.2, 0.0], $
     [0.0, 0.3, -2.0, 5.3], $
     [2.1, 1.0,  4.3, 2.2], $
     [0.0, 5.5,  3.8, 0.2]]

; Compute the Singular Value Decomposition:
SVDC, A, W, U, V

; Print the singular values:
PRINT, W
```

IDL prints:

```
8.81973      2.65502      4.30598      6.84484
```

To verify the decomposition, use the relationship A = U ## SV ## TRANSPOSE(V), where SV is a diagonal array created from the output vector W:

```
sv = FLTARR(4, 4)
FOR K = 0, 3 DO sv[K,K] = W[K]
result = U ## sv ## TRANSPOSE(V)
PRINT, result
```

IDL prints:

```
      1.00000      2.00000     -1.00000      2.50000
      1.50000      3.30000    -0.500001      2.00000
      3.10000     0.700000      2.20000      0.00000
  2.23517e-08     0.300000     -2.00000      5.30000
      2.10000     0.999999      4.30000      2.20000
 -3.91155e-07      5.50000      3.80000     0.200000
```

This is the input array, to within machine precision.

## Version History

Introduced: 4.0

## See Also

CHOLDC, LA_SVD, LUDC, SVSOL, "Linear Systems" in Chapter 22 of the *Using IDL* manual.

# SVDFIT

The SVDFIT function performs a least squares fit with optional error estimates. Either a user-supplied function written in the IDL language or a built-in polynomial can be used to fit the data.

SVDFIT is based on the routine `svdfit` described in section 15.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = SVDFIT( *X*, *Y* [, *M*] [, A=*vector*] [, CHISQ=*variable*] [, COVAR=*variable*] [, /DOUBLE] [, FUNCTION_NAME=*string*] [, /LEGENDRE] [, MEASURE_ERRORS=*vector*] [, SIGMA=*variable*] [, SING_VALUES=*variable*] [, SINGULAR=*variable*] [, STATUS=*variable*] [, TOL=*value*] [, VARIANCE=*variable*] [, YFIT=*variable*] )

## Return Value

Returns a vector of coefficients.

## Arguments

### X

An n-element vector of independent variables.

### Y

A vector of dependent variables, the same length as *X*.

### M

The number of coefficients in the fitting function. For polynomials, *M* is equal to the degree of the polynomial + 1. If the *M* argument is not specified, you must supply initial coefficient estimates using the A keyword. In this case, *M* is set equal to the number of elements of the array specified by the A keyword.

# Keywords

## A

This keyword is both an input and output keyword. Set this keyword equal to a variable containing a vector of initial estimates for the fitted function parameters. On exit, SVDFIT returns in this variable a vector of coefficients that are improvements of the initial estimates. If A is supplied, the *M* argument will be set equal to the number of elements in the vector specified by A.

## CHISQ

Set this keyword equal to a named variable that will contain the value of the chi-sqaure goodness-of-fit.

## COVAR

Set this keyword equal to a named variable that will contain the covariance matrix of the fitted coefficients.

**Note**

The COVAR matrix depends only upon the independent variable X and (optionally) the MEASURE_ERRORS. The values do not depend upon Y. See section 15.4 of *Numerical Recipes in C* (Second Edition) for details.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## FUNCTION_NAME

Set this keyword equal to a string containing the name of a user-supplied IDL basis function with *M* coefficients. If this keyword is omitted, and the LEGENDRE keyword is not set, IDL assumes that the IDL procedure SVDFUNCT, found in the file `svdfunct.pro`, located in the `lib` subdirectory of the IDL distribution, is to be used. SVDFUNCT uses the basis functions for the fitting polynomial:

$$y = \sum_{i=0}^{M} A(i)x^{i}$$

The function to be fit must be written as an IDL function and compiled prior to calling SVDFIT. The function must accept values of *X* (a scalar), and *M* (a scalar). It must return an *M*-element vector containing the basis functions.

See the "Examples" section below for an example function.

## LEGENDRE

Set this keyword to use Legendre polynomials instead of the function specified by the FUNCTION_NAME keyword. If the LEGENDRE keyword is set, the IDL uses the function SVDLEG found in the file `svdleg.pro`, located in the `lib` subdirectory of the IDL distribution.

## MEASURE_ERRORS

Set this keyword to a vector containing standard measurement errors for each point *Y*[*i*]. This vector must be the same length as *X* and *Y*.

**Note**

For Gaussian errors (e.g., instrumental uncertainties), MEASURE_ERRORS should be set to the standard deviations of each point in *Y*. For Poisson or statistical weighting, MEASURE_ERRORS should be set to SQRT(*Y*).

## SIGMA

Set this keyword to a named variable that will contain the 1-sigma uncertainty estimates for the returned parameters.

**Note**

If MEASURE_ERRORS is omitted, then you are assuming that the polynomial (or your user-supplied model) is the correct model for your data, and therefore, no independent goodness-of-fit test is possible. In this case, the values returned in SIGMA are multiplied by SQRT(CHISQ/(*N*–*M*)), where *N* is the number of points in *X*, and *M* is the number of coefficients. See section 15.2 of *Numerical Recipes in C* (Second Edition) for details.

## SING_VALUES

Set this keyword to a named variable in which to return the singular values from the SVD. Singular values which have been removed will be set to zero.

## SINGULAR

Set this keyword equal to a named variable that will contain the number of singular values returned. This value should be 0. If not, the basis functions do not accurately characterize the data.

## STATUS

Set this keyword to a named variable that will contain the status of the computation. Possible values are:

- STATUS = 0: The computation was successful.
- STATUS > 0: Singular values were found and were removed. STATUS contains the number of singular values.

**Note**

If STATUS is not specified, any error messages will be output to the screen.

## TOL

Set this keyword to the tolerance used when removing singular values. The default is $10^{-5}$ for single precision, and $2x10^{-12}$ for double precision (these defaults are approximately 100 and 10000 times the machine precisions for single and double precision, respectively).

Setting TOL to a larger value may remove coefficients that do not contribute to the solution, which may reduce the errors on the remaining coefficients.

## VARIANCE

Set this keyword equal to a named variable that will contain the variance (sigma squared) of each coefficient *M*.

## WEIGHTS

*The WEIGHTS keyword is obsolete and has been replaced by the MEASURE_ERRORS keyword. Code that uses the WEIGHTS keyword will continue to work as before, but new code should use the MEASURE_ERRORS keyword. Note that the definition of the MEASURE_ERRORS keyword is not the same as the WEIGHTS keyword. Using the WEIGHTS keyword, 1/WEIGHTS[i] represents the measurement error for each point Y[i]. Using the MEASURE_ERRORS keyword, the measurement error is represented as simply MEASURE_ERRORS[i].*

### YFIT

Set this keyword equal to a named variable that will contain the vector of calculated *Y* values.

## Examples

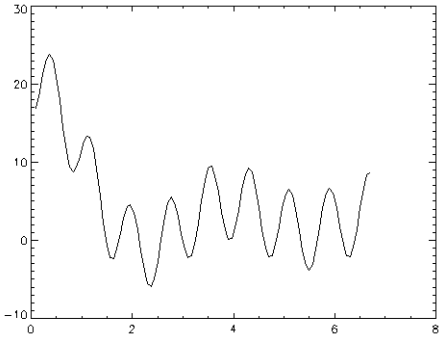
This example fits a function of the following form:

$$F(x) = A(0) + A(1)\sin\frac{(2x)}{x} + A(2)\cos(4x)^2$$

First, create the function in IDL, then create a procedure to perform the fit. Create the following file called `example_svdfit.pro`:

```
PRO example_svdfit

; Provide an array of coefficients:
C = [7.77, 8.88, -9.99]
X = FINDGEN(100)/15.0 + 0.1
Y = C[0] + C[1] * SIN(2*X)/X + C[2] * COS(4.*X)^2.

; Set uncertainties to 5%:
measure_errors = 0.05 * Y

; Provide an initial guess:
A=[1,1,1]
result_a = SVDFIT(X, Y, A=A, MEASURE_ERRORS=measure_errors, $
   FUNCTION_NAME='myfunct', SIGMA=SIGMA, YFIT=YFIT)

; Plot the results:
PLOT, X, YFIT
FOR I = 0, N_ELEMENTS(A)-1 DO $
   PRINT, I, result_a[I], SIGMA[I], C[I],$
   FORMAT = $
   '(" result_a ( ",I1," ) = ",F7.4," +- ",F7.4," VS. ",F7.4)'
END

FUNCTION myfunct, X ,M
   RETURN,[ [1.0], [SIN(2*X)/X], [COS(4.*X)^2.] ]
END
```

Place the file `example_svdfit.pro` in a directory in the IDL search path, and enter `example_svdfit` at the command prompt to create the plot.




In addition to creating the above plot, IDL prints:

```
result_a ( 0 ) =  7.7700 +-  0.0390 VS.  7.7700
result_a ( 1 ) =  8.8800 +-  0.0468 VS.  8.8800
result_a ( 2 ) = -9.9900 +-  0.0506 VS. -9.9900
```

## Version History

Introduced: Original

SING_VALUES, STATUS, and TOL keywords added: 5.6

## See Also

CURVEFIT, GAUSSFIT, LINFIT, LMFIT, POLY_FIT, REGRESS, SFIT

# SVSOL

The SVSOL function uses “back-substitution” to solve a set of simultaneous linear equations Ax = b, given the *U*, *W*, and *V* arrays returned by the SVDC procedure. None of the input arguments are modified, making it possible to call SVSOL multiple times with different right hand vectors, *B*.

SVSOL is based on the routine `svbksb` described in section 2.6 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = SVSOL( *U*, *W*, *V*, *B* [, /COLUMN] [, /DOUBLE] )

## Return Value

Returns the solution to the linear system using decomposition and back substitution.

## Arguments

### U

An *n*-column, *m*-row orthogonal array used in the decomposition of *A*. Normally, *U* is returned from the SVDC procedure.

### W

An *n*-element vector containing “singular values.” Normally, *W* is returned from the SVDC procedure. Small values (close to machine floating-point precision) should be set to zero prior to calling SVSOL.

### V

An *n*-column, *n*-row orthogonal array used in the decomposition of *A*. Normally, *V* is returned from the SVDC procedure.

### B

An *m*-element vector containing the right hand side of the linear system Ax = b.

# Keywords

## COLUMN

Set this keyword if the input arrays *U* and *V* are in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

To solve the linear system Ax = b using Singular-value decomposition and back substitution, begin with an array A which serves as the coefficient array:

```
; Define the array A:
A = [[1.0, 2.0, -1.0, 2.5], $
     [1.5, 3.3, -0.5, 2.0], $
     [3.1, 0.7,  2.2, 0.0], $
     [0.0, 0.3, -2.0, 5.3], $
     [2.1, 1.0,  4.3, 2.2], $
     [0.0, 5.5,  3.8, 0.2]]

; Define the right-hand side vector B:
B = [0.0, 1.0, 5.3, -2.0, 6.3, 3.8]

; Decompose A:
SVDC, A, W, U, V

; Compute the solution and print the result:
PRINT, SVSOL(U, W, V, B)
```

IDL prints:

```
1.00095   0.00881170     0.984176   -0.0100954
```

This is the correct solution.

# Version History

Introduced: 4.0

# See Also

CRAMER, GS_ITER, LU_COMPLEX, CHOLSOL, LUSOL, SVDC, TRISOL

# SWAP_ENDIAN

The SWAP_ENDIAN function reverses the byte ordering of arbitrary scalars, arrays or structures. It can make “big endian” number “little endian” and vice-versa.

**Note**

The BYTEORDER procedure can be used to reverse the byte ordering of *scalars and arrays* (SWAP_ENDIAN also allows structures).

This routine is written in the IDL language. Its source code can be found in the file `swap_endian.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = SWAP_ENDIAN(*Variable* [, /SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN])

## Return Value

SWAP_ENDIAN returns values of the same type and structure as the input value, with the pertinent bytes reversed.

## Arguments

### Variable

The named variable—scalar, array, or structure—to be swapped.

## Keywords

### SWAP_IF_BIG_ENDIAN

If this keyword is set, the swap request will only be performed if the platform running IDL uses “big endian” byte ordering. On little endian machines, the SWAP_ENDIAN request quietly returns without doing anything. Note that this keyword does not refer to the byte ordering of the input data, but to the computer hardware.

### SWAP_IF_LITTLE_ENDIAN

If this keyword is set, the swap request will only be performed if the platform running IDL uses “little endian” byte ordering. On big endian machines, the SWAP_ENDIAN

request quietly returns without doing anything. Note that this keyword does not refer to the byte ordering of the input data, but to the computer hardware.

## Examples

```
; Reverse the byte order of A:
A = SWAP_ENDIAN(A)
```

## Version History

Introduced: Pre 4.0

SWAP_IF_BIG_ENDIAN and SWAP_IF_LITTLE_ENDIAN keywords added: 5.6

## See Also

BYTEORDER, SWAP_ENDIAN_INPLACE

# SWAP_ENDIAN_INPLACE

The SWAP_ENDIAN_INPLACE procedure reverses the byte ordering of arbitrary scalars, arrays or structures. It can make “big endian” number “little endian” and vice-versa.

**Note**

The BYTEORDER procedure can be used to reverse the byte ordering of *scalars and arrays* (SWAP_ENDIAN_INPLACE also allows structures).

SWAP_ENDIAN_INPLACE differs from the SWAP_ENDIAN function in that it alters the input data in place rather than making a copy as does SWAP_ENDIAN. SWAP_ENDIAN_INPLACE can therefore be more efficient, if a copy of the data is not needed. The pertinent bytes in the input variable are reversed.

This routine is written in the IDL language. Its source code can be found in the file `swap_endian_inplace.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

SWAP_ENDIAN_INPLACE, *Variable* [, /SWAP_IF_BIG_ENDIAN] [, /SWAP_IF_LITTLE_ENDIAN]

## Arguments

### Variable

The named variable—scalar, array, or structure—to be swapped.

## Keywords

### SWAP_IF_BIG_ENDIAN

If this keyword is set, the swap request will only be performed if the platform running IDL uses “big endian” byte ordering. On little endian machines, the SWAP_ENDIAN_INPLACE request quietly returns without doing anything. Note that this keyword does not refer to the byte ordering of the input data, but to the computer hardware.

### SWAP_IF_LITTLE_ENDIAN

If this keyword is set, the swap request will only be performed if the platform running IDL uses “little endian” byte ordering. On big endian machines, the SWAP_ENDIAN_INPLACE request quietly returns without doing anything. Note that this keyword does not refer to the byte ordering of the input data, but to the computer hardware.

## Examples

Reverse the byte order of A:

```
SWAP_ENDIAN_INPLACE, A
```

## Version History

Introduced: 5.6

## See Also

BYTEORDER, SWAP_ENDIAN

# SWITCH

The SWITCH statement is used to select one statement for execution from multiple choices, depending upon the value of the expression following the word SWITCH.

Each statement that is part of a SWITCH statement is preceded by an expression that is compared to the value of the SWITCH expression. SWITCH executes by comparing the SWITCH expression with each selector expression in the order written. If a match is found, program execution jumps to that statement and execution continues from that point. Whereas CASE executes at most one statement within the CASE block, SWITCH executes the first matching statement and any following statements in the SWITCH block. Once a match is found in the SWITCH block, execution falls through to any remaining statements. For this reason, the BREAK statement is commonly used within SWITCH statements to force an immediate exit from the SWITCH block.

The ELSE clause of the SWITCH statement is optional. If included, it matches any selector expression, causing its code to be executed. For this reason, it is usually written as the last clause in the switch statement. The ELSE statement is executed only if none of the preceding statement expressions match. If an ELSE clause is not included and none of the values match the selector, program execution continues immediately below the SWITCH without executing any of the SWITCH statements.

SWITCH is similar to the CASE statement. For more information on using SWITCH and other IDL program control statements, as well as the differences between SWITCH and CASE, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

SWITCH *expression* OF

*expression*: *statement*

...

*expression*: *statement*

ELSE: *statement*

ENDSWITCH

## Examples

This example illustrates how, unlike CASE, SWITCH executes the first matching statement and any following statements in the SWITCH block:

```
x=2

SWITCH x OF
   1: PRINT, 'one'
   2: PRINT, 'two'
   3: PRINT, 'three'
   4: PRINT, 'four'
ENDSWITCH
```

IDL Prints:

```
two
three
four
```

## Version History

Introduced: 5.4

## See Also

CASE

# SYSTIME

The SYSTIME function returns the current time as either a date/time string, as the number of seconds elapsed since 1 January 1970, or as a Julian date/time value.

## Syntax

*String* = SYSTIME( [0 [, *ElaspedSeconds*]] [, /UTC] )

or

*Seconds* = SYSTIME( 1 | /SECONDS )

or

*Julian* = SYSTIME( /JULIAN [, /UTC] )

## Return Value

Returns the specified time.

## Arguments

### SecondsFlag

If *SecondsFlag* is present and nonzero, the number of seconds elapsed since 1 January 1970 UTC is returned as a double-precision, floating-point value.

Otherwise, if *SecondsFlag* is not present or zero, a scalar string containing the date/time is returned in standard 24-character system format as follows:

```
DOW MON DD HH:MM:SS YEAR
```

where DOW is the day of the week, MON is the month, DD is the day of the month, HH is the hour, MM is the minute, SS is the second, and YEAR is the year. By default, the date/time string is adjusted for the local time zone; use the UTC keyword to override this default.

**Note**

If the JULIAN or SECONDS keyword is set, the *SecondsFlag* argument is ignored.

### ElapsedSeconds

If the *SecondsFlag* argument is zero, the *ElapsedSeconds* argument may be set to the number of seconds past 1 January 1970 UTC. In this case, SYSTIME returns the

corresponding date/time string (rather than the string for the current time). The returned date/time string is adjusted for the local time zone, unless the UTC keyword is set. If this argument is present, the JULIAN keyword is not allowed.

# Keywords

## JULIAN

Set this keyword to specify that the current time is to be returned as a a double precision floating value containing the current Julian date/time. By default, the current time is adjusted for the local time zone; use the UTC keyword to override this default. This keyword is not allowed if the *ElapsedSeconds* argument is present.

**Note**

If the JULIAN keyword is set, a small offset is added to the returned Julian date to eliminate roundoff errors when calculating the day fraction from hours, minutes, and seconds. This offset is given by the larger of EPS and EPS*Julian, where Julian is the integer portion of the Julian date, and EPS is the EPS field from MACHAR. For typical Julian dates, this offset is approximately $6x10^{-10}$ (which corresponds to $5x10^{-5}$ seconds). This offset ensures that if the Julian date is converted back to hour, minute, and second, then the hour, minute, and second will have the same integer values as were originally input.

## SECONDS

Set this keyword to specify that the current time is to be returned as the number of seconds elapsed since 1 January 1970 UTC. This option is equivalent to setting the *SecondsFlag* argument to a non-zero value.

## UTC

Set this keyword to specify that the value returned by SYSTIME is to be returned in Universal Time Coordinated (UTC) rather than being adjusted for the current time zone. UTC time is defined as Greenwich Mean Time updated with leap seconds.

# Examples

Print today’s date as a string:

```
PRINT, SYSTIME()
```

Print today’s date as a string in UTC (rather than local time zone):

```
PRINT, SYSTIME(/UTC)
```

Print today's date as a Julian date/time value in UTC:

```
PRINT, SYSTIME(/JULIAN, /UTC), FORMAT='(f12.2)'
```

Compute the seconds elapsed since 1 January 1970 UTC:

```
seconds = SYSTIME(1) ; or seconds = SYSTIME(/SECONDS)
```

Verify that the seconds from the previous example are correct:

```
PRINT, SYSTIME(0, seconds)
```

Print the day of the week:

```
PRINT, STRMID(SYSTIME(0), 0, 3)
```

Compute the time required to perform a 16,384 point FFT:

```
T = SYSTIME(1)
A = FFT(FINDGEN(16384), -1)
PRINT, SYSTIME(1) - T, 'Seconds'
```

## Version History

Introduced: Original

## See Also

CALDAT, CALENDAR, JULDAY, TIMEGEN

# T_CVF

The T_CVF function computes the cutoff value *V* in a Student's t distribution with *Df* degrees of freedom such that the probability that a random variable *X* is greater than *V* is equal to a user-supplied probability *P*.

**Note**

T_CVF computes the cutoff value using the one-tailed probability. The cutoff value for the two-tailed probability, which is the probability that the absolute value of *X* is greater than *V*), can be computed as T_CVF(*P*/2, *Df*).

This routine is written in the IDL language. Its source code can be found in the file `t_cvf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = T_CVF(*P, Df*)

## Return Value

Returns the cutoff value.

## Arguments

### P

A non-negative single- or double-precision floating-point scalar, in the interval [0.0, 1.0], that specifies the probability of occurrence or success.

### Df

A positive integer, single- or double-precision floating-point scalar that specifies the number of degrees of freedom of the Student's t distribution.

## Keywords

None.

## Examples

Use the following command to compute the cutoff value in a Student’s t distribution with five degrees of freedom such that the probability that a random variable X is greater than the cutoff value is 0.025.

```
result = T_CVF(0.025, 5)
PRINT, result
```

IDL prints:

```
2.57058
```

## Version History

Introduced: 4.0

## See Also

CHISQR_CVF, F_CVF, GAUSS_CVF, T_PDF

# T_PDF

The T_PDF function computes the probability *P* that, in a Student's t distribution with *Df* degrees of freedom, a random variable *X* is less than or equal to a user-specified cutoff value *V*.

**Note**

T_PDF computes the one-tailed probability. The two-tailed probability, which is the probability that the absolute value of *X* is less than or equal to *V*, can be computed as 1 - 2×(1 - T_PDF(*V, Df*)).

This routine is written in the IDL language. Its source code can be found in the file `t_pdf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = T_PDF(*V, Df*)

## Return Value

If both arguments are scalar, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of *V* and *Df*, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the input array.

If any of the arguments are double-precision, the result is double-precision, otherwise the result is single-precision.

## Arguments

### V

A scalar or array that specifies the cutoff value(s).

### Df

A scalar or array that specifies the number of degrees of freedom of the Student's t distribution.

## Keywords

None.

## Examples

Use the following command to compute the probability that a random variable X, from the Student's t distribution with 15 degrees of freedom, is less than or equal to 0.691:

```
PRINT, T_PDF(0.691, 15)
```

IDL prints:

```
0.749940
```

## Version History

Introduced: 4.0

## See Also

BINOMIAL, CHISQR_PDF, F_PDF, GAUSS_PDF, T_CVF

# T3D

The T3D procedure implements three-dimensional transforms.

This routine accumulates one or more sequences of translation, scaling, rotation, perspective, and oblique transformations and stores the result in !P.T, the 3D transformation system variable. All the IDL graphic routines use this (4,4) matrix for output. Note that !P.T3D is *not* set, so for the transformations to have effect you must set !P.T3D = 1 (or set the T3D keyword in subsequent calls to graphics routines).

This procedure is based on that of Foley & Van Dam, *Fundamentals of Interactive Computer Graphics*, Chapter 8, “Viewing in Three Dimensions”. The matrix notation is reversed from the normal IDL sense, i.e., here, the first subscript is the column, the second is the row, in order to conform with this reference.

A right-handed system is used. Positive rotations are counterclockwise when looking from a positive axis position towards the origin.

This routine is written in the IDL language. Its source code can be found in the file `t3d.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

T3D [, *Array* | , /RESET] [, MATRIX=*variable*] [, OBLIQUE=*vector*]
[, PERSPECTIVE=*p*{eye at (0,0,*p*)}] [, ROTATE=*[x, y, z]*] [, SCALE=*[x, y, z]*]
[, TRANSLATE=*[x, y, z]*] [, /XYEXCH | , /XZEXCH | , /YZEXCH]

## Arguments

### Array

An optional 4 x 4 matrix used as the starting transformation. If *Array* is missing, the current !P.T transformation is used. *Array* is ignored if /RESET is set.

## Keywords

The transformation specified by each keyword is performed in the order of their descriptions below (e.g., if both TRANSLATE and SCALE are specified, the translation is done first).

## MATRIX

Set this keyword to a named variable that will contain the result. If this keyword is specified, !P.T is not modified.

## OBLIQUE

A two-element vector of oblique projection parameters. Points are projected onto the XY plane at Z=0 as follows:

```
x' = x + z(d * COS(a))
y' = y + z(d * SIN(a))
```

where OBLIQUE[0] = d and OBLIQUE[1] = a.

## PERSPECTIVE

Perspective transformation. This parameter is a scalar (p) that indicates the Z distance of the center of the projection. Objects are projected into the XY plane at Z=0, and the “eye” is at point (0,0,p).

## RESET

Set this keyword to reset the transformation to the default identity matrix.

## ROTATE

A three-element vector of the rotations, in DEGREES, about the X, Y, and Z axes. Rotations are performed in the order of X, Y, and then Z.

## SCALE

A three-element vector of scale factors for the X, Y, and Z axes.

## TRANSLATE

A three-element vector of the translations in the X, Y, and Z directions.

## XYEXCH

Set this keyword to exchange the X and Y axes.

## XZEXCH

Set this keyword to exchange the X and Z axes.

### YZEXCH

Set this keyword to exchange the Y and Z axes.

## Examples

To reset the transformation, rotate 30 degs about the X axis and do perspective transformation with the center of the projection at Z = -1, X=0, and Y=0, enter:

```
T3D, /RESET, ROT = [ 30,0,0], PERS = 1.
```

Transformations may be cascaded, for example:

```
T3D, /RESET, TRANS = [-.5,-.5,0], ROT = [0,0,45]
T3D, TRANS = [.5,.5,0]
```

The first command resets, translates the point (.5,.5,0) to the center of the viewport, then rotates 45 degrees counterclockwise about the Z axis. The second call to T3D moves the origin back to the center of the viewport.

## Version History

Introduced: Original

## See Also

SCALE3, SCALE3D, SURFR

# TAG_NAMES

The TAG_NAMES function returns a string array containing the names of the tags in a structure expression. It can also be used to determine the expression's structure name (if the structure has a name).

## Syntax

*Result* = TAG_NAMES( *Expression* [, /STRUCTURE_NAME] )

## Return Value

Returns structure tag names or the expression's structure name.

## Arguments

### Expression

The structure expression for which the tag names are returned. This argument must be of structure type. TAG_NAMES does not search for tags recursively, so if *Expression* is a structure containing nested structures, only the names of tags in the outermost structure are returned.

## Keywords

### STRUCTURE_NAME

Set this keyword to return a scalar string that contains the name of the structure instead of the names of the tags in the structure. If the structure is "anonymous", a null string is returned.

## Examples

Print the names of the tags in the system variable !P by entering:

```
PRINT, TAG_NAMES(!P)
```

IDL prints:

```
BACKGROUND CHARSIZE CHARTHICK CLIP COLOR FONT LINESTYLE MULTI
NOCLIP NOERASE NSUM POSITION PSYM REGION SUBTITLE SYMSIZE T
T3D THICK TITLE TICKLEN CHANNEL
```

Print the name of the structure in the system variable !P:

```
PRINT, TAG_NAMES(!P, /STRUCTURE_NAME)
```

IDL prints:

```
!PLT
```

## Version History

Introduced: Original

## See Also

CREATE_STRUCT, N_TAGS

# TAN

The TAN function computes the tangent of *X*.

## Syntax

*Result* = TAN(*X*)

## Return Value

Returns the tangent of the specified angle.

## Arguments

### X

The angle for which the tangent is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. If *X* is an array, the result has the same structure, with each element containing the tangent of the corresponding element of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

```
; Find the tangent of 0.5 radians and store the result in
; the variable T:
T = TAN(0.5)
```

## Version History

Introduced: Original

## See Also

ATAN, TANH

# TANH

The TANH function returns the hyperbolic tangent of X.

## Syntax

*Result* = TANH(*X*)

## Return Value

Returns the single- or double-precision hyperbolic tangent.

## Arguments

### X

The value for which the hyperbolic tangent is desired, specified in radians. If *X* is double-precision floating or complex, the result is of the same type. All other types are converted to single-precision floating-point and yield floating-point results. TANH is defined as:

$$\tanh(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$$

If *X* is an array, the result has the same structure, with each element containing the hyperbolic tangent of the corresponding element of *X*.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

```
; Find the hyperbolic tangent of 1 radian and print the result:
PRINT, TANH(1)

; Plot the hyperbolic tangent from -5 to +5 with an increment
; of 0.1:
PLOT, TANH(FINDGEN(101)/10. - 5)
```

## Version History

Introduced: Original

## See Also

ATAN, TAN

# TEK_COLOR

The TEK_COLOR procedure loads a 32-color colortable similar to the default Tektronix 4115 colortable. This colortable is useful because of its distinct colors.

By default, this palette consists of 32 colors. The first 9 colors are: Index 0=black, 1=white, 2=red, 3=green, 4=blue, 5=cyan, 6=magenta, 8=orange.

## Syntax

TEK_COLOR [, *Start_Index*, *Colors*]

## Arguments

### Start_Index

An optional starting index for the palette. The default is 0. If this argument is included, the colors are loaded into the current colortable starting at the specified index.

### Colors

The number of colors to load. The default is 32, which is also the maximum.

## Keywords

None.

## Version History

Introduced: Pre 4.0

## See Also

LOADCT, XLOADCT

# TEMPORARY

The TEMPORARY function returns a temporary copy of a variable, and sets the original variable to “undefined”. This function can be used to conserve memory when performing operations on large arrays, as it avoids making a new copy of results that are only temporary. In general, the TEMPORARY routine can be used to advantage whenever a variable containing an array on the left hand side of an assignment statement is also referenced on the right hand side.

## Syntax

*Result* = TEMPORARY(*Variable*)

## Return Value

Returns a copy of a specified variable.

## Arguments

### Variable

The variable to be referenced and deleted.

## Keywords

None.

## Examples

Assume the variable `A` is a large array of integers. The statement:

```
A = A + 1
```

creates a new array for the result of the addition, places the sum into the new array, assigns it to `A`, and then frees the old allocation of `A`. Total storage required is twice the size of `A`. The statement:

```
A = TEMPORARY(A) + 1
```

requires no additional space.

**Note**

If the operation performed on *Variable* requires that *Variable* be converted to another data type, there is no benefit to using TEMPORARY. For instance, if the

array A in the above example contained byte data rather than integer data, the array would have to be converted to integer type before the addition could be performed. In such a case, memory could not be re-used.

## Version History

Introduced: Pre 4.0

## See Also

DELVAR

# TETRA_CLIP

The TETRA_CLIP function clips a tetrahedral mesh to an arbitrary plane in space and returns a tetrahedral mesh of the remaining portion. An auxiliary array of data may also be passed and clipped. This array can have multiple values for each vertex (the trailing array dimension must match the number of vertices in the Vertsin array).

A tetrahedral connectivity array consists of groups of four vertex index values. Each set of four index values specifies four vertices which define a single tetrahedron.

## Syntax

*Result* = TETRA_CLIP ( *Plane*, *Vertsin*, *Connin*, *Vertsout*, *Connout* [, AUXDATA_IN=*array*, AUXDATA_OUT=*variable*] [, CUT_VERTS=*variable*] )

## Return Value

The return value is the number of tetrahedra returned.

## Arguments

### Plane

Input four-element array describing the equation of the plane to be clipped to. The elements are the coefficients (*a*,*b*,*c*,*d*) of the equation $ax+by+cz+d=0$.

### Vertsin

Input array of tetrahedral vertices [3, *n*].

### Connin

Input tetrahedral mesh connectivity array.

### Vertsout

Output array of tetrahedral vertices [3, *n*].

### Connout

Output tetrahedral mesh connectivity array.

# Keywords

## AUXDATA_IN

Input array of auxiliary data. If present, these values are interpolated and returned through AUXDATA_OUT. The trailing array dimension must match the number of vertices in the Vertsin array.

## AUXDATA_OUT

Set this keyword to a named variable to contain an output array of interpolated auxiliary data.

## CUT_VERTS

Set this keyword to a named variable to contain an output array of vertex indices (into Vertsout) of the vertices which are considered to be ‘on’ the clipped surface.

# Version History

Introduced: 5.5

# TETRA_SURFACE

The TETRA_SURFACE function extracts a polygonal mesh as the exterior surface of a tetrahedral mesh. The output of this function is a polygonal mesh connectivity array that can be used with the input Verts array to display the outer surface of the tetrahedral mesh.

## Syntax

*Result* = TETRA_SURFACE (*Verts*, *Connin*)

## Return Value

Returns a polygonal mesh connectivity array. When used with the input vertex array, this function yields the exposed tetrahedral mesh surface.

## Arguments

### Verts

Array of vertices [3, *n*].

### Connin

Tetrahedral connectivity array.

## Keywords

None.

## Version History

Introduced: 5.5

# TETRA_VOLUME

The TETRA_VOLUME function computes properties of a tetrahedral mesh array. The basic property is the volume. An auxiliary data array may be supplied which specifies weights at each vertex which are interpolated through the volume during integration. Higher order moments (with respect to the X, Y, and Z axis) may be computed as well (with or without weights).

## Syntax

*Result* = TETRA_VOLUME ( *Verts*, *Conn* [, AUXDATA=*array*] [, MOMENT=*variable*] )

## Return Value

Returns the cumulative (weighted) volume of the tetrahedrons in the mesh.

## Arguments

### Verts

Array of vertices [3, *n*].

### Conn

Tetrahedral connectivity array.

## Keywords

### AUXDATA

Array of input auxiliary data (one value per vertex). If present, these values are used to weight a vertex. The volume area integral will linearly interpolate these values. The volume integral will linearly interpolate these values within each tetrahedra. The default weight is 1.0 which results in a basic volume.

### MOMENT

Set this keyword to a named variable that will contain a three-element float vector which corresponds to the first order moments computed with respect to the X, Y and Z axis. The computation is:

$$\vec{m} = \sum_{ntetras} v_i \vec{c}_i$$

where v is the (weighted) volume of the tetrahedron and c is the centroid of the tetrahedron, thus

$$\vec{m} / volume$$

yields the (weighted) centroid of the tetrahedral mesh.

## Version History

Introduced: 5.5

# THIN

The THIN function returns the “skeleton” of a bi-level image. The skeleton of an object in an image is a set of lines that reflect the shape of the object. The set of skeletal pixels can be considered to be the medial axis of the object. For a much more extensive discussion of skeletons and thinning algorithms, see *Algorithms for Graphics and Image Processing*, Theo Pavlidis, Computer Science Press, 1982. The THIN function is adapted from Algorithm 9.1 (the classical thinning algorithm).

On input, the bi-level image is a rectangular array in which pixels that compose the object have a nonzero value. All other pixels are zero. The result is a byte type image in which skeletal pixels are set to 2 and all other pixels are zero.

## Syntax

*Result* = THIN( *Image* [, /NEIGHBOR_COUNT] [, /PRUNE] )

## Return Value

Returns the thinned, two-dimensional byte array.

## Arguments

### Image

The two-dimensional image (array) to be thinned.

## Keywords

### NEIGHBOR_COUNT

Set this keyword to select an alternate form of output. In this form, output pixel values count the number of neighbors an individual skeletal pixel has (including itself). For example, a pixel that is part of a line will have the value 3 (two neighbors and itself). Terminal pixels will have the value 2, while isolated pixels have the value 1.

### PRUNE

If the PRUNE keyword is set, pixels with single neighbors are removed iteratively until only pixels with 2 or more neighbors exist. This effectively removes (or “prunes”) skeleton branches, leaving only closed paths.

## Examples

The following commands display the “thinned” edges of a Sobel filtered image:

```
; Open a file for reading:
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])

; Create a byte array in which to store the image:
A = BYTARR(192, 192)

; Read first 192 by 192 image:
READU, 1, A

; Close the file:
CLOSE, 1

; Display the image:
TV, A, 0

; Apply the Sobel filter, threshold the image at value 75, and
; display the thinned edges:
TVSCL, THIN(SOBEL(A) GT 75), 1
```

## Version History

Introduced: Pre 4.0

## See Also

ROBERTS, SOBEL

# THREED

The THREED procedure plots a 2-D array as a pseudo 3-D plot. The orientation of the data is fixed. This routine is written in the IDL language. Its source code can be found in the file `threed.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

THREED, *A* [, *Sp*] [, TITLE=*string*] [, XTITLE=*string*] [, YTITLE=*string*]

## Arguments

### A

The two-dimensional array to plot.

### Sp

The spacing between plot lines. If *Sp* is omitted, the spacing is set to: (MAX(*A*)-MIN(*A*))/ROWS. If *Sp* is negative, hidden lines are not removed.

## Keywords

### TITLE

Set this keyword to the main plot title.

### XTITLE

Set this keyword to the X axis title.

### YTITLE

Set this keyword to the Y axis title.

## Examples

```
; Create a 2-D dataset:
A = -SHIFT(DIST(30), 15, 15)
; Make a THREED plot:
THREED, A
; Compare to SURFACE:
SURFACE, A
```

## Version History

Introduced: Original

## See Also

SURFACE

# TIME_TEST2

The TIME_TEST2 procedure is a general-purpose IDL benchmark program that performs approximately 20 common operations and prints the time required.

This routine is written in the IDL language. Its source code can be found in the file `time_test.pro` in the `lib` subdirectory of the IDL distribution. This file also contains the procedure GRAPHICS_TIMES, used to time graphical operations.

## Syntax

TIME_TEST2 [, *Filename*]

## Arguments

### Filename

An optional string that contains the name of output file for the results of the time test.

## Keywords

None.

## Examples

```
; Run the computational tests:
TIME_TEST2

; Run the graphics tests. Note that TIME_TEST2 must be compiled
; before GRAPHICS_TIMES will run:
GRAPHICS_TIMES
```

## Version History

Introduced: 4.0

## See Also

SYSTIME

# TIMEGEN

The TIMEGEN function returns an array, with specified dimensions, of double-precision floating-point values that represent times in terms of Julian dates.

The Julian date is the number of days elapsed since Jan. 1, 4713 B.C.E., plus the time expressed as a day fraction. Following the astronomical convention, the day is defined to start at 12 PM (noon). Julian date 0.0d is therefore Jan. 1, 4713 B.C.E. at 12:00:00.

The first value of the returned array corresponds to a Julian date start time, and each subsequent value corresponds to the next Julian date in the sequence. The sequence is determined by specifying the time unit (such as months or seconds) and the step size, or spacing, between the units. You can also construct more complicated arrays by including smaller time units within each major time interval.

A small offset is added to each Julian date to eliminate roundoff errors when calculating the day fraction from the hour, minute, second. This offset is given by the larger of EPS and EPS*Julian, where Julian is the integer portion of the Julian date and EPS is the double-precision floating-point precision parameter from MACHAR. For typical Julian dates the offset is approximately $6x10^{-10}$ (which corresponds to $5x10^{-5}$ seconds). This offset ensures that when the Julian date is converted back to the hour, minute, and second, the hour, minute, and second will have the same integer values.

**Tip**

Because of the large magnitude of the Julian date (1 Jan 2000 is Julian day 2451545), the precision of most Julian dates is limited to 1 millisecond (0.001 seconds). If you are not interested in the date itself, you can improve the precision by subtracting a large offset or setting the START keyword to zero.

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000, respectively.

## Syntax

*Result* = TIMEGEN( [*D1,...,D8* | , FINAL=*value*] [, DAYS=*vector*] [, HOURS=*vector*] [, MINUTES=*vector*] [, MONTHS=*vector*] [, SECONDS=*vector*] [, START=*value*] [, STEP_SIZE=*value*] [, UNITS=*string*] [, YEAR=*value*] )

# Return Value

Returns the specified time values.

# Arguments

## $D_i$

The dimensions of the result. The dimension parameters may be any scalar expression. Up to eight dimensions may be specified. If the dimension arguments are not integer values, IDL will truncate them to integer values before creating the new array. The dimension arguments are required unless keyword FINAL is set, in which case they are ignored.

# Keywords

## DAYS

Set this keyword to a scalar or a vector giving the day values that should be included within each month. This keyword is ignored if the UNITS keyword is set to “Days”, “Hours”, “Minutes”, or “Seconds”.

**Note**

Day values that are beyond the end of the month will be set equal to the last day for that month. For example, setting `DAY=[31]` will automatically return the last day in each month.

## FINAL

Set this keyword to a double-precision value representing the Julian date/time to use as the last value in the returned array. In this case, the dimension arguments are ignored and *Result* is a one-dimensional array, with the number of elements depending upon the step size. The FINAL time may be less than the START time, in which case STEP_SIZE should be negative.

**Note**

If the step size is not an integer then the last element may not be equal to the FINAL time. In this case, TIMEGEN will return enough elements such that the last element is less than or equal to FINAL.

## HOURS

Set this keyword to a scalar or a vector giving the hour values that should be included within each day. This keyword is ignored if UNITS is set to “Hours”, “Minutes”, or “Seconds”.

## MINUTES

Set this keyword to a scalar or a vector giving the minute values that should be included within each hour. This keyword is ignored if UNITS is set to “Minutes” or “Seconds”.

## MONTHS

Set this keyword to a scalar or a vector giving the month values that should be included within each year. This keyword is ignored if UNITS is set to “Months”, “Days”, “Hours”, “Minutes”, or “Seconds”.

## SECONDS

Set this keyword to a scalar or a vector giving the second values that should be included within each minute. This keyword is ignored if UNITS is set to “Seconds”.

## START

Set this keyword to a double-precision value representing the Julian date/time to use as the first value in the returned array. The default is 0.0d [corresponding to January 1, 4713 B.C.E. at 12 pm (noon)].

**Note**

If subintervals are provided by MONTHS, DAYS, HOURS, MINUTES, or SECONDS, then the first element may not be equal to the START time. In this case the first element in the returned array will be greater than or equal to START.

**Tip**

Other array generation routines in IDL (such as FINDGEN) do not allow you to specify a starting value because the resulting array can be added to a scalar representing the start value. For TIMEGEN it is correct to add a scalar to the array if the units are days, hours, minutes, seconds, or sub-seconds. For example:

```
MyTimes = TIMEGEN(365, UNITS="Days") + SYSTIME(/JULIAN)
```

However, if the units are months or years, the start value is necessary because the number of days in a month or year can vary depending upon the year in which they

fall (for instance, consider leap years). For example:

```
MyTimes = TIMEGEN(12, UNITS="Months", START=JULDAY(1,1,2000))
```

## STEP_SIZE

Set this keyword to a scalar value representing the step size between the major intervals of the returned array. The step size may be negative. The default step size is 1. When the UNITS keyword is set to “Years” or “Months”, the STEP_SIZE value is rounded to the nearest integer.

## UNITS

Set this keyword to a scalar string indicating the time units to be used for the major intervals for the generated array. Valid values include:

- “Years” or “Y”
- “Months” or “M”
- “Days” or “D”
- “Hours” or “H”
- “Minutes” or “I”
- “Seconds” or “S”

The case (upper or lower) is ignored. If this keyword is not specified, then the default for UNITS is the time unit that is larger than the largest keyword present:

| Largest Keyword Present | Default UNITS |
|---|---|
| SECONDS=*vector* | “Minutes” |
| MINUTES=*vector* | “Hours” |
| HOURS=*vector* | “Days” |
| DAYS=*vector* | “Months” |
| MONTHS=*vector* | “Years” |
| YEAR=*value* | “Years” |

*Table 93: Defaults for the UNITS keyword*

If none of the above keywords are present, the default is UNITS="Days".

### YEAR

Set this keyword to a scalar giving the starting year. If YEAR is specified then the starting year from START is ignored.

## Examples

Generate an array of 366 time values that are one day apart starting with January 1, 2000:

```
MyDates = TIMEGEN(366, START=JULDAY(1,1,2000))
```

Generate an array of 20 time values that are 12 hours apart starting with the current time:

```
MyTimes = TIMEGEN(20, UNITS='Hours', STEP_SIZE=12, $
   START=SYSTIME(/JULIAN))
```

Generate an array of time values that are 1 hour apart from 1 January 2000 until the current time:

```
MyTimes = TIMEGEN(START=JULDAY(1,1,2000), $
   FINAL=SYSTIME(/JULIAN), UNITS='Hours')
```

Generate an array of time values composed of seconds, minutes, and hours that start from the current hour:

```
MyTimes = TIMEGEN(60, 60, 24, $
   START=FLOOR(SYSTIME(/JULIAN)*24)/24d, UNITS='S')
```

Generate an array of 24 time values with monthly intervals, but with subintervals at 5 PM on the first and fifteenth of each month:

```
MyTimes = TIMEGEN(24, START=FLOOR(SYSTIME(/JULIAN)), $
   DAYS=[1,15], HOURS=17)
```

## Version History

Introduced: 5.4

## See Also

"Format Codes" in Chapter 10 of the *Building IDL Applications* manual, CALDAT, JULDAY, LABEL_DATE, SYSTIME

# TM_TEST

The TM_TEST function computes the Student's T-statistic and the probability that two sample populations *X* and *Y* have significantly different means. *X* and *Y* may be of different lengths. The default assumption is that the data is drawn from populations with the same true variance. This type of test is often referred to as the t-means test.

The T-statistic for sample populations *x* and *y* with means $\bar{x}$ and $\bar{y}$ is defined as:

$$T = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{\sum_{j=0}^{N-1} (x_i - \bar{x})^2 + \sum_{j=0}^{M-1} (y_i - \bar{y})^2}{(N + M - 2)} \left(\frac{1}{N} + \frac{1}{M}\right)}}$$

where $x = (x_0, x_1, x_2, ..., x_{N-1})$ and $y = (y_0, y_1, y_2 ..., y_{M-1})$

This routine is written in the IDL language. Its source code can be found in the file `tm_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = TM_TEST( *X*, *Y* [, /PAIRED] [, /UNEQUAL] )

## Return Value

The result is a two-element vector containing the T-statistic and its significance. The significance is a value in the interval [0.0, 1.0]; a small value (0.05 or 0.01) indicates that *X* and *Y* have significantly different means.

## Arguments

### X

An *n*-element integer, single-, or double-precision floating-point vector.

### Y

An *m*-element integer, single-, or double-precision floating-point vector. If the PAIRED keyword is set, *X* and *Y* must have the same number of elements.

## Keywords

### PAIRED

If this keyword is set, *X* and *Y* are assumed to be paired samples and must have the same number of elements.

### UNEQUAL

If this keyword is set, *X* and *Y* are assumed to be from populations with unequal variances.

## Examples

```
; Define two n-element sample populations.
X = [257, 208, 296, 324, 240, 246, 267, 311, 324, 323, 263, $
     305, 270, 260, 251, 275, 288, 242, 304, 267]
Y = [201, 56, 185, 221, 165, 161, 182, 239, 278, 243, 197, $
     271, 214, 216, 175, 192, 208, 150, 281, 196]

; Compute the Student's t-statistic and its significance assuming
; that X and Y belong to populations with the same true variance:
PRINT, TM_TEST(X, Y)
```

IDL prints:

```
5.52839  2.52455e-06
```

The result indicates that *X* and *Y* have significantly different means.

## Version History

Introduced: 4.0

## See Also

FV_TEST, KW_TEST, RS_TEST, S_TEST

# TOTAL

The TOTAL function returns the sum of the elements of *Array*. The sum of the array elements over a given dimension is returned if the *Dimension* argument is present.

## Syntax

*Result* = TOTAL( *Array* [, *Dimension*] [, /CUMULATIVE] [, /DOUBLE] [, /NAN] )

## Return Value

Returns the array sum for the specified dimensions.

## Arguments

### Array

The array to be summed. This array can be of any basic type except string. If *Array* is double-precision floating-point, complex, or double-precision complex, the result is of the same type. Otherwise, the result is single-precision floating-point.

### Dimension

The dimension over which to sum, starting at one. If this argument is not present or zero, the scalar sum of all the array elements is returned. If this argument is present, the result is an array with one less dimension than *Array*. For example, if the dimensions of *Array* are $N_1$, $N_2$, $N_3$, and *Dimension* is 2, the dimensions of the result are ($N_1$, $N_3$), and element *(i,j)* of the result contains the sum:

$$\sum_{k=0}^{N_2-1} A_{i,k,j}$$

## Keywords

### CUMULATIVE

If this keyword is set, the result is an array of the same size as the input, with each element, i, containing the sum of the input array elements 0 to i. This keyword also works with the Dimension parameter, in which case the sum is performed over the given dimension.

## DOUBLE

Set this keyword to perform the summation in double-precision floating-point.

## NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

**Note**

Since the value NaN is treated as missing data, if *Array* contains only NaN values the TOTAL routine will return 0.

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

The thread pool is used for non-cumulative sums, and is not used if the CUMULATIVE keyword is specified. In a cumulative sum, each result value depends on all of the previous results, so overlapped execution is not possible.

You should be aware that when summing a large number of values, the result from TOTAL can depend heavily upon the order in which the numbers are added. Since the thread pool will add values in a different order, you may obtain a different — but equally correct — result than that obtained using the standard non-threaded implementation. This effect occurs because TOTAL uses floating point arithmetic, and the mantissa of a floating point value has a fixed number of significant digits. The effect is especially obvious when using single precision arithmetic, but can also affect double precision computations. Such differences do not mean that the sums are incorrect. Rather, they mean that they are equal within the ability of the floating point representation used to represent them. For more information on floating-point numbers, see "Accuracy & Floating-Point Operations" in Chapter 22 of the *Using IDL* manual.

It is also worth noting that this effect, while illustrated by the use of the thread pool, is not caused by the use of threading. It is simply caused by the different order in which

the numbers are summed, as can be illustrated by the following non-threaded example:

```
vec = FINDGEN(100000)
PRINT, TOTAL(vec, /TPOOL_NO) - TOTAL(REVERSE(vec), /TPOOL_NO)
```

IDL prints:

```
-96768.0
```

As you can see, the small floating-point errors can accumulate across the sum of a large number of values.

**Note**

The computation above was done on a Sun Sparc workstation. Your result will depend on the architecture of your CPU; it may be slightly different, and in the notable case of Intel-compatible X86 CPUs may actually be zero due to the use of internal 80-bit floating point registers on that CPU which give it better than double precision accuracy for some computations. Nonetheless, you should be aware of the fact that the order of operations can influence the result.

# Examples

## Example 1

This example sums the elements of a one-dimensional array:

```
; Define a one-dimensional array:
A = [20, 10, 5, 5, 3]

; Sum the elements of the array:
SUMA = TOTAL([20, 10, 5, 5, 3])

; Print the results:
PRINT, 'A = ', A
PRINT, 'Sum of A = ', SUMA
```

IDL prints:

```
A =   20   10   5   5   3
Sum of A =   43.0000
```

## Example 2

The results are different when a multi-dimensional array is used:

```
; Define a multi-dimensional array:
A = FINDGEN(5,5)
```

```
; Sum each of the rows in A:
SUMROWS = TOTAL(A, 1)

; Sum each of the columns in A:
SUMCOLS = TOTAL(A, 2)

; Print the results:
PRINT, 'A = ', A
PRINT, 'Sum of each row:', SUMROWS
PRINT, 'Sum of each column:', SUMCOLS
```

IDL prints:

```
A = 0.000000   1.00000   2.00000   3.00000   4.00000
    5.00000    6.00000   7.00000   8.00000   9.00000
    10.0000    11.0000   12.0000   13.0000   14.0000
    15.0000    16.0000   17.0000   18.0000   19.0000
    20.0000    21.0000   22.0000   23.0000   24.0000

Sum of each row:  10.0000  35.0000  60.0000  85.0000  110.000

Sum of each column:  50.0000  55.0000  60.0000  65.0000  70.0000
```

## Version History

Introduced: Original

## See Also

FACTORIAL

# TRACE

The TRACE function computes the trace of an *n* by *n* array.

This routine is written in the IDL language. Its source code can be found in the file `trace.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = TRACE( *A* [, /DOUBLE] )

## Return Value

Returns the sum of the values along the array diagonal.

## Arguments

### A

An *n* by *n* real or complex array.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

```
; Define an array:
A = [[ 2.0,1.0,  1.0, 1.5], $
     [ 4.0, -6.0,  0.0, 0.0], $
     [-2.0,  7.0,  2.0, 2.5], $
     [ 1.0,  0.5,  0.0, 5.0]]

; Compute the trace of A:
result = TRACE(A)

;Print the result:
PRINT, 'TRACE(A) = ', result
```

IDL prints:

```
TRACE(A) =   3.00000
```

## Version History

Introduced: 5.0

## See Also

TOTAL

# TrackBall Object

See Appendix , “TrackBall”

# TRANSPOSE

The TRANSPOSE function returns the transpose of *Array*. If an optional permutation vector is provided, the dimensions of *Array* are rearranged as well.

## Syntax

*Result* = TRANSPOSE( *Array* [, *P*] )

## Return Value

Returns the reflection of the array along a diagonal.

## Arguments

### Array

The array to be transposed.

### P

A vector specifying how the dimensions of *Array* will be permuted. The elements of *P* correspond to the dimensions of *Array*; the *i*th dimension of the output array is dimension *P*[*i*] of the input array. Each element of the vector *P* must be unique. Dimensions start at zero and can not be repeated.

If *P* is not present, the order of the dimensions of *Array* is reversed.

## Keywords

None.

## Examples

### Example 1

Print a simple array and its transpose by entering:

```
; Create an array:
A = INDGEN(3,3)
TRANSA = TRANSPOSE(A)
```

```
; Print the array and its transpose:
PRINT, 'A:'
PRINT, A
PRINT, 'Transpose of A:'
PRINT, TRANSA
```

IDL prints:

```
A:
   0  1  2
   3  4  5
   6  7  8

Transpose of A:
   0  3  6
   1  4  7
   2  5  8
```

### Example 2

This example demonstrates multi-dimensional transposition:

```
; Create the array:
A = INDGEN(2, 3, 4)

; Take the transpose, reversing the order of the indices:
B = TRANSPOSE(A)

; Re-order the dimensions of A, so that the second dimension
; becomes the first, the third becomes the second, and the first
; becomes the third:
C = TRANSPOSE(A, [1, 2, 0])

; View the sizes of the three arrays:
HELP, A, B, C
```

IDL prints:

```
A   INT  = Array[2, 3, 4]
B   INT  = Array[4, 3, 2]
C   INT  = Array[3, 4, 2]
```

## Version History

Introduced: Original

## See Also

REFORM, ROT, ROTATE, REVERSE

# TRI_SURF

The TRI_SURF function interpolates a regularly- or irregularly-gridded set of points with a smooth quintic surface.

TRI_SURF is similar to MIN_CURVE_SURF but the surface fitted is a smooth surface, not a minimum curvature surface. TRI_SURF has the advantage of being much more efficient for larger numbers of points.

**Note**

The TRI_SURF function is designed to interpolate low resolution data. Large arrays may cause TRI_SURF to issue the following error message:
`Partial Derivative Approximation Failed to Converge`"
In such cases, interpolation is most likely unnecessary.

This routine is written in the IDL language. Its source code can be found in the file `tri_surf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = TRI_SURF( *Z* [, *X*, *Y*] [, /EXTRAPOLATE] [, MISSING=*value*] [, /REGULAR] [, XGRID=*[xstart, xspacing]* | [, XVALUES=*array*]] [, YGRID=*[yxstart, yspacing]* | [, YVALUES=*array*]] [, GS=*[xspacing, yspacing]*] [, BOUNDS=*[xmin, ymin, xmax, ymax]*] [, NX=*value*] [, NY=*value*] )

## Return Value

The result is s a two-dimensional floating-point array containing the interpolated surface, sampled at the grid points.

## Arguments

### X, Y, Z

arrays containing the X, Y, and Z coordinates of the data points on the surface. Points need not be regularly gridded. For regularly gridded input data, X and Y are not used: the grid spacing is specified via the XGRID and YGRID (or XVALUES and YVALUES) keywords, and Z must be a two dimensional array. For irregular grids, all three parameters must be present and have the same number of elements.

# Keywords

## EXTRAPOLATE

Set this keyword to cause TRI_SURF to extrapolate the surface to points outside the convex hull of input points. This keyword has no effect if the input points are regularly gridded.

## LINEAR

Set this keyword to use linear interpolation, without gradient estimates, instead of quintic interpolation. Linear interpolation does not extrapolate, although it is faster and more numerically stable.

## MISSING

Set this keyword equal to the value to which points outside the convex hull of input points should be set. The default is 0. This keyword has no effect if the input points are regularly gridded.

**Input Grid Description:**

## REGULAR

If set, the *Z* parameter is a two-dimensional array of dimensions (*n*,*m*), containing measurements over a regular grid. If any of XGRID, YGRID, XVALUES, or YVALUES are specified, REGULAR is implied. REGULAR is also implied if there is only one parameter, *Z*. If REGULAR is set, and no grid specifications are present, the grid is set to (0, 1, 2, ...).

## XGRID

A two-element array, [*xstart*, *xspacing*], defining the input grid in the *x* direction. Do not specify both XGRID and XVALUES.

## XVALUES

An *n*-element array defining the *x* locations of Z[*i*,*j*]. Do not specify both XGRID and XVALUES.

## YGRID

A two-element array, [*ystart*, *yspacing*], defining the input grid in the *y* direction. Do not specify both YGRID and YVALUES.

### YVALUES

An *n*-element array defining the *y* locations of Z[*i*,*j*]. Do not specify both YGRID and YVALUES.

**Output Grid Description:**

**Note**

The output grid must enclose the convex hull of the input points.

### GS

The output grid spacing. If present, GS must be a two-element vector [*xs*, *ys*], where *xs* is the horizontal spacing between grid points and *ys* is the vertical spacing. The default is based on the extents of *x* and *y*. If the grid starts at *x* value *xmin* and ends at *xmax*, then the default horizontal spacing is (*xmax* - *xmin*)/(NX-1). YS is computed in the same way. The default grid size, if neither NX or NY are specified, is 26 by 26.

### BOUNDS

If present, BOUNDS must be a four-element array containing the grid limits in *x* and *y* of the output grid: [*xmin*, *ymin*, *xmax*, *ymax*]. If not specified, the grid limits are set to the extent of *x* and *y*.

### NX

The output grid size in the *x* direction. NX need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

### NY

The output grid size in the *y* direction. NY need not be specified if the size can be inferred from GS and BOUNDS. The default value is 26.

## Examples

### Example 1

Regularly gridded case:

```
; Make some random data
Z = randomu(seed, 5, 6)

; Interpolate to a 26 x 26 grid:
CONTOUR, TRI_SURF(Z, /REGULAR)
```

### Example 2

Irregularly gridded case:

```
; Make a random set of points that lie on a Gaussian:
N = 15
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; The Gaussian:
Z = EXP(-2 * ((X-.5)^2 + (Y-.5)^2))

; Use a 26 by 26 grid over the rectangle bounding x and y.
; Get the surface:
R = TRI_SURF(Z, X, Y)

; Alternatively, get a surface over the unit square, with spacing
; of 0.05:
R = TRI_SURF(z, x, y, GS=[0.05, 0.05], BOUNDS=[0,0,1,1])

; Alternatively, get a 10 by 10 surface over the rectangle bounding
; x and y:
R = TRI_SURF(z, x, y, NX=10, NY=10)
```

## Version History

Introduced: Pre 4.0

## See Also

CONTOUR, MIN_CURVE_SURF

# TRIANGULATE

The TRIANGULATE procedure constructs a Delaunay triangulation of a planar set of points. Delaunay triangulations are very useful for the interpolation, analysis, and visual display of irregularly-gridded data. In most applications, after the irregularly gridded data points have been triangulated, the function TRIGRID is invoked to interpolate surface values to a regular grid.

Since Delaunay triangulations have the property that the circumcircle of any triangle in the triangulation contains no other vertices in its interior, interpolated values are only computed from nearby points.

TRIANGULATE can, optionally, return the adjacency list that describes, for each node, the adjacent nodes in the Delaunay triangulation. With this list, the Voronoi polygon (the polygon described by the set of points which are closer to that node than to any other node) can be computed for each node. This polygon contains the area influenced by its associated node. Tiling of the region in this manner is also called Dirichlet, Wigner-Seithz, or Thiessen tessellation.

The grid returned by the TRIGRID function can be input to various routines such as SURFACE, TV, and CONTOUR. See the description of TRIGRID for an example.

TRIANGULATE and TRIDGRID can also be used to perform gridding and interpolation over the surface of a sphere. The interpolation is $C_1$ continuous, meaning that the result is continuous over both the function value and its first derivative. This feature is ideal for interpolating an irregularly-sampled dataset over part or all of the surface of the earth (or other (spherical) celestial bodies). Extrapolation outside the convex hull of sample points is also supported. To perform spherical gridding, you must include the FVALUE and SPHERE keywords described below. The spherical gridding technique used in IDL is based on the paper "Interpolation of Data on the Surface of a Sphere", R. Renka, *Oak Ridge National Laboratory Report ORNL/CSD-108*, 1982.

## Syntax

TRIANGULATE, *X*, *Y*, *Triangles* [, *B*] [, CONNECTIVITY=*variable*]
[, SPHERE=*variable* [, /DEGREES]] [, FVALUE=*variable*] [, REPEATS=*variable*]

## Arguments

### X

An array that contains the X coordinates of the points to be triangulated.

### Y

An array that contains the Y coordinates of the points to be triangulated. Parameters *X* and *Y* must have the same number of elements.

### Triangles

A named variable that, on exit, contains the list of triangles in the Delaunay triangulation of the points specified by the X and Y arguments. Triangles is a longword array dimensioned (3, *number of triangles*), where `Triangles[0, i]`, `Triangles[1, i]`, and `Triangles[2, i]` contain the indices of the vertices of the *i*-th triangle (i.e., `X[Tr[*, i]]` and `Y[Triangles[*, i]]` are the X and Y coordinates of the vertices of the *i*-th triangle).

### B

An optional, named variable that, upon return, contains a list of the indices of the boundary points in counterclockwise order.

## Keywords

### CONNECTIVITY

Set this keyword to a named variable in which the adjacency list for each of the *N* nodes (xy point) is returned. The list has the following form:

Each element *i*, $0 \le i < N$, contains the starting index of the connectivity list for node *i* within the list array. To obtain the adjacency list for node i, extract the list elements from LIST[*i*] to LIST[*i*+1]-1.

The adjacency list is ordered in the counter-clockwise direction. The first item on the list of boundary nodes is the subscript of the node itself. For interior nodes, the list contains the subscripts of the adjacent nodes in counter-clockwise order.

For example, the call:

```
TRIANGULATE, X, Y, CONNECTIVITY = LIST
```

returns the adjacency list in the variable LIST. The subscripts of the nodes adjacent to X[i] and Y[i] are contained in the array:

```
LIST[LIST[i] : LIST[i+1]-1]
```

### DEGREES

Set this keyword to indicate that the *X* and *Y* arguments contain longitude and latitude coordinates specified in degrees. This keyword is only effective if the SPHERE

keyword is specified. If DEGREES is not set, *X* and *Y* are assumed to be specified in radians when a spherical triangulation is performed.

### FVALUE

Set this keyword to a named variable that contains sample values for each longitude/latitude point in a spherical triangulation. On output, the elements of FVALUE are rearranged to correspond to the new ordering of *X* and *Y* (as described in the SPHERE keyword, below). This reordered array can be passed to TRIGRID to complete the interpolation.

### REPEATS

Set this keyword to a named variable to return a (2, *n*) list of the indices of duplicated points. That is, for each *i*,

```
X[REPEATS[0,i]] = X[REPEATS[1,i]]
```

and

```
Y[REPEATS[0,i]] = Y[REPEATS[1,i]]
```

**Note**

Use the GRID_INPUT procedure to handle repeated points (duplicate locations).

### SPHERE

Set this keyword to a named variable in which the results from a spherical triangulation are returned. This result is a structure that can be passed to TRIGRID to perform spherical gridding. The structure contains the 3D Cartesian locations sample points and the adjacency list that describes the triangulation.

When spherical triangulation is performed, *X* and *Y* are interpreted as longitude and latitude, in either degrees or radians (see the DEGREE keyword, above). Also, the order of the elements within the *X* and *Y* parameters is rearranged (see the FVALUE keyword, above).

## Examples

For some examples using the TRIANGULATE routine, see the TRIGRID function.

## Version History

Introduced: Pre 4.0

## See Also

SPH_SCAT, TRIGRID

# TRIGRID

Given data points defined by the parameters *X*, *Y*, and *Z* and a triangulation of the planar set of points determined by *X* and *Y*, the TRIGRID function returns a regular grid of interpolated *Z* values. Linear or smooth quintic polynomial interpolation can be selected. Extrapolation for gridpoints outside of the triangulation area is also an option.

An input triangulation can be constructed using the procedure TRIANGULATE. Together, the TRIANGULATE procedure and the TRIGRID function constitute IDL's solution to the problem of irregularly-gridded data, including spherical gridding.

## Syntax

*Result* = TRIGRID( *X*, *Y*, *Z*, *Triangles* [, *GS*, *Limits*] )

For spherical gridding: *Result* = TRIGRID( *F* , *GS*, *Limits*, SPHERE=*S* )

**Keywords:** [, /DEGREES] [, EXTRAPOLATE=*array* | , /QUINTIC] [, INPUT=*variable*] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, MISSING=*value*] [, NX=*value*] [, NY=*value*] [, SPHERE=*variable*] [, XGRID=*variable*] [, YGRID=*variable*] [, XOUT=*vector*, YOUT=*vector*]

## Return Value

The resulting grid is a two-dimensional array with user-specified bounds and spacing. The data type of the resulting grid is either floating-point or double-precision floating-point depending upon the data type of *Z*.

## Arguments

### X, Y, Z

Input arrays of X, Y, and Z coordinates of data points. Integer, long, double-precision and floating-point values are allowed. In addition, *Z* can be a complex array. All three arrays must have the same number of elements.

### F

When performing a spherical gridding, this argument should be the named variable that contains the rearranged sample values that were returned by TRIANGULATE's FVALUE keyword.

### Triangles

A longword array of the form output by TRIANGULATE. That is, *Triangles* has the dimensions (3, *number of triangles*) and, for each *i*, `Triangles[0,i]`, `Triangles[1,i]`, and `Triangles[2,i]` are the indices of the vertices of the *i*-th triangle.

### GS

If present, *GS* should be a two-element vector [*XS, YS*], where *XS* is the horizontal spacing between grid points and *YS* is the vertical spacing. The default is based on the extents of *X* and *Y*. If the grid starts at *X* value $x_0$ and ends at $x_1$,then the horizontal spacing is

$(x_1 - x_0)/50$

The default for *YS* is computed in the same way. Since the default grid spacing divides each axis into 50 intervals and produces 51 samples, TRIGRID returns a grid with dimensions (51, 51).

If the NX or NY keywords are set to specify the output grid dimensions, either or both of the values of *GS* may be set to 0. In this case, the grid spacing is computed as the respective range divided by the dimension minus one:

$(x_1 - x_0)/(NX-1)$ and $(y_1 - y_0)/(NY-1)$

For spherical gridding, *GS* is assumed to be specified in radians, unless the DEGREES keyword is set.

### Limits

If present, *Limits* should be a four-element vector $[x_0, y_0, x_1, y_1]$ that specifies the data range to be gridded ($x_0$ and $y_0$ are the lower X and Y data limits, and $x_1$ and $y_1$ are the upper limits). The default for *Limits* is:

```
[MIN(X), MIN(Y), MAX(X), MAX(Y)]
```

If the NX or NY keywords are not specified, the size of the grid produced is specified by the value of *Limits*. If the NX or NY keywords are set to specify the output grid dimensions, a grid of the specified size will be used regardless of the value of *Limits*.

## Keywords

### DEGREES

For a spherical gridding, set this keyword to indicate that the grid spacing (the *GS* argument) is specified in degrees rather than radians.

## EXTRAPOLATE

Set this keyword equal to an array of boundary node indices (as returned by the optional parameter B of the TRIANGULATE procedure) to extrapolate to grid points outside the triangulation. The extrapolation is not smooth, but should give acceptable results in most cases.

Setting this keyword sets the quintic interpolation mode, as if the QUINTIC keyword has been specified.

## INPUT

Set this keyword to a named variable (which must be an array of the appropriate size to hold the output from TRIGRID) in which the results of the gridding are returned. This keyword is provided to make it easy and memory-efficient to perform multiple calls to TRIGRID. The interpolates within each triangle overwrite the array and the array is not initialized.

## MAX_VALUE

Set this keyword to a value that represents the maximum *Z* value to be gridded. Data larger than this value are treated as missing data and are not gridded.

## MIN_VALUE

Set this keyword to a value that represents the minimum *Z* value to be gridded. Data smaller than this value are treated as missing data and are not gridded.

## MISSING

The *Z* value to be used for grid points that lie outside the triangles in *Triangles*. The default is 0. This keyword also applies to data points outside the range specified by MIN_VALUE and MAX_VALUE.

**Note**

Letting MISSING default to 0 does not always produce the same result as explicitly setting it to 0. For example, if you specify INPUT and not EXTRAPOLATE, letting MISSING default to 0 will result in the INPUT values being used for data outside the Triangles; explicitly setting MISSSING to 0 will result in 0 being used for the data outside the Triangles.

## NX

The output grid size in the *x* direction. The default value is 51.

## NY

The output grid size in the *y* direction. The default value is 51.

## QUINTIC

If QUINTIC is set, smooth interpolation is performed using Akima's quintic polynomials from "A Method of Bivariate Interpolation and Smooth Surface Fitting for Irregularly Distributed Data Points" in *ACM Transactions on Mathematical Software*, 4, 148-159. The default method is linear interpolation.

Derivatives are estimated by Renka's global method in "A Triangle-Based C1 Interpolation Method" in *Rocky Mountain Journal of Mathematics*, vol. 14, no. 1, 1984.

QUINTIC is not available for complex data values. Setting the EXTRAPOLATE keyword implies the use of quintic interpolation; it is not necessary to specify both.

## SPHERE

For a spherical gridding, set this keyword to the named variable that contains the results of the spherical triangulation returned by TRIANGULATE's SPHERE keyword.

## XGRID

Set this keyword to a named variable that will contain a vector of *X* values for the output grid.

## XOUT

Set this keyword to a vector specifying the output grid *X* values. If this keyword is supplied, the *GS* and *Limits* arguments are ignored. Use this keyword to specify irregularly spaced rectangular output grids. If XOUT is specified, YOUT must also be specified. If keyword NX is also supplied then only the first NX points of XOUT will be used.

## YGRID

Set this keyword to a named variable that will contain a vector of *Y* values for the output grid.

The following table shows the interrelationships between the keywords EXATRAPOLATE, INPUT, MAX_VALUE, MIN_VALUE, MISSING, and QUINTIC.

| INPUT | EXTRAPOLATE | MISSING | Not in Triangles | Beyond MIN_VALUE, MAX_VALUE |
|---|---|---|---|---|
| no | no | no | uses 0 | uses 0 |
| no | no | yes | uses MISSING | uses MISSING |
| no | yes | no | EXTRAPOLATEs | uses 0 |
| no | yes | yes | EXTRAPOLATEs | uses MISSING |
| yes | no | no | uses INPUT | uses INPUT |
| yes | no | yes | uses MISSING | uses MISSING |
| yes | yes | no | EXTRAPOLATEs | uses INPUT |
| yes | yes | yes | EXTRAPOLATEs | uses MISSING |

*Table 94: Keyword Interrelationships for the TRIGRID function*

### YOUT

Set this keyword to a vector specifying the output grid *Y* values. If this keyword is supplied, the *GS* and *Limits* arguments are ignored. Use this keyword to specify irregularly spaced rectangular output grids. If keyword NY is also supplied then only the first NY points of YOUT will be used.

## Examples

### Example 1

This example creates and displays a 50 point random normal distribution. The random points are then triangulated, with the triangulation displayed. Next, the interpolated surface is computed and displayed using linear and quintic interpolation. Finally, the smooth extrapolated surface is generated and shown.

```
PRO TrigridExample

; Make 50 normal x, y points:
x = RANDOMN(seed, 50)
```

```
y = RANDOMN(seed, 50)

; Make the Gaussian:
z = EXP(-(x^2 + y^2))

; Show points:
PLOT, x, y, psym=1
in=' '
READ,"Press enter",in

; Obtain triangulation:
TRIANGULATE, x, y, tr, b

; Show the triangles:
FOR i=0, N_ELEMENTS(tr)/3-1 DO BEGIN & $
   ; Subscripts of vertices [0,1,2,0]:
   t = [tr[*,i], tr[0,i]] & $
   ; Connect triangles:
   PLOTS, x[t], y[t] & $
ENDFOR

; Show linear surface:
SURFACE, TRIGRID(x, y, z, tr)
in=' '
READ,"Press enter",in

; Show smooth quintic surface:
SURFACE, TRIGRID(x, y, z, tr, /QUINTIC)
in=' '
READ,"Press enter",in

; Show smooth extrapolated surface:
SURFACE, TRIGRID(x, y, z, tr, EXTRA = b)
in=' '
READ,"Press enter",in

; Output grid size is 12 x 24:
SURFACE, TRIGRID(X, Y, Z, Tr, NX=12, NY=24)
in=' '
READ,"Press enter",in

; Output grid size is 20 x 11. The X grid is
; [0, .1, .2, ..., 19 * .1 = 1.9].  The Y grid goes from 0 to 1:
SURFACE, TRIGRID(X, Y, Z, Tr, [.1, .1], NX=20)
in=' '
READ,"Press enter",in
```

```
; Output size is 20 x 40.  The range of the grid in X and Y is
; specified by the Limits parameter.  Grid spacing in X is
; [5-0]/(20-1) = 0.263.  Grid spacing in Y is (4-0)/(40-1) = 0.128:
SURFACE, TRIGRID(X, Y, Z, Tr, [0,0], [0,0,5,4],NX=20, NY=40)
in=' '
READ,"Press enter",in

WDELETE

END
```

## Example 2

This example shows how to perform spherical gridding:

```
PRO SphericalGrid
; Create some random longitude points:
lon = RANDOMU(seed, 50) * 360. - 180.

; Create some random latitude points:
lat = RANDOMU(seed, 50) * 180. - 90.

; Make a fake function value to be passed to FVALUE. The system
; variable !DTOR contains the conversion value for degrees to
; radians.
f = SIN(lon * !DTOR)^2 * COS(lat * !DTOR)

; Perform a spherical triangulation:
TRIANGULATE, lon, lat, tr, $
    SPHERE=s, FVALUE=f, /DEGREES

; Perform a spherical triangulation using the values returned from
; TRIANGULATE. The result, r, is a 180 by 91 element array:
r=TRIGRID(f, SPHERE=s, [2.,2.],$
   [-180.,-90.,178.,90.], /DEGREES)

; Display the surface
SURFACE, r
END
```

## Example 3

This example demonstrates the use of the INPUT keyword:

```
PRO TrigridInputKeyword

; Make 50 normal x, y points:
x = RANDOMN(seed, 50)
y = RANDOMN(seed, 50)
```

```
; Make the Gaussian:
z = EXP(-(x^2 + y^2))

; Show points:
PLOT, x, y, psym=1

; Obtain triangulation:
TRIANGULATE, x, y, tr, b

;Show the triangles.
FOR i=0, N_ELEMENTS(tr)/3-1 DO BEGIN $
   ; Subscripts of vertices [0,1,2,0]:
   t = [tr[*,i], tr[0,i]] & $
   ; Connect triangles:
   PLOTS, x[t], y[t]
ENDFOR

; The default size for the return value of trigrid. xtemp should be
; the same type as Z. xtemp provides temporary space for trigrid:
xtemp=FLTARR(51,51)
xtemp = TRIGRID(x, y, z, INPUT = xtemp, tr)

; Show linear surface:
SURFACE, xtemp, TITLE='Linear surface', CHARSIZE=2
in=' '
READ,"Press enter",in
xtemp = TRIGRID(x, y, z, tr, INPUT = xtemp, /QUINTIC)

; Show smooth quintic surface:
SURFACE, xtemp, TITLE='Smooth Quintic surface', CHARSIZE=2
in=' '
READ,"Press enter",in
xtemp = TRIGRID(x, y, z, tr, INPUT = xtemp, EXTRA = b)

; Show smooth extrapolated surface:
SURFACE, xtemp, TITLE='Smooth Extrapolated surface', CHARSIZE=2
in=' '
READ,"Press enter",in
END
```

## Example 4

The XOUT and YOUT keywords allow you to obtain an irregular interval from the TRIGRID routine. This example creates an irregularly-gridded dataset of a Gaussian surface. A grid is formed from these points with the TRIANGULATE and TRIGRID routines. The inputs to the XOUT and YOUT keywords are determined at random to produce an irregular interval. These inputs are sorted before setting them to XOUT and YOUT because these keywords require monotonically ascending or descending

values. The lines of the resulting surface are spaced at the irregular intervals provided by the settings of the XOUT and YOUT keywords.

```
PRO GriddingIrregularIntervals

; Make 100 normal x, y points:
x = RANDOMN(seed, 100)
y = RANDOMN(seed, 100)
PRINT, MIN(x), MAX(x)
PRINT, MIN(y), MAX(y)

; Make a Gaussian surface:
z = EXP(-(x^2 + y^2))

; Obtain triangulation:
TRIANGULATE, x, y, triangles, boundary

; Create random x values.  These values will be used to
; form the x locations of the resulting grid.
gridX = RANDOMN(seed, 30)
; Sort x values. Sorted values are required for the XOUT
; keyword.
sortX = UNIQ(gridX, SORT(gridX))
gridX = gridX[sortX]
; Output sorted x values to be used with the XOUT
; keyword.
PRINT, 'gridX:'
PRINT, gridX

; Create random y values.  These values will be used to
; form the y locations of the resulting grid.
gridY = RANDOMN(seed, 30)
; Sort y values. Sorted values are required for the YOUT
; keyword.
sortY = UNIQ(gridY, SORT(gridY))
gridY = gridY[sortY]
; Output sorted y values to be used with the YOUT
; keyword.
PRINT, 'gridY:'
PRINT, gridY

; Derive grid of initial values.  The location of the
; resulting grid points are the inputs to the XOUT and
; YOUT keywords.
grid = TRIGRID(x, y, z, triangles, XOUT = gridX, $
   YOUT = gridY, EXTRAPOLATE = boundary)
```

```
; Display resulting grid.  The grid lines are not
; at regular intervals because of the randomness of the
; inputs to the XOUT and YOUT keywords.
SURFACE, grid, gridX, gridY, /XSTYLE, /YSTYLE

END
```

## Version History

Introduced: Pre 4.0

## See Also

SPH_SCAT, TRIANGULATE

# TRIQL

The TRIQL procedure uses the QL algorithm with implicit shifts to determine the eigenvalues and eigenvectors of a real, symmetric, tridiagonal array. The routine TRIRED can be used to reduce a real, symmetric array to the tridiagonal form suitable for input to this procedure.

TRIQL is based on the routine `tqli` described in section 11.3 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_TRIQL procedure.

## Syntax

TRIQL, *D*, *E*, *A* [, /DOUBLE]

## Arguments

### D

On input, this argument should be an *n*-element vector containing the diagonal elements of the array being analyzed. On output, *D* contains the eigenvalues.

### E

An *n*-element vector containing the off-diagonal elements of the array. $E_0$ is arbitrary. On output, this parameter is destroyed.

### A

A named variable that returns the *n* eigenvectors. If the eigenvectors of a tridiagonal array are desired, *A* should be input as an identity array. If the eigenvectors of an array that has been reduced by TRIRED are desired, *A* is input as the array *Q* output by TRIRED.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

To compute eigenvalues and eigenvectors of a real, symmetric, tridiagonal array, begin with an array A representing a symmetric array:

```
; Create the array A:
A = [[ 3.0,  1.0, -4.0], $
    [ 1.0,  3.0, -4.0], $
    [-4.0, -4.0,  8.0]]

; Compute the tridiagonal form of A:
TRIRED, A, D, E

; Compute the eigenvalues (returned in vector D) and the
; eigenvectors (returned in the rows of the array A):
TRIQL, D, E, A

; Print eigenvalues:
PRINT, 'Eigenvalues:'
PRINT, D

; Print eigenvectors:
PRINT, 'Eigenvectors:'
PRINT, A
```

IDL prints:

```
Eigenvalues:
  2.00000  4.76837e-7  12.0000

Eigenvectors:
  0.707107  -0.707107   0.00000
 -0.577350  -0.577350  -0.577350
 -0.408248  -0.408248   0.816497
```

The exact eigenvalues are:

```
[2.0, 0.0, 12.0]
```

The exact eigenvectors are:

```
[ 1.0/sqrt(2.0), -1.0/sqrt(2.0), 0.0/sqrt(2.0)],
[-1.0/sqrt(3.0), -1.0/sqrt(3.0), -1.0/sqrt(3.0)],
[-1.0/sqrt(6.0), -1.0/sqrt(6.0), 2.0/sqrt(6.0)]
```

# Version History

Introduced: 4.0

## See Also

EIGENVEC, ELMHES, HQR, LA_TRIQL, TRIRED

# TRIRED

The TRIRED procedure uses Householder's method to reduce a real, symmetric array to tridiagonal form.

TRIRED is based on the routine `tred2` described in section 11.2 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_TRIRED procedure.

## Syntax

TRIRED, *A*, *D*, *E* [, /DOUBLE]

## Arguments

### A

An *n* by *n* real, symmetric array that is replaced, on exit, by the orthogonal array *Q* effecting the transformation. The routine TRIQL can use this result to find the eigenvectors of the array *A*.

### D

An *n*-element output vector containing the diagonal elements of the tridiagonal array.

### E

An *n*-element output vector containing the off-diagonal elements.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

See the description of TRIQL for an example using this function.

## Version History

Introduced: 4.0

## See Also

EIGENVEC, ELMHES, HQR, LA_TRIRED, TRIQL

# TRISOL

The TRISOL function solves tridiagonal systems of linear equations that have the form: $A^T U = R$

**Note**

Because IDL subscripts are in column-row order, the equation above is written $A^T U = R$ rather than $AU = R$. The result *U* is a vector of length *n* whose type is identical to *A*.

TRISOL is based on the routine `tridag` described in section 2.4 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

**Note**

If you are working with complex inputs, instead use the LA_TRISOL procedure.

## Syntax

*Result* = TRISOL( *A*, *B*, *C*, *R* [, /DOUBLE] )

## Return Value

Returns a vector containing the solutions.

## Arguments

### A

A vector of length *n* containing the *n*-1 sub-diagonal elements of $A^T$. The first element of *A*, $A_0$, is ignored.

### B

An *n*-element vector containing the main diagonal elements of $A^T$.

### C

An *n*-element vector containing the *n*-1 super-diagonal elements of $A^T$. The last element of *C*, $C_{n-1}$, is ignored.

### R

An *n*-element vector containing the right hand side of the linear system $A^T U = R$.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Example

To solve a tridiagonal linear system, begin with an array representing a real tridiagonal linear system. (Note that only three vectors need be specified; there is no need to enter the entire array shown.)

$$\begin{bmatrix} -4.0 & 1.0 & 0.0 & 0.0 \\ 2.0 & -4.0 & 1.0 & 0.0 \\ 0.0 & 2.0 & -4.0 & 1.0 \\ 0.0 & 0.0 & 2.0 & -4.0 \end{bmatrix}$$

```
; Define a vector A containing the sub-diagonal elements with a
; leading 0.0 element:
A = [0.0, 2.0, 2.0, 2.0]

; Define B containing the main diagonal elements:
B = [-4.0, -4.0, -4.0, -4.0]

; Define C containing the super-diagonal elements with a trailing
; 0.0 element:
C = [1.0, 1.0, 1.0, 0.0]

; Define the right-hand side vector:
R = [6.0, -8.0, -5.0, 8.0]

; Compute the solution and print:
result = TRISOL(A, B, C, R)
PRINT, result
```

IDL prints:

```
-1.00000  2.00000  2.00000  -1.00000
```

The exact solution vector is [-1.0, 2.0, 2.0, -1.0].

## Version History

Introduced: 4.0

## See Also

CRAMER, GS_ITER, LA_TRISOL, LU_COMPLEX, CHOLSOL, LUSOL, SVSOL, TRISOL

# TRUNCATE_LUN

The TRUNCATE_LUN procedure truncates the contents of a file (which must be open for write access) at the current position of the file pointer. After this operation, all data before the current file pointer remains intact, and all data following the file pointer are gone. The position of the current file pointer is not altered.

## Syntax

TRUNCATE_LUN, *Unit*$_1$, ..., *Unit*$_n$

## Arguments

### Unit$_n$

Scalar or array variables containing the logical file unit numbers of the open files to be truncated.

## Keywords

None.

## Examples

### Example 1

Truncate the entire contents of an existing file:

```
OPENU, unit, 'baddata.dat', /GET_LUN
TRUNCATE_LUN, unit
FREE_LUN, unit
```

### Example 2

Given an existing file of 10,000 bytes, throw away the final 5,000 bytes, and then write an additional 2,000 byte array in their place. The resulting file will be 7,000 bytes in length.

```
OPENU, unit, 'mydata.dat', /GET_LUN
POINT_LUN, unit, 5000
TRUNCATE_LUN, unit
WRITEU, unit, BYTARR(2000)
FREE_LUN, unit
```

## Version History

Introduced: 5.6

## See Also

GET_LUN, OPEN, POINT_LUN

# TS_COEF

The TS_COEF function computes the coefficients $\phi_1$, $\phi_2$, ... , $\phi_P$ used in a *P*-th order autoregressive time-series forecasting model. This routine is written in the IDL language. Its source code can be found in the file `ts_coef.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = TS_COEF( *X*, *P* [, /DOUBLE] [, MSE=*variable*] )

## Return Value

Returns a *P*-element vector whose type is identical to *X*.

## Arguments

### X

An *n*-element single- or double-precision floating-point vector containing time-series samples.

### P

An integer or long integer scalar that specifies the number of coefficients to be computed.

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### MSE

Set this keyword to a named variable that will contain the mean square error of the *P*-th order autoregressive model.

## Examples

```
; Define an n-element vector of time-series samples:
X = [6.63, 6.59, 6.46, 6.49, 6.45, 6.41, 6.38, 6.26, 6.09, 5.99, $
     5.92, 5.93, 5.83, 5.82, 5.95, 5.91, 5.81, 5.64, 5.51, 5.31, $
     5.36, 5.17, 5.07, 4.97, 5.00, 5.01, 4.85, 4.79, 4.73, 4.76]
; Compute the coefficients of a 5th order autoregressive model:
PRINT, TS_COEF(X, 5)
```

IDL prints:

```
1.30168    -0.111783    -0.224527     0.267629    -0.233363
```

## Version History

Introduced: 4.0

## See Also

TS_FCAST

# TS_DIFF

The TS_DIFF function recursively computes the forward differences of an *n*-element time-series *k* times. This routine is written in the IDL language. Its source code can be found in the file `ts_diff.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = TS_DIFF( *X*, *K* [, /DOUBLE] )

## Return Value

The result is an *n*-element differenced time-series with its last *k* elements as zeros.

## Arguments

### X

An *n*-element integer, single- or double-precision floating-point vector containing time-series samples.

### K

A positive integer or long integer scalar that specifies the number of times *X* is to be differenced. *K* must be in the interval [1, N_ELEMENTS(*X*) - 1].

## Keywords

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## Examples

```
; Define an n-element vector of time-series samples:
X = [389, 345, 303, 362, 412, 356, 325, 375, $
     410, 350, 310, 388, 399, 362, 325, 382, $
     399, 382, 318, 385, 437, 357, 310, 391]
; Compute the second forward differences of X:
PRINT, TS_DIFF(X, 2)
```

IDL prints:

```
     2  101   -9 -106   25   81  -15  -95   20
   118  -67  -48    0   94  -40  -34  -47  131
   -15 -132   33  128    0    0
```

## Version History

Introduced: 4.0

## See Also

SMOOTH, TS_FCAST

# TS_FCAST

The TS_FCAST function computes future or past values of a stationary time-series using a *P*-th order autoregressive model.

A *P*-th order autoregressive model relates a forecasted value $x_t$ of the time series $X = [x_0, x_1, x_2, \ldots, x_{t-1}]$, as a linear combination of *P* past values.

$$x_t = \phi_1 x_{t-1} + \phi_2 x_{t-2} + \ldots + \phi_P x_{t-P} + w_t$$

The coefficients $\phi_1, \phi_2, \ldots, \phi_P$ are calculated such that they minimize the uncorrelated random error terms, *wt*.

This routine is written in the IDL language. Its source code can be found in the file `ts_fcast.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = TS_FCAST( *X*, *P*, *Nvalues* [, /BACKCAST] [, /DOUBLE] )

## Return Value

The result is an *Nvalues*-element vector whose type is identical to *X*.

## Arguments

### X

An *n*-element single- or double-precision floating-point vector containing time-series samples.

### P

An integer or long integer scalar that specifies the number of actual time-series values to be used in the forecast. In general, a larger number of values results in a more accurate forecast.

### Nvalues

An integer or long integer scalar that specifies the number of future or past values to be computed.

# Keywords

## BACKCAST

Set this keyword to produce past values (backward forecasts or “backcasts”)

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

# Examples

```
; Define an n-element vector of time-series samples:
X = [6.63, 6.59, 6.46, 6.49, 6.45, 6.41, 6.38, 6.26, 6.09, 5.99, $
     5.92, 5.93, 5.83, 5.82, 5.95, 5.91, 5.81, 5.64, 5.51, 5.31, $
     5.36, 5.17, 5.07, 4.97, 5.00, 5.01, 4.85, 4.79, 4.73, 4.76]

; Compute and print five future values of the time-series using ten
; time-series values:
PRINT, TS_FCAST(X, 10, 5)

; Compute five past values of the time-series using ten time-series
;values:
PRINT, TS_FCAST(X, 10, 5, /BACKCAST)
```

IDL prints:

```
4.65870      4.58380      4.50030      4.48828      4.46971
6.94862      6.91103      6.86297      6.77826      6.70282
```

# Version History

Introduced: 4.0

# See Also

A_CORRELATE, COMFIT, CURVEFIT, SMOOTH, TS_COEF, TS_DIFF

# TS_SMOOTH

The TS_SMOOTH function computes central, backward, or forward moving averages of an *n*-element time-series. Autoregressive forecasting and backcasting are used to extrapolate the time-series and compute a moving average for each point.

**Note**

Central moving averages require *Nvalues*/2 forecasts and *Nvalues*/2 backcasts. Backward moving averages require *Nvalues*-1 backcasts. Forward moving averages require *Nvalues*-1 forecasts.

This routine is written in the IDL language. Its source code can be found in the file `ts_smooth.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = TS_SMOOTH( *X*, *Nvalues* [, /BACKWARD] [, /DOUBLE] [, /FORWARD] [, ORDER=*value*] )

## Return Value

The result is an *n*-element vector of the same data type as the input vector.

## Arguments

### X

An *n*-element single- or double-precision floating-point vector containing time-series samples. Note that *n* must be greater than or equal to 11.

### Nvalues

A scalar of type integer or long integer that specifies the number of time-series values used to compute each moving-average. If central-moving averages are computed (the default), this parameter must be an odd integer greater than or equal to three.

# Keywords

## BACKWARD

Set this keyword to compute backward-moving averages. If BACKWARD is set, the *Nvalues* argument must be an integer greater than one.

## DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

## FORWARD

Set this keyword to compute forward-moving averages. If FORWARD is set, the *Nvalues* argument must be an integer greater than one.

## ORDER

An integer or long-integer scalar that specifies the order of the autoregressive model used to compute the forecasts and backcasts of the time-series. By default, a time-series with a length between 11 and 219 elements will use an autoregressive model with an order of 10. A time-series with a length greater than 219 will use an autoregressive model with an order equal to 5% of its length. The ORDER keyword is used to override this default.

# Examples

```
; Define an n-element vector of time-series samples:
X = [6.63, 6.59, 6.46, 6.49, 6.45, 6.41, 6.38, 6.26, 6.09, 5.99,$
     5.92, 5.93, 5.83, 5.82, 5.95, 5.91, 5.81, 5.64, 5.51, 5.31,$
     5.36, 5.17, 5.07, 4.97, 5.00, 5.01, 4.85, 4.79, 4.73, 4.76]

; Compute the 11-point central-moving-averages of the time-series:
PRINT, TS_SMOOTH(X, 11)
```

IDL prints:

```
6.65761 6.60592 6.54673 6.47646 6.40480 6.33364
6.27000 6.20091 6.14273 6.09364 6.04455 5.99000
5.92273 5.85455 5.78364 5.72636 5.65818 5.58000
5.50182 5.42727 5.34182 5.24545 5.15273 5.07000
5.00182 4.94261 4.87205 4.81116 4.75828 4.71280
```

# Version History

Introduced: 5.0

## See Also

SMOOTH, TS_DIFF, TS_FCAST

# TV

The TV procedure displays images on the image display without scaling the intensity. To display an image with scaling, use the TVSCL procedure.

**Note**

To display a TrueColor image (an image with 16, 24, or 32 bits per pixel) you must specify the TRUE keyword.

While the TV procedure does not *scale* the intensity of an image, it does convert the input image data to byte type. Values outside the range [0,255] are "wrapped" during the conversion. In addition, for displays with less than 256 colors, elements of the input image with values between !D.TABLE_SIZE and 255 will be displayed using the color index !D.TABLE_SIZE-1.

## Syntax

TV, *Image* [, *Position*]

or

TV, *Image* [, *X*, *Y* [, *Channel*]]

**Keywords:** [, /CENTIMETERS | , /INCHES] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /WORDS] [, XSIZE=*value*] [, YSIZE=*value*]

**Graphics Keywords:** [, CHANNEL=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, /T3D | Z=*value*]

## Arguments

### Image

A vector or two-dimensional array to be displayed as an image. If this argument is not already of byte type, it is converted prior to use.

### X, Y

If *X* and *Y* are present, they specify the lower-left coordinate of the displayed image, relative to the lower-left corner of the screen.

## Position

An integer specifying the position for *Image* within the graphics window. Image positions run from the top left of the screen to the bottom right. If a position number is used instead of *X* and *Y*, the position of the image is calculated from the dimensions of the image as follows (integer arithmetic is used).

$$\text{Xsize, Ysize} = \text{Size of display or window}$$

$$\text{Xdim, Ydim} = \text{Dimensions of image to be displayed}$$

$$N_x = \frac{\text{Xsize}}{\text{Ydim}} = \text{Images across screen}$$

$$X = \text{Xdim}\,\text{Position}_{\text{modulo}\,N_x} = \text{Starting X}$$

$$Y = \text{Ysize} - \text{Ydim}\left[1 + \frac{\text{Position}}{N_x}\right] = \text{Starting Y}$$

For example, when displaying 128 by 128 images on a 512 by 512 display, the position numbers run from 0 to 15 as follows:

| | | | |
|---|---|---|---|
| 0 | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 |

**Note**

When using a device with scalable pixels (e.g., PostScript), the XSIZE and YSIZE keywords should also be used.

## Channel

The memory channel to be written to. The *Channel* argument is identical to the CHANNEL graphics keyword.

# Keywords

## CENTIMETERS

Set this keyword to indicate that the *X*, *Y*, *Xsize*, *Ysize*, and *Z* arguments are given in centimeters from the origin. This system is useful when dealing with devices, such as PostScript printers, that do not provide a direct relationship between image pixels and the size of the resulting image.

## INCHES

Set this keyword to indicate that all position and size values are given in inches from the origin. This system is useful when dealing with devices, such as PostScript printers, that do not provide a direct relationship between image pixels and the size of the resulting image.

## ORDER

If specified, ORDER overrides the current setting of the !ORDER system variable for the current image only. If set, the image is drawn from the top down instead of the normal bottom up.

## TRUE

Set this keyword to a nonzero value to indicate that a TrueColor (16-, 24-, or 32-bit) image is to be displayed. The value assigned to TRUE specifies the index of the dimension over which color is interleaved. The image parameter must have three dimensions, one of which must be equal to three. For example, set TRUE to 1 to display an image that is pixel interleaved and has dimensions of (3, *m*, *n*). Specify 2 for row-interleaved images, of size (*m*, 3, *n*), and 3 for band-interleaved images of the form (*m*, *n*, 3).

See “TrueColor Images” on page 3842 for an example using this keyword to write 24-bit images to the PostScript device.

## WORDS

Set this keyword to indicate that words (short integers) instead of 8-bit bytes are to be transferred to the device. This keyword is valid only when using devices that can transfer 16-bit pixels. The normal transfer uses 8-bit pixels. If this keyword is set, the *Image* parameter is converted to short integer type, if necessary, and then written to the display.

### XSIZE

The width of the resulting image. On devices with scalable pixel size (such as PostScript), if XSIZE is specified the image will be scaled to fit the specified width. If neither XSIZE nor YSIZE is specified, the image will be scaled to fill the plotting area, while preserving the image's aspect ratio. This keyword is ignored by pixel-based devices that are unable to change the size of their pixels.

### YSIZE

The height of the resulting image. On devices with scalable pixel size (such as PostScript), if YSIZE is specified the image will be scaled to fit the specified height. If neither XSIZE nor YSIZE is specified, the image will be scaled to fill the plotting area, while preserving the image's aspect ratio. This keyword is ignored by pixel-based devices that are unable to change the size of their pixels.

### Graphics Keywords Accepted

See Appendix B, "Graphics Keywords" for the description of graphics and plotting keywords not listed above. CHANNEL, DATA, DEVICE, NORMAL, T3D, Z.

## Examples

```
; Create and display a simple image:
D = BYTSCL(DIST(256)) & TV, D

; Erase the screen:
ERASE

; Use the position parameter to display a number of images in the
; same window.
; Display the image in the upper left corner.
TV, D, 0

; Display another copy of the image in the next position:
TV, D, 1
```

## Version History

Introduced: Original

## See Also

ERASE, IIMAGE, SLIDE_IMAGE, TVRD, TVSCL, WIDGET_DRAW, WINDOW

# TVCRS

The TVCRS procedure manipulates the display device cursor. The initial state of the cursor is device dependent. Call TVCRS with one argument to enable or disable the cursor. Call TVCRS with two parameters to enable the cursor and place it on pixel location *(X, Y)*.

## Syntax

TVCRS [, *ON_OFF*]

or

TVCRS [, *X*, *Y*]

**Keywords:** [, /CENTIMETERS | , /INCHES] [, /HIDE_CURSOR]

**Graphics Keywords:** [, /DATA | , /DEVICE | , /NORMAL] [, /T3D | Z=*value*]

## Arguments

### ON_OFF

This argument specifies whether the cursor should be on or off. If this argument is present and nonzero, the cursor is enabled. If *ON_OFF* is zero or no parameters are specified, the cursor is turned off.

### X

The column to which the cursor is set.

### Y

The row to which the cursor is set.

## Keywords

### CENTIMETERS

Set this keyword to cause X and Y to be interpreted as centimeters, based on the current device resolution.

### INCHES

Set this keyword to cause X and Y to be interpreted as inches, based on the current device resolution.

### HIDE_CURSOR

By default, disabling the cursor works differently for window systems than for other devices. For window systems, the cursor is restored to the standard cursor used for non-IDL windows (and remains visible), while for other devices it is completely blanked out. If the HIDE keyword is set, disabling the cursor causes it to always be blanked out.

### Graphics Keywords Accepted

See Appendix B, “Graphics Keywords” for the description of graphics and plotting keywords not listed above. DATA, DEVICE, NORMAL, T3D, Z.

## Examples

To enable the graphics cursor and position it at device coordinate (100, 100), enter:

```
TVCRS, 100, 100
```

To position the cursor at data coordinate (0.5, 3.2), enter:

```
TVCRS, 0.5, 3.2, /DATA
```

## Version History

Introduced: Original

## See Also

CURSOR, RDPIX

# TVLCT

The TVLCT procedure loads the display color translation tables from the specified variables. Although IDL uses the RGB color system internally, color tables can be specified to TVLCT using any of the following color systems: RGB (Red, Green, Blue), HLS (Hue, Lightness, Saturation), and HSV (Hue, Saturation, Value). Alpha values may also be used when using the second form of the command. The type and meaning of each argument is dependent upon the color system selected, as described below. Color arguments can be either scalar or vector expressions. If no color-system keywords are present, the RGB color system is used.

## Syntax

TVLCT, $V_1$, $V_2$, $V_3$ [, *Start*] [, /GET] [, /HLS | , /HSV]

or

TVLCT, *V* [, *Start*] [, /GET] [, /HLS | , /HSV]

## Arguments

TVLCT will accept either three *n*-element vectors ($V_1$, $V_2$, and $V_3$) or a single *n*-by-3 array (*V*) as an argument. The vectors (or columns of the array) have different meanings depending on the color system chosen. If an array *V* is specified, *V*[*,0] is the same as $V_1$, *V*[*,1] is the same as $V_2$, *V*[*,2] is the same as $V_3$. In the description below, we assume that three vectors, $V_1$, $V_2$, and $V_3$ are specified.

The $V_1$, $V_2$, and $V_3$ arguments have different meanings depending upon which color system they represent.

### R, G, B Color System

The parameters $V_1$, $V_2$, and $V_3$ contain the Red, Green, and Blue values, respectively. Values are interpreted as integers in the range 0 (lowest intensity) to 255 (highest intensity). The parameters can be scalars or vectors of up to 256 elements. By default, the three arguments are assumed to be R, G, and B values.

### H, L, S Color System

Parameters $V_1$, $V_2$, and $V_3$ contain the Hue, Lightness, and Saturation values respectively. All parameters are floating-point. Hue is expressed in degrees and is reduced modulo 360. $V_2$ (lightness) and $V_3$ (saturation) and can range from 0 to 1.0. Set the HLS keyword to have the arguments interpreted this way.

### H, S, V Color System

Parameters $V_1$, $V_2$, and $V_3$ contain values for Hue, Saturation, and Value (similar to intensity). All parameters are floating-point. Hue is in degrees. The Saturation and Value can range from 0 to 1.0. Set the HSV keyword to have the arguments interpreted this way.

### Start

An integer value that specifies the starting point in the color translation table into which the color intensities are loaded. If this argument is not specified, a value of zero is used, causing the tables to be loaded starting at the first element of the translation tables.

## Keywords

### GET

Set this keyword to return the RGB values from the internal color tables into the $V_1$, $V_2$, and $V_3$ parameters. For example, the statements:

```
TVLCT, H, S, V, /HSV
TVLCT, R, G, B, /GET
```

load a color table based in the HSV system, and then read the equivalent RGB values into the variables R, G, and B.

### HLS

Set this keyword to indicate that the parameters specify color using the HLS color system.

### HSV

Set this keyword to indicate that the parameters specify color using the HSV color system.

## Examples

```
; Initialize display.
DEVICE, DECOMPOSED = 0

; Create a set of R, G, and B colormap vectors:
R = BYTSCL(SIN(FINDGEN(256)))
G = BYTSCL(COS(FINDGEN(256)))
B = BINDGEN(256)
```

```
; Load these vectors into the color table:
TVLCT, R, G, B

; Display an image to see the effect of the new color table:
TVSCL, DIST(400)
```

## Version History

Introduced: Original

## See Also

LOADCT, XLOADCT, XPALETTE

# TVRD

The TVRD function returns the contents of the specified rectangular portion of the current graphics window or device. ($X_0$, $Y_0$) is the coordinate of the lower left corner of the area to be read and $N_x$, $N_y$ is the size of the rectangle in columns and rows. The result is a byte array of dimensions $N_x$ by $N_y$. All parameters are optional. If no arguments are supplied, the entire display device area is read.

### Important Note about TVRD and Backing Store

On some systems, when backing store is provided by the window system (the RETAIN keyword to DEVICE or WINDOW is set to 1), reading data from a window using TVRD may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (set the RETAIN keyword to 2) ensures that the window contents will be read properly. More detailed notes about TVRD and the X Window system can be found below in "Unexpected Results Using TVRD with X Windows" on page 2053.

**Note**

When using TVRD on 16-bit TrueColor displays only 5 or 6 bits of pixel data are stored for each color channel. Using TVRD on these displays returns channel data where only the high 5 or 6 bits are significant; the other bits are indeterminate.

## Syntax

*Result* = TVRD( [$X_0$ [, $Y_0$ [, $N_x$ [, $N_y$ [, *Channel*]]]]] [, CHANNEL=*value*] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /WORDS] )

## Return Value

Returns a byte array of the specified dimensions.

## Arguments

### $X_0$

The starting column of data to read. The default is 0.

### $Y_0$

The starting row of data to read. The default is 0.

### $N_x$

The number of columns to read. The default is the width of the display device or window less $X_0$.

### $N_y$

The number of rows to read. The default is the height of the display device or window less $Y_0$.

### Channel

The memory channel to be read. If not specified, this argument is assumed to be zero. This parameter is ignored on display systems that have only one memory channel.

## Keywords

### CHANNEL

The memory channel to be read. The CHANNEL keyword is identical to the optional *Channel* argument.

**Note**

If the display is a 24-bit display, and both the CHANNEL and TRUE parameters are absent, the maximum RGB value in each pixel is returned.

### ORDER

Set this keyword to override the current setting of the !ORDER system variable for the current image only. If set, it causes the image to be read from the top down instead of the normal bottom up.

### TRUE

If this keyword is present, it indicates that a TrueColor image is to be read, if the display is capable. The value assigned to TRUE specifies the index of the dimension over which color is interleaved. The result is an (3, $n_x$, $n_y$) pixel-interleaved array if TRUE is 1; or an ($n_x$, 3, $n_y$) line-interleaved array if TRUE is 2; or an ($n_x$, $n_y$, 3) image-interleaved array if TRUE is 3.

### WORDS

Set this keyword to indicate that words are to be transferred from the device. This keyword is valid only when using devices that can transfer 16-bit pixels. The normal transfer uses 8-bit pixels. If this keyword is set, the function result is an integer array.

## Unexpected Results Using TVRD with X Windows

When using TVRD with the X Windows graphics device, there are two unexpected behaviors that can be confusing to users:

- When reading from a window that is obscured by another window (i.e., the target window has another window “on top” or “in front” of it), TVRD may return the contents of the window in front as part of the image contained in the target window.
- When reading from an iconified window, the X server may return a stream of “BadMatch” protocol events.

IDL uses the Xlib function `XGetSubImage()` to implement TVRD. The following quote is from the documentation for XGetSubImage() found in *The X Window System* by Robert W. Scheifler and James Gettys, Second Edition, page 174. It explains the reasons for the behaviors described above:

“If the drawable is a window, the window must be viewable, and it must be the case that if there were no... overlapping windows, the specified rectangle of the window would be fully visible on the screen, ... or a BadMatch error results. If the window has backing-store, then the backing-store contents are returned for regions of the window that are obscured... If the window does not have backing-store, the returned contents of such obscured regions are undefined.”

Hence, the first behavior is caused by attempting to use TVRD on an obscured window that does not have backing store provided by the X server. The result in this case is undefined, meaning that the different servers can produce entirely different results. Many servers simply return the image of the obscuring window.

The second behavior is caused by attempting to read from a non-viewable (i.e., unmapped) window. Although IDL could refuse to allow TVRD to work with unmapped windows, some X servers return valid and useful results. Therefore, TVRD is allowed to attempt to read from unmapped windows.

Both of these behavior problems can be solved by using one of the following methods:

- Always make sure that your target window is mapped and is not obscured before using TVRD on it. The following IDL command can be used:

```
WSET, Window_Index
```

- Make IDL provide backing store (rather than the window system) by setting the RETAIN keyword to DEVICE or WINDOW equal to 2.

For a full description of backing store, see “Backing Store” on page 3824. Note that under X Windows, backing store is a request that may or may not be honored by the X server. Many servers will honor backing store for 8-bit visuals but ignore them for 24-bit visuals because they require three times as much memory.

## Examples

```
; Read the entire contents of the current display device into the
; variable T:
T = TVRD()
```

## Version History

Introduced: Original

## See Also

RDPIX, TV, WINDOW

# TVSCL

The TVSCL procedure scales the intensity values of *Image* into the range of the image display and outputs the data to the image display at the specified location. The array is scaled so the minimum data value becomes 0 and the maximum value becomes the maximum number of available colors (held in the system variable !D.TABLE_SIZE) as follows:

$$\text{Output} = (\text{!D.TABLE\_SIZE} - 1)\frac{\text{Data} - \text{Data}_{\text{min}}}{\text{Data}_{\text{max}} - \text{Data}_{\text{min}}}$$

where the maximum and minimum are found by scanning the array. The parameters and keywords of the TVSCL procedure are identical to those accepted by the TV procedure. For additional information about each parameter, consult the description of TV.

## Syntax

TVSCL, *Image* [, *Position*]

or

TVSCL, *Image* [, *X*, *Y* [, *Channel*]]

**Keywords:** [, /CENTIMETERS | , /INCHES] [, /NAN] [, /ORDER] [, TOP=*value*] [, TRUE={1 | 2 | 3}] [, /WORDS] [, XSIZE=*value*] [, YSIZE=*value*]

**Graphics Keywords:** [, CHANNEL=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, /T3D | Z=*value*]

## Arguments

### Image

A two-dimensional array to be displayed as an image. If this argument is not already of byte type, it is converted prior to use.

### X, Y

If *X* and *Y* are present, they specify the lower left coordinate of the displayed image.

### Position

Image position. See the discussion of the TV procedure for a full description.

### Channel

The memory channel to be written. This argument is assumed to be zero if not specified. This parameter is ignored on display systems that have only one memory channel.

## Keywords

TVSCL accepts all of the keywords accepted by the TV routine. See "TV" on page 2042. In addition, there are two unique keywords:

### NAN

Set this keyword to cause TVSCL to treat elements of *Image* that are not numbers (that is, elements that have the special floating-point values *Infinity* or *NaN*) as missing data, and display them using color index 0 (zero). Note that color index 0 is also used to display elements that have the minimum value in the *Image* array.

### TOP

The maximum value of the scaled result. If TOP is not specified, !D.TABLE_SIZE-1 is used. Note that the minimum value of the scaled result is always 0.

### Graphics Keywords Accepted

See Appendix B, "Graphics Keywords" for the description of graphics and plotting keywords not listed above. CHANNEL, DATA, DEVICE, NORMAL, T3D, Z.

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

Display a floating-point array as an image using the TV command:

```
TV, DIST(200)
```

Note that the image is not easily visible because the values in the array have not been scaled into the full range of display values. Now display the image with the TVSCL command by entering:

```
TVSCL, DIST(200)
```

Notice how much brighter the image appears.

## Version History

Introduced: Original

## See Also

ERASE, SLIDE_IMAGE, TV, WIDGET_DRAW, WINDOW

# UINDGEN

The UINDGEN function creates an unsigned integer array. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = UINDGEN($D_1$ [, ..., $D_8$])

## Return Value

Returns an unsigned integer array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create UI, a 10-element by 10-element 16-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
UI = UINDGEN(10, 10)
```

## Version History

Introduced: 5.2

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, SINDGEN, UL64INDGEN, ULINDGEN

# UINT

The UINT function returns a result equal to *Expression* converted to unsigned integer type.

## Syntax

*Result* = UINT( *Expression[, Offset [, $D_1$ [, ..., $D_8$]]]* )

## Return Value

Returns the specified dimensions of the given expression as an unsigned integer type.

## Arguments

### Expression

The expression to be converted to unsigned integer.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as unsigned integer data. See the description in Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual for details.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

If A contains the floating-point value 32000.0, it can converted to an unsigned integer and stored in the variable B by entering:

```
B = UINT(A)
```

# Version History

Introduced: 5.2

# See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, ULONG, ULONG64

# UINTARR

The UINTARR function creates an unsigned integer vector or array.

## Syntax

*Result* = UINTARR( $D_1$ *[, ..., $D_8$]* [, /NOZERO] )

## Return Value

Returns an unsigned integer vector or array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, UINTARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and UINTARR executes faster.

## Examples

To create L, a 100-element, unsigned integer vector with each element set to 0, enter:

```
L = UINTARR(100)
```

## Version History

Introduced: 5.2

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, ULON64ARR, ULONARR

# UL64INDGEN

The UL64INDGEN function returns an unsigned 64-bit integer array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = UL64INDGEN($D_1$ [, ..., $D_8$])

## Return Value

Returns the specified unsigned integer array.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create L, a 10-element by 10-element 64-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
L = UL64INDGEN(10, 10)
```

## Version History

Introduced: 5.2

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, SINDGEN, UINDGEN, ULINDGEN

# ULINDGEN

The ULINDGEN function returns an unsigned longword array with the specified dimensions. Each element of the array is set to the value of its one-dimensional subscript.

## Syntax

*Result* = ULINDGEN($D_1$ [, ..., $D_8$])

## Return Value

Returns the specified unsigned longword array.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified. If the dimension arguments are not integer values, IDL will convert them to integer values before creating the new array.

## Keywords

### Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

## Examples

To create L, a 10-element by 10-element 32-bit array where each element is set to the value of its one-dimensional subscript, enter:

```
L = ULINDGEN(10, 10)
```

## Version History

Introduced: 5.2

## See Also

BINDGEN, CINDGEN, DCINDGEN, DINDGEN, FINDGEN, L64INDGEN, LINDGEN, SINDGEN, UINDGEN, UL64INDGEN

# ULON64ARR

The ULON64ARR function returns an unsigned 64-bit integer vector or array.

## Syntax

*Result* = ULON64ARR( $D_1$ *[, ..., $D_8$]* [, /NOZERO] )

## Return Value

Returns a vector or array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, ULON64ARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and ULON64ARR executes faster.

## Examples

To create L, a 100-element, unsigned 64-bit vector with each element set to 0, enter:

```
L = ULON64ARR(100)
```

## Version History

Introduced: 5.2

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULONARR

# ULONARR

The ULONARR function returns an unsigned longword integer vector or array.

## Syntax

*Result* = ULONARR( $D_1$ *[*, ..., $D_8$*]* [, /NOZERO] )

## Return Value

Returns an unsigned longword integer array of the specified dimensions.

## Arguments

### $D_i$

Either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

## Keywords

### NOZERO

Normally, ULONARR sets every element of the result to zero. If NOZERO is set, this zeroing is not performed and ULONARR executes more quickly.

## Examples

To create L, a 100-element, unsigned longword vector with each element set to 0, enter:

```
L = ULONARR(100)
```

## Version History

Introduced: 5.2

## See Also

BYTARR, COMPLEXARR, DBLARR, DCOMPLEXARR, FLTARR, INTARR, LON64ARR, LONARR, MAKE_ARRAY, STRARR, UINTARR, ULON64ARR,

# ULONG

The ULONG function returns a result equal to *Expression* converted to the unsigned longword integer type.

## Syntax

*Result* = ULONG( *Expression[, Offset [, $D_1$ [, ..., $D_8$]]]* )

## Return Value

Returns the specified dimensions of the given expression as an unsigned longword integer type.

## Arguments

### Expression

The expression to be converted to unsigned longword integer.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as unsigned longword integer data. See the description in Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual for details.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

If A contains the floating-point value 32000.0, it can converted to an unsigned longword integer and stored in the variable B by entering:

```
B = ULONG(A)
```

# Version History

Introduced: 5.2

# See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG64

# ULONG64

The ULONG64 function returns a result equal to *Expression* converted to the unsigned 64-bit integer type.

## Syntax

*Result* = ULONG64( *Expression[, Offset [, $D_1$ [, ..., $D_8$]]]* )

## Return Value

Returns the specified dimensions of the given expression as an unsigned 64-bit integer type.

## Arguments

### Expression

The expression to be converted to unsigned 64-bit integer.

### Offset

Offset from beginning of the *Expression* data area. Specifying this argument allows fields of data extracted from *Expression* to be treated as unsigned 64-bit integer data. See the description in Chapter 3, “Constants and Variables” in the *Building IDL Applications* manual for details.

### $D_i$

When extracting fields of data, the $D_i$ arguments specify the dimensions of the result. If no dimension arguments are given, the result is taken to be scalar.

The $D_i$ arguments can be either an array or a series of scalar expressions specifying the dimensions of the result. If a single argument is specified, it can be either a scalar expression or an array of up to eight elements. If multiple arguments are specified, they must all be scalar expressions. Up to eight dimensions can be specified.

When converting from a string argument, it is possible that the string does not contain a valid integer and no conversion is possible. The default action in such cases is to print a warning message and return 0. The ON_IOERROR procedure can be used to establish a statement to be jumped to in case of such errors.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

If A contains the floating-point value 32000.0, it can converted to an unsigned 64-bit integer and stored in the variable B by entering:

```
B = ULONG64(A)
```

# Version History

Introduced: 5.2

# See Also

BYTE, COMPLEX, DCOMPLEX, DOUBLE, FIX, FLOAT, LONG, LONG64, STRING, UINT, ULONG

# UNIQ

The UNIQ function returns the subscripts of the unique elements in an array. Note that repeated elements must be adjacent in order to be found. This routine is intended to be used with the SORT function: see the examples below. This function was inspired by the UNIX `uniq(1)` command.

This routine is written in the IDL language. Its source code can be found in the file `uniq.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = UNIQ( *Array* [, *Index*] )

## Return Value

UNIQ returns an array of indices into the original array. Note that the index of the last element in each set of non-unique elements is returned. The following expression is a copy of the sorted array with duplicate adjacent elements removed:

*Array*`(UNIQ(`*Array*`))`

UNIQ returns 0 (zero) if the argument supplied is a scalar rather than an array.

## Arguments

### Array

The array to be scanned. For UNIQ to work properly, the array must be sorted into monotonic order unless the optional parameter *Idx* is supplied.

### Index

This optional parameter is an array of indices into *Array* that order the elements into monotonic order. That is, the expression:

*Array*`(`*Index*`)`

yields an array in which the elements of *Array* are rearranged into monotonic order. If the array is not already in monotonic order, use the command:

```
UNIQ(Array, SORT(Array))
```

## Examples

Find the unique elements of an unsorted array:

```
; Create an array:
array = [1, 2, 1, 2, 3, 4, 5, 6, 6, 5]

; Variable B holds an array containing the sorted, unique values in
; array:
b = array[UNIQ(array, SORT(array))]
PRINT, b
```

IDL prints

```
1    2    3    4    5    6
```

## Version History

Introduced: Pre 4.0

## See Also

SORT, WHERE

# USERSYM

The USERSYM procedure is used to define the plotting symbol that marks points when the plotting symbol is set to plus or minus 8. Symbols can be drawn with vectors or can be filled. Symbols can be of any size and can have up to 50 vertices. See"Defining Your Own Plotting Symbols" in Chapter 17 of the *Using IDL* manual .

## Syntax

USERSYM, *X* [, *Y*] [, COLOR=*value*] [, /FILL] [, THICK=*value*]

## Arguments

### X, Y

The *X* and/or *Y* parameters define the vertices of the symbol as offsets from the data point in units of approximately the size of a character. In the case of a vector drawn symbol, the symbol is formed by connecting the vertices in order. If only one argument is specified, it must be a (2, *N*) array of vertices, with element [0, *i*] containing the X coordinate of the vertex, and element [1, *i*] containing the Y. If both arguments are provided, *X* contains only the X coordinates.

## Keywords

### COLOR

The color used to draw the symbols, or used to fill the polygon. The default color is the same as the line color.

### FILL

Set this keyword to fill the polygon defined by the vertices. If FILL is not set, lines are drawn connecting the vertices.

### THICK

The thickness of the lines used in drawing the symbol. The default thickness is 1.0.

## Examples

Make a large, diamond-shaped plotting symbol. Define the vectors of X values by entering:

```
X = [-6, 0, 6, 0, -6]
```

Define the vectors of Y values by entering:

```
Y = [0, 6, 0, -6, 0]
```

Now call USERSYM to create the new plotting symbol 8. Enter:

```
USERSYM, X, Y
```

Generate a simple plot to test the plotting symbol by entering:

```
PLOT, FINDGEN(20), PSYM = 8
```

## Version History

Introduced: Original

## See Also

PLOT

# VALUE_LOCATE

The VALUE_LOCATE function finds the intervals within a given monotonic vector that brackets a given set of one or more search values. This function is useful for interpolation and table-lookup, and is an adaptation of the locate() routine in Numerical Recipes. VALUE_LOCATE uses the bisection method to locate the interval.

## Syntax

*Result* = VALUE_LOCATE ( *Vector*, *Value* [, /L64 ] )

## Return Value

Each return value, *Result* [*i*], is an index, *j*, into *Vector*, corresponding to the interval into which the given *Value* [*i*] falls. The returned values are in the range $-1 \le j \le N-1$, where *N* is the number of elements in the input vector.

If *Vector* is monotonically increasing, the result *j* is:

if $j = -1$ *Value* [*i*] < *Vector* [0]

if $0 \le j < N-1$ *Vector* [*j*] ≤ *Value* [*i*] < *Vector* [*j*+1]

if $j = N-1$ *Vector* [*N*–1] ≤ *Value* [*i*]

If *Vector* is monotonically decreasing

if $j = -1$ *Vector* [*0*] ≤ *Value* [*i*]

if $0 \le j < N-1$ *Vector* [*j*+1] ≤ *Value* [*i*] < *Vector* [*j*]

if $j = N-1$ *Value* [*i*] < *Vector* [*N*–1]

## Arguments

### Vector

A vector of monotonically increasing or decreasing values. *Vector* may be of type string, or any numeric type except complex, and may not contain the value NaN (not-a-number).

### Value

The value for which the location of the intervals is to be computed. *Value* may be either a scalar or an array. The return value will contain the same number of elements as this parameter.

## Keywords

### L64

By default, the result of VALUE_LOCATE is 32-bit integer when possible, and 64-bit integer if the number of elements being processed requires it. Set L64 to force 64-bit integers to be returned in all cases.

**Note**

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit result. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

## Examples

```
; Define a vector of values.
vec = [2,5,8,10]

; Compute location of other values within that vector.
loc = VALUE_LOCATE(vec, [0,3,5,6,12])
PRINT, loc
```

IDL prints:

```
-1   0   1   1   3
```

## Version History

Introduced: 5.3

# VARIANCE

The VARIANCE function computes the statistical variance of an *n*-element vector.

## Syntax

*Result* = VARIANCE( *X* [, /DOUBLE] [, /NAN] )

## Return Value

Returns the floating-point or double-precision statistical variance of the input vector.

## Arguments

### X

An *n*-element, floating-point or double-precision vector.

## Keywords

### DOUBLE

If this keyword is set, VARIANCE performs its computations in double precision arithmetic and returns a double precision result. If this keyword is not set, the computations and result depend upon the type of the input data (integer and float data return float results, while double data returns double results).

### NAN

Set this keyword to cause the routine to check for occurrences of the IEEE floating-point value NaN in the input data. Elements with the value NaN are treated as missing data. (See "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual for more information on IEEE floating-point values.)

## Examples

```
; Define the n-element vector of sample data:
x = [1, 1, 1, 2, 5]
; Compute the variance:
result = VARIANCE(x)
PRINT, result
```

IDL prints:

```
3.00000
```

## Version History

Introduced: 5.1

## See Also

KURTOSIS, MEAN, MEANABSDEV, MOMENT, STDDEV, SKEWNESS

# VECTOR_FIELD

The VECTOR_FIELD procedure is used to place colored, oriented vectors of specified length at each vertex in an input vertex array. The output can be sent directly to an IDLgrPolyline object. The generated display is generally referred to as a hedgehog display and is used to convey various aspects of a vector field.

## Syntax

VECTOR_FIELD, *Field*, *Outverts*, *Outconn* [, ANISOTROPY=*array*] [, SCALE=*value*] [, VERTICES=*array*]

## Arguments

### Field

Input vector field array. This can be a [3, *x*, *y*, *z*] array or a [2, *x*, *y*] array. The leading dimension is the vector quantity to be displayed.

### Outverts

Output vertex array ([3, *N*] or [2, *N*] array of floats). Useful if the routine is to be used with Direct Graphics or the user wants to manipulate the data directly.

### Outconn

Output polyline connectivity array to be applied to the output vertices.

## Keywords

### ANISOTROPY

Set this keyword to a two- or three-element array describing the distance between grid points in each dimension. The default value is [1.0, 1.0, 1.0] for three-dimensional data and [1.0, 1.0] for two-dimensional data.

### SCALE

Set this keyword to a scalar scaling factor. All vector lengths are multiplied by this value. The default is 1.0.

### VERTICES

Set this keyword to a [3, *n*] or [2, *n*] array of points. If this keyword is set, the vector field is interpolated at these points. The resulting interpolated vectors are displayed as line segments at these locations. If the keyword is not set, each spatial sample point in the input Field grid is used as the base point for a line segment.

## Version History

Introduced: 5.3

# VEL

The VEL procedure draws a velocity (flow) field with arrows following the field proportional in length to the field strength. Arrows are composed of a number of small segments that follow the streamlines.

This routine is written in the IDL language. Its source code can be found in the file `vel.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

VEL, *U*, *V* [, NVECS=*value*] [, XMAX= *value*{*xsize*/*ysize*}]
[, LENGTH=*value*{*longest*/*steps*}] [, NSTEPS=*value*] [, TITLE=*string*]

## Arguments

### U

The X component at each point of the vector field. *U* must be a 2-D array.

### V

The Y component at each point of the vector field. *V* must have the same dimensions as *U*.

## Keywords

### LENGTH

The length of each arrow line segment expressed as a fraction of the longest vector divided by the number of steps. The default is 0.1.

### NSTEPS

The number of shoots or line segments for each arrow. The default is 10.

### NVECS

The number of vectors (arrows) to draw. If this keyword is omitted, 200 vectors are drawn.

### TITLE

A string containing the title for the plot.

### XMAX

X axis size as a fraction of Y axis size. The default is 1.0. This argument is ignored when !P.MULTI is set.

## Examples

```
; Create a vector of X values:
X = DIST(20)

; Create a vector of Y values:
Y = SIN(X)*100

; Plot the vector field:
VEL, X, Y
```

## Version History

Introduced: Pre 4.0

## See Also

FLOW3, PLOT_FIELD, VELOVECT

# VELOVECT

The VELOVECT procedure produces a two-dimensional velocity field plot. A directed arrow is drawn at each point showing the direction and magnitude of the field.

This routine is written in the IDL language. Its source code can be found in the file `velovect.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

VELOVECT, *U*, *V* [, *X*, *Y*] [, COLOR=*index*] [, MISSING=*value* [, /DOTS]] [, LENGTH=*value*] [, /OVERPLOT] [Also accepts all PLOT keywords]

## Arguments

### U

The X component of the two-dimensional field. *U* must be a two-dimensional array.

### V

The Y component of the two dimensional field. *V* must have the same dimensions as *U*.

### X

Optional abscissae values. *X* must be a vector with a length equal to the first dimension of *U* and *V*.

### Y

Optional ordinate values. *Y* must be a vector with a length equal to the second dimension of *U* and *V*.

## Keywords

**Note**

Keywords not described here are passed directly to the PLOT procedure and may be used to set options such as TITLE, POSITION, NOERASE, etc.

### COLOR

Set this keyword equal to the color index used for the plot.

### DOTS

Set this keyword to 1 to place a dot at each missing point. Set this keyword to 0 or omit it to draw nothing for missing points. Has effect only if MISSING is specified.

### LENGTH

Set this keyword equal to the length factor. The default of 1.0 makes the longest (*U*,*V*) vector the length of a cell.

### MISSING

Set this keyword equal to the missing data value. Vectors with a length greater than MISSING are ignored.

### OVERPLOT

Set this keyword to make VELOVECT “overplot”. That is, the current graphics screen is not erased, no axes are drawn, and the previously established scaling remains in effect.

### PLOT Keywords

In addition to the keywords described above, all other keywords accepted by the PLOT procedure are accepted by VELOVECT. See PLOT.

## Examples

```
; Create some random data:
U = RANDOMN(S, 20, 20)
V = RANDOMN(S, 20, 20)

; Plot the vector field:
VELOVECT, U, V

; Plot the field, using dots to represent vectors with values
; greater than 18:
VELOVECT, U, V, MISSING=18, /DOTS

; Plot with a title. Note that the XTITLE keyword is passed
; directly to the PLOT procedure:
VELOVECT, U, V, MISSING=18, /DOTS, XTITLE='Random Vectors'
```

## Version History

Introduced: Original

## See Also

FLOW3, PLOT, PLOT_FIELD, VEL

# VERT_T3D

The VERT_T3D function transforms a 3-D array by a 4x4 transformation matrix. The 3-D points are typically an array of polygon vertices that were generated by SHADE_VOLUME or MESH_OBJ.

This routine is written in the IDL language. Its source code can be found in the file `vert_t3d.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = VERT_T3D( *Vertex_List* [, DOUBLE=*value*] [, MATRIX=*4x4_array*] [, /NO_COPY] [, /NO_DIVIDE [, SAVE_DIVIDE=*variable*]] )

## Return Value

Returns the single- or double-precision coordinates of the transformed array.

## Arguments

### Vertex_List

A 3 x *n* array of 3-D coordinates to transform.

## Keywords

### DOUBLE

Set this keyword to a nonzero value to indicate that the returned coordinates should be double-precision. If this keyword is not set, the default is to return single-precision coordinates (unless double-precision arguments are input, in which case the DOUBLE keyword is implied to be non-zero).

### MATRIX

The 4x4 transformation matrix to use. The default is to use the system viewing matrix (!P.T).

### NO_COPY

Normally, a copy of *Vertex_list* is transformed and the original *Vertex_list* is preserved. If NO_COPY is set, however, then the original *Vertex_List* will be undefined after the call to VERT_T3D. Using the NO_COPY requires less memory.

### NO_DIVIDE

Normally, when a [*x*, *y*, *z*, 1] vector is transformed by a 4x4 matrix, the final homogeneous coordinates are obtained by dividing the *x*, *y*, and *z* components of the result vector by the fourth element in the result vector. Setting the NO_DIVIDE keyword will prevent VERT_T3D from performing this division. In some cases (usually when a perspective transformation is involved) the fourth element in the result vector can be very close to (or equal to) zero.

### SAVE_DIVIDE

Set this keyword to a named variable that will hold receive the fourth element of the transformed vector(s). If *Vertex_list* is a vector then SAVE_DIVIDE is a scalar. If *Vertex_list* is an array then SAVE_DIVIDE is an array of *n* elements. This keyword only has effect when the NO_DIVIDE keyword is set.

## Examples

Transform four points representing a square in the x-y plane by first translating +2.0 in the positive X direction, and then rotating 60.0 degrees about the Y axis.

```
points = [[0.0, 0.0, 0.0], [1.0, 0.0, 0.0], $
          [1.0, 1.0, 0.0], [0.0, 1.0, 0.0]]
T3D, /RESET
T3D, TRANSLATE=[2.0, 0.0, 0.0]
T3D, ROTATE=[0.0, 60.0, 0.0]
points = VERT_T3D(points)
```

## Version History

Introduced: Pre 4.0

## See Also

T3D

# VOIGT

The VOIGT function returns the value of the classical Voigt function, H(*a*, *u*), defined in terms of the Voigt damping parameter *a* and the frequency offset *u*:

$$H(a, u) = \frac{a}{\pi} \int_{-\infty}^{\infty} \frac{e^{-y^2} dy}{a^2 + (u - y)^2}$$

The dimensionless frequency offset *u* and the damping parameter *a* are determined by:

$$u = \frac{\nu - \nu_0}{\Delta\nu_D}$$

$$a = \frac{\Gamma}{4\pi\Delta\nu_D}$$

where $\nu_0$ is the line center frequency and the Doppler width $\Delta\nu_D$ (assuming no turbulence), is defined as:

$$\Delta\nu_D = \frac{\nu_0}{c} b = \frac{\nu_0}{c} \sqrt{2kT/m}$$

and, $\Gamma$ is the transition rate:

$$\Gamma = \gamma + 2\nu_{col}$$

where $\gamma$ is the spontaneous decay rate, and $\nu_{col}$ is the atomic collision rate. (See *Radiative Processes in Astrophysics* by G. B. Rybicki and A. P. Lightman (1979) p. 291 for more information.)

The Voigt function can be used to compute the intensity of an atomic absorption line profile (also known as a VOIGT profile). The line profile $\phi(a, u)$ is defined as:

$$\phi(a, u) \equiv \frac{H(a, u)}{\Delta v_D \sqrt{\pi}}$$

The algorithm is from Armstrong, *JQSRT 7*, 85. (1967). The definition of the classical Voigt function H(*a*,*u*) can be found in Equation 7.4.13 of Abramowitz, M. and Stegun, I.A., 1964, *Handbook of Mathematical Functions* (Washington:National Bureau of Standards).

# Syntax

*Result* = VOIGT(*A*, *U*)

# Return Value

If both arguments are scalars, the function returns a scalar. If both arguments are arrays, the function matches up the corresponding elements of A and U, returning an array with the same dimensions as the smallest array. If one argument is a scalar and the other argument is an array, the function uses the scalar value with each element of the array, and returns an array with the same dimensions as the smallest input array. If A is double-precision, the result is double-precision, otherwise the result is single-precision.

# Arguments

## A

A scalar or array specifying the values for the Voigt damping parameter.

## U

A scalar or array specifying the values for the dimensionless frequency offset in Doppler widths.

# Keywords

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Version History

Introduced: Pre 4.0

# See Also

LEEFILT, ROBERTS, SOBEL

# VORONOI

The VORONOI procedure computes the Voronoi polygon of a point within an irregular grid of points, given the Delaunay triangulation. The Voronoi polygon of a point contains the region closer to that point than to any other point.

For interior points, the polygon is constructed by connecting the midpoints of the lines connecting the point with its Delaunay neighbors. Polygons are traversed in a counterclockwise direction.

For exterior points, the set is described by the midpoints of the connecting lines, plus the circumcenters of the two triangles that connect the point to the two adjacent exterior points.

This routine is written in the IDL language. Its source code can be found in the file `voronoi.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

VORONOI, *X*, *Y*, *I0*, *C*, *Xp*, *Yp*, *Rect*

## Arguments

### X

An array containing the X locations of the points.

### Y

An array containing the Y locations of the points.

### I0

An array containing the indices of the points.

### C

A connectivity list from the Delaunay triangulation. This list is produced with the CONNECTIVITY keyword of the TRIANGULATE procedure.

### Xp, Yp

Named variables that will contain the X and Y vertices of Voronoi polygon.

### Rect

The bounding rectangle: [Xmin, Ymin, Xmax, Ymax]. Because the Voronoi polygon (VP) for points on the convex hull extends to infinity, a clipping rectangle must be supplied to close the polygon. This rectangle has no effect on the VP of interior points. If this rectangle does not enclose all the Voronoi vertices, the results will be incorrect. If this parameter, which must be a named variable, is undefined or set to a scalar value, it will be calculated.

## Examples

To draw the Voronoi polygons of each point of an irregular grid:

```
N = 20

; Create a random grid of N points:
X = RANDOMU(seed, N)
Y = RANDOMU(seed, N)

; Triangulate it:
TRIANGULATE, X, Y, tr, CONN=C

FOR I=0, N-1 DO BEGIN & $
   ; Get the ith polygon:
   VORONOI, X, Y, I, C, Xp, Yp & $
      ; Draw it:
      POLYFILL, Xp, Yp, COLOR = (I MOD 10) + 2 & $
ENDFOR
```

## Version History

Introduced: Pre 4.0

## See Also

TRIANGULATE

# VOXEL_PROJ

The VOXEL_PROJ function generates visualizations of volumetric data by computing 2-D projections of a colored, semi-transparent volume. Parallel rays from any given direction are cast through the volume, onto the viewing plane. User-selected colors and opacities can be assigned to arbitrary data ranges, simulating the appearance of the materials contained within the volume.

The VOXEL_PROJ function can be combined with the Z-buffer to render volume data over objects. Cutting planes can also be specified to view selected portions of the volume. Other options include: selectable resolution to allow quick “preview” renderings, and average and maximum projections.

VOXEL_PROJ renders volumes using an algorithm similar to the one described by Drebin, Carpenter, and Hanrahan, in “Volume Rendering”, *Computer Graphics*, Volume 22, Number 4, August 1988, pp. 125-134, but without the surface extraction and enhancement step.

Voxel rendering can be quite time consuming. The time required to render a volume is proportional to the viewing areas size, in pixels, times the thickness of the volume cube in the viewing direction, divided by the product of the user-specified X, Y, and Z steps.

## Syntax

*Result* = VOXEL_PROJ( *V* [, *RGBO*] [, BACKGROUND=*array*] [, CUTTING_PLANE=*array*] [, /INTERPOLATE] [, /MAXIMUM_INTENSITY] [, STEP=*[Sx, Sy, Sz]*] [, XSIZE=*pixels*] [, YSIZE=*pixels*] [, ZBUFFER=*int_array*] [, ZPIXELS=*byte_array*] )

## Return Value

Returns the specified voxel projection results.

## Arguments

### V

A three-dimensional array containing the volume to be rendered. This array is converted to byte type if necessary.

### RGBO

This optional parameter is used to specify the look-up tables that indicate the color and opacity of each voxel value. This argument can be one of the following types:

- A (256, 4) byte array for TrueColor rendering. This array represents 256 sets of red, green, blue, and opacity (RGBO) components for each voxel value, scaled into the range of bytes (0 to 255). The R, G, and B components should already be scaled by the opacity. For example, if a voxel value of 100 contains a material that is red, and 35% opaque, the RGBO values should be, respectively: [89, 0, 0, 89] because 255 * 0.35 = 89. If more than one material is present, the RGBO arrays contain the sum of the individual RGBO arrays. The content and shape of the RGBO curves is highly dependent upon the volume data and experimentation is often required to obtain the best display.
- A (256, 2) byte array for volumes with only one material or monochrome rendering. This array represents 256 sets of pixel values and their corresponding opacities for each voxel value.
- If this argument is omitted, the average projection method, or maximum intensity method (if the MAXIMUM_INTENSITY keyword is set) is used.

## Keywords

### BACKGROUND

A one- or three-element array containing the background color indices. The default is (0,0,0), yielding a black background with most color tables.

### CUTTING_PLANE

A floating-point array specifying the coefficients of additional cutting planes. The array has dimensions of (4, N), where N is the number of additional cutting planes from 1 to 6. Cutting planes are constraints in the form of:

C[0] * X + C[1] * Y + C[2] * Z + D > 0

The X, Y, and Z coordinates are specified in voxel coordinates. For example, to specify a cutting plane that excludes all voxels with an X value greater than 10:

CUTTING_PLANE = [-1.0, 0, 0, 10.], for the constraint: -X + 10 > 0.

### INTERPOLATE

Set this keyword to use tri-linear interpolation to determine the data value for each step on a ray. Otherwise, the nearest-neighbor method is used. Setting this keyword

improves the quality of images produced, especially when the volume has low resolution in relation to the size of the viewing plane, at the cost of more computing time.

## MAXIMUM_INTENSITY

Set this keyword to make the value of each pixel in the viewing plane the maximum data value along the corresponding ray. The *RGBO* argument is ignored if present.

## STEP

Set this keyword to a three-element vector, [*Sx*, *Sy*, *Sz*], that controls the resolution of the resulting projection. The first two elements contain the step size in the X and Y view plane, in pixels. The third element is the sampling step size in the Z direction, given in voxels. *Sx* and *Sy* must be integers equal to or greater than one, while *Sz* can contain a fractional part. If *Sx* or *Sy* are greater than one, the values of intermediate pixels in the output image are linearly interpolated. Higher step sizes require less time because fewer rays are cast, at the expense of lower resolution in the output image.

## XSIZE

The width, in pixels, of the output image. If this keyword is omitted, the output image is as wide as the currently-selected output device.

## YSIZE

The height, in pixels, of the output image. If this keyword is omitted, the output image is as tall as the currently selected output device.

## ZBUFFER

An integer array, with the same width and height as the output image, that contains the depth portion of the Z-buffer. Include this parameter to combine the previously-read contents of a Z-buffer with a voxel rendering. See the third example, below, for details.

## ZPIXELS

A byte array, with the same width and height as the output image, that contains the image portion of the Z-buffer. Include this parameter to combine the contents of a Z-buffer with a voxel rendering. See the third example, below, for details.

# Examples

## Example 1

In the following example, assume that variable V contains a volume of data, with dimensions Vx by Vy by Vz. The volume contains two materials, muscle tissue represented by a voxel range of 50 to 70, that we want to render with red color, and an opacity of 20; and bone tissue represented by a voxel range of 220-255, that we want to render with white color, and an opacity of 50:

```
; Create the opacity vector:
rgbo = BYTARR(256,4)

; Red and opacity for muscle:
rgbo[50:70, [0,3]] = 20

; White and opacity for bone:
rgbo[220:255, *] = 50
```

## Example 2

Although it is common to use trapezoidal or Gaussian functions when forming the RGBO arrays, this example uses rectangular functions for simplicity.

```
; Set up the axis scaling and default rotation:
SCALE3, XRANGE=[0, Vx-1], YRANGE=[0, Vy-1], ZRANGE=[0, Vz-1]

; Compute projected image:
C = VOXEL_PROJ(V, rgbo)

; Convert from 24-bit to 8-bit image and display:
TV, COLOR_QUAN(C, 3, R, G, B)

; Load quantized color tables:
TVLCT, R, G, B
```

This example required approximately 27 seconds on a typical workstation to compute the view in a 640- by 512-pixel viewing window. Adding the keyword STEP=[2,2,1] in the call to VOXEL_PROJ decreased the computing time to about 8 seconds, at the expense of slightly poorer resolution.

When viewing a volume with only one constituent, the RGBO array should contain only an intensity/opacity value pair. To illustrate, if in the above example, only muscle was of interest we create the RGBO argument as follows:

```
; Create an empty 256 x 2 array:
rgbo = BYTARR(256,2)
```

```
; Intensity and opacity for muscle:
rgbo[50:70, *] = 20
SCALE3, XRANGE=[0, Vx-1], YRANGE=[0, Vy-1], ZRANGE=[0, Vz-1]

; Compute and display the projected image:
TV, VOXEL_PROJ(V, rgbo)

; Create color table array for red:
C = (FINDGEN(256)/255.) # [255., 0., 0]

; Load colors:
TVLCT, C[*,0], C[*,1], C[*,2]
```

## Example 3

This example demonstrates combining a volume with the contents of the Z-buffer:

```
; Set plotting to Z-buffer:
SET_PLOT, 'Z'

; Turn on Z buffering:
DEVICE, /Z_BUFFER

; Set scaling:
SCALE3, XRANGE=[0, Vx-1], YRANGE=[0, Vy-1], ZRANGE=[0, Vz-1]

; Draw a polygon at z equal to half the depth:
POLYFILL, [0, Vx-1, Vx-1, 0], [0, 0, Vy-1, Vy-1], Vz/2., /T3D

; Read pixel values from the Z-buffer:
zpix = TVRD()

; Read depth values from the Z-buffer:
zbuff = TVRD(/WORDS,/CHAN)

; Back to display window:
SET_PLOT, 'X'

; Compute the voxel projection and use the ZPIXELS and ZBUFFER
; keywords to combine the volume with the previously-read contents
; of the Z-buffer:
C = VOXEL_PROJ(V, rgbo, ZPIX=zpix, ZBUFF=zbuff)

;Convert from 24-bit to 8-bit image and display.
TV, COLOR_QUAN(C, 3, R, G, B)

; Load the quantized color tables:
TVLCT, R, G, B
```

## Version History

Introduced: Pre 4.0

## See Also

POLYSHADE, PROJECT_VOL, RECON3, SHADE_VOLUME

# WAIT

The WAIT procedure suspends execution of an IDL program for a specified period. Note that because of other activity on the system, the duration of program suspension may be longer than requested.

## Syntax

WAIT, *Seconds*

## Arguments

### Seconds

The duration of the wait, specified in seconds. This parameter can be a floating-point value to specify a fractional number of seconds.

## Keywords

None.

## Examples

To make an IDL program suspend execution for about five and one half seconds, use the command:

```
WAIT, 5.5
```

## Version History

Introduced: Original

## See Also

EXIT, STOP

# WARP_TRI

The WARP_TRI function returns an image array with a specified geometric correction applied. Images are warped using control (tie) points such that locations (*Xi*, *Yi*) are shifted to (*Xo*, *Yo*).

The irregular grid defined by (*Xo*, *Yo*) is triangulated using TRIANGULATE. Then the surfaces defined by (*Xo*, *Yo*, *Xi*) and (*Xo*, *Yo*, *Yi*) are interpolated using TRIGRID to get the locations in the input image of each pixel in the output image. Finally, INTERPOLATE is called to obtain the result. Linear interpolation is used by default. Smooth quintic interpolation is used if the QUINTIC keyword is set.

This routine is written in the IDL language. Its source code can be found in the file `warp_tri.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = WARP_TRI( *Xo*, *Yo*, *Xi*, *Yi*, *Image* [, OUTPUT_SIZE=*vector*] [, /QUINTIC] [, /EXTRAPOLATE] [, /TPS] )

## Return Value

Returns the warped image array.

## Arguments

### Xo, Yo

Vectors containing the locations of the control (tie) points in the output image.

### Xi, Yi

Vectors containing the location of the control (tie) points in the input image. *Xi* and *Yi* must be the same length as *Xo* and *Yo*.

### Image

The image to be warped. May be any type of data.

# Keywords

## OUTPUT_SIZE

Set this keyword equal to a 2-element vector containing the size of the output image. If omitted, the output image is the same size as *Image*.

## QUINTIC

Set this keyword to use smooth quintic interpolation. Quintic interpolation is slower but the derivatives are continuous across triangles, giving a more pleasing result than the default linear interpolation.

## EXTRAPOLATE

Set this keyword to extrapolate outside the convex hull of the tie points. Setting this keyword implies the use of QUINTIC interpolation.

## TPS

Set this keyword to use Thin Plate Spline interpolation, which interpolates a set of irregularly sampled data value over a regular two dimensional grid. Thin plate splines are ideal for modeling functions with complex local distortions, such as warping functions, which are too complex to be fit with polynomials.

# Version History

Introduced: Pre 4.0

# See Also

INTERPOLATE, TRIANGULATE, TRIGRID

# WATERSHED

The WATERSHED function applies the morphological watershed operator to a grayscale image. This operator segments images into watershed regions and their boundaries. Considering the gray scale image as a surface, each local minimum can be thought of as the point to which water falling on the surrounding region drains. The boundaries of the watersheds lie on the tops of the ridges. This operator labels each watershed region with a unique index, and sets the boundaries to zero.

Typically, morphological gradients, or images containing extracted edges are used for input to the watershed operator. Noise and small unimportant fluctuations in the original image can produce spurious minima in the gradients, which leads to oversegmentation. Smoothing, or manually marking the seed points are two approaches to overcoming this problem. For further reading, see Dougherty, “An Introduction to Morphological Image Processing”, SPIE Optical Engineering Press, 1992.

## Syntax

*Result* = WATERSHED ( *Image* [, CONNECTIVITY={4 | 8} ] )

## Return Value

Returns an image of the same dimensions as the input image. Each pixel of the result will be either zero if the pixel falls along the segmentation between basins, or the identifier of the basin in which that pixel falls.

## Arguments

### Image

The two-dimensional image to be segmented. *Image* is converted to byte type if necessary.

## Keywords

### CONNECTIVITY

Set this keyword to either 4 (to select 4-neighbor connectivity) or 8 (to select 8-neighbor connectivity). Connectivity indicates which pixels in the neighborhood of a given pixel are sampled during the segmentation process. 4-neighbor connectivity

samples only the pixels that are immediately adjacent horizontally and vertically. 8-neighbor connectivity samples the diagonally adjacent neighbors in addition to the immediate horizontal and vertical neighbors. The default is 4-neighbor connectivity.

## Examples

The following code crudely segments the grains in the data file in the IDL Demo data directory containing an magnified image of grains of pollen. Note that the IDL Demos must be installed in order to read the image used in this example.

It inverts the image, because the watershed operator finds holes, and the grains of pollen are bright. Next, the morphological closing operator is applied with a disc of radius 9, contained within a 19 by 19 kernel, to eliminate holes in the image smaller than the disc. The watershed operator is then applied to segment this image. The borders of the watershed images, which have pixel values of zero, are then merged with the original image and displayed as white.

```
;Radius of disc...
r = 9

;Create a disc of radius r
disc = SHIFT(DIST(2*r+1), r, r) LE r

;Read the image
READ_JPEG, FILEPATH('pollens.jpg', $
   SUBDIR=['examples','demo','demodata']), a

;Invert the image
b = MAX(a) - a

TVSCL, b, 0

;Remove holes of radii less than r
c = MORPH_CLOSE(b, disc, /GRAY)

TVSCL, c, 1

;Create watershed image
d = WATERSHED(c)

;Display it, showing the watershed regions
TVSCL, d, 2

;Merge original image with boundaries of watershed regions
e = a > (MAX(a) * (d EQ 0b))

TVSCL, e, 3
```

## Version History

Introduced: 5.3

# Wavelet Toolkit

For information, see the *Chapter 1, "Introduction to the IDL Wavelet Toolkit"* in the *IDL Wavelet Toolkit* manual.

# WDELETE

The WDELETE procedure deletes IDL windows.

## Syntax

WDELETE [, *Window_Index* [, ...]]

## Arguments

### Window_Index

A list of one or more window indices to delete. If this argument is not specified, the current window (as specified by the system variable !D.WINDOW) is deleted. If the window being deleted is not the active window, the value of !D.WINDOW remains unchanged. If the window being deleted is the active window, !D.WINDOW is set to the highest numbered window index or to -1 if no windows remain open.

If this window index is the widget ID of a draw widget, that widget is deleted.

## Keywords

None.

## Examples

Create IDL graphics window number 5 by entering:

```
WINDOW, 5
```

Delete window 5 by entering:

```
WDELETE, 5
```

## Version History

Introduced: Original

## See Also

WINDOW, WSET, WSHOW

# WF_DRAW

The WF_DRAW procedure draws weather fronts of various types using parametric spline interpolation to smooth the lines. WF_DRAW uses the POLYFILL routine to make the annotations on the front lines.

This routine is written in the IDL language. Its source code can be found in the file `wf_draw.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

WF_DRAW, *X*, *Y* [[, /COLD | , FRONT_TYPE=1] | [, /WARM | , FRONT_TYPE=2] | [, /OCCLUDED | , FRONT_TYPE=3] | [, /STATIONARY | , FRONT_TYPE=4] | [, /CONVERGENCE | , FRONT_TYPE=5]] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, INTERVAL=*value*] [, PSYM=*value*] [, SYM_HT=*value*] [, SYM_LEN=*value*] [, THICK=*value*]

## Arguments

### X, Y

Vectors of abscissae and ordinates defining the front to be drawn.

## Keywords

### COLD

Set this keyword to draw a cold front. The default is a plain line with no annotations. A cold front can also be specified by setting the keyword FRONT_TYPE = 1.

### COLOR

Use this keyword to specify the color to use. The default = !P.COLOR.

### CONVERGENCE

Set this keyword to draw a convergence line. A convergence line can also be specified by setting the keyword FRONT_TYPE = 5.

### DATA

Set this keyword if X and Y are specified in data coordinates.

## DEVICE

Set this keyword if X and Y are specified in device coordinates.

## FRONT_TYPE

Set this keyword equal to the numeric index of type of front to draw. Front type indices are as follows: COLD=1, WARM=2, OCCLUDED=3, STATIONARY=4, CONVERGENCE = 5. Not required if plain line is desired or if an explicit front type keyword is specified.

## INTERVAL

Use this keyword to specify the spline interpolation interval, in normalized units. The default = 0.01. Larger values give coarser approximations to curves, smaller values make more interpolated points.

## NORMAL

Set this keyword if X and Y are specified in normalized coordinates. This is the default.

## OCCLUDED

Set this keyword to draw an occluded front. An occluded front can also be specified by setting the keyword FRONT_TYPE = 3.

## PSYM

Set this keyword a standard PSYM value to draw a marker on each actual (*X*, *Y*) data point. See “PSYM” on page 3878 for a list of the symbol types.

## STATIONARY

Set this keyword to draw a stationary front. A stationary front can also be specified by setting the keyword FRONT_TYPE = 4.

## SYM_HT

Use this keyword to specify the height of front symbols, in normalized units. The default = 0.02.

## SYM_LEN

Use this keyword to specify the length and spacing factor for front symbols, in normalized units. The default = 0.15.

### THICK

Use this keyword to specify the line thickness. The default = 1.0.

### WARM

Set this keyword to draw a warm front. A warm front can also be specified by setting the keyword FRONT_TYPE = 2.

## Examples

This example draws various fronts on a map of the United States. Note that this example code is in the file `wf_draw.pro`, and can be run by entering `test_wf_draw` at the IDL command line.

```
PRO test_wf_draw

 MAP_SET, LIMIT = [25, -125, 50, -70], /GRID, /USA
 WF_DRAW, [ -120, -110, -100], [30, 50, 45], /COLD, /DATA, THICK=2
 WF_DRAW, [ -80, -80, -75], [ 50, 40, 35], /WARM, /DATA, THICK=2
 WF_DRAW, [ -80, -80, -75]-10., [ 50, 40, 35], /OCCLUDED, /DATA,$
    THICK=2
 WF_DRAW, [ -120, -105], [ 40,35], /STATION, /DATA, THICK=2
 WF_DRAW, [ -100, -90, -90], [ 30,35,40], /CONVERG, /DATA, THICK=2

 names=['None','Cold','Warm','Occluded','Stationary','Convergent']
 x = [.015, .30]
 y = 0.04
 dy = 0.05
 ty = N_ELEMENTS(names) * dy + y
 POLYFILL, x[[0,1,1,0]],[0, 0, ty, ty],/NORM, COLOR=!P.BACKGROUND
 FOR i=0, N_ELEMENTS(names)-1 DO BEGIN
    WF_DRAW, x, y, /NORM, FRONT_TYPE=i, THICK=2
    XYOUTS, x[1]+0.015, y[0], names[i], /NORM, CHARS=1.5
    y = y + dy
 ENDFOR

END
```

## Version History

Introduced: Pre 4.0

## See Also

ANNOTATE, XYOUTS

# WHERE

The WHERE function returns a vector that contains the one-dimensional subscripts of the nonzero elements of *Array_Expression*. The length of the resulting vector is equal to the number of nonzero elements in *Array_Expression*. Frequently the result of WHERE is used as a vector subscript to select elements of an array using given criteria.

### Note: When WHERE Returns –1

If all the elements of *Array_Expression* are zero, WHERE returns a scalar integer with a value of –1. Attempting to use this result as an index into another array results in a “subscripts out of bounds” error. In situations where this is possible, code similar to the following can be used to avoid errors:

```
; Use Count to get the number of nonzero elements:
index = WHERE(array, count)

; Only subscript the array if it’s safe:
IF count NE 0 THEN result = array[index]
```

## Syntax

*Result* = WHERE( *Array_Expression* [, *Count*] [, COMPLEMENT=*variable*] [, /L64] [, NCOMPLEMENT=*variable*] )

## Return Value

Returns a longword vector containing the subscripts of non-zero array elements matching the specified conditions.

## Arguments

### Array_Expression

The array to be searched. Both the real and imaginary parts of a complex number must be zero for the number to be considered zero.

### Count

A named variable that will receive the number of nonzero elements found in *Array_Expression*. This value is returned as a longword integer.

**Note**

The system variable !ERR is set to the number of nonzero elements. This effect is for compatibility with previous versions of IDL and should *not* be used in new code. Use the COUNT argument to return this value instead.

# Keywords

## COMPLEMENT

Set this keyword to a named variable that receives the subscripts of the zero elements of *Array_Expression*. These are the subscripts that are not returned in *Result*. Together, *Result* and COMPLEMENT specify every subscript in *Array_Expression*. If there are no zero elements in *Array_Expression*, COMPLEMENT returns a scalar integer with the value -1.

## L64

By default, the result of WHERE is 32-bit integer when possible, and 64-bit integer if the number of elements being processed requires it. Set L64 to force 64-bit integers to be returned in all cases.

**Note**

Only 64-bit versions of IDL are capable of creating variables requiring a 64-bit result. Check the value of !VERSION.MEMORY_BITS to see if your IDL is 64-bit or not.

## NCOMPLEMENT

Set this keyword to a named variable that receives the number of zero elements found in *Array_Expression*. This value is the number of subscripts that will be returned via the COMPLEMENT keyword if it is specified.

## Thread Pool Keywords

This routine is written to make use of IDL's *thread pool*, which can increase execution speed on systems with multiple CPUs. The values stored in the !CPU system variable control whether IDL uses the thread pool for a given computation. In addition, you can use the thread pool keywords TPOOL_MAX_ELTS, TPOOL_MIN_ELTS, and TPOOL_NOTHREAD to override the defaults established by !CPU for a single invocation of this routine. See Appendix C, "Thread Pool Keywords" for details.

# Examples

## Example 1

```
; Create a 10-element integer array where each element is
; set to the value of its subscript:
array = INDGEN(10)
PRINT, 'array = ', array

; Find the subscripts of all the elements in the array that have
; a value greater than 5:
B = WHERE(array GT 5, count, COMPLEMENT=B_C, NCOMPLEMENT=count_c)

; Print how many and which elements met the search criteria:
PRINT, 'Number of elements > 5: ', count
PRINT, 'Subscripts of elements > 5: ', B
PRINT, 'Number of elements <= 5: ', count_c
PRINT, 'Subscripts of elements <= 5: ', B_C
```

IDL prints:

```
array =  0  1  2  3  4  5  6  7  8  9
Number of elements > 5:  4
Subscripts of elements > 5:  6  7  8  9
Number of elements <= 5:  6
Subscripts of elements <= 5:  0  1  2  3  4  5
```

## Example 2

The WHERE function behaves differently with different kinds of array expressions. For instance, if a relational operator is used to compare an array, A, with a scalar, B, then every element of A is searched for B. However, if a relational operator is used to compare two arrays, C and D, then a comparison is made between each corresponding element (i.e. $C_i$ & $D_i$, $C_i$+1 & $D_i$+1, etc) of the two arrays. If the two arrays have different lengths then a comparison is only made up to the number of elements for the shorter array. The following example illustrates this behavior:

```
; Compare array, a, and scalar, b:
a = [1,2,3,4,5,5,4,3,2,1]
b = 5
PRINT, 'a = ', a
PRINT, 'b = ', b

result=WHERE(a EQ b)
PRINT,'Subscripts of a that equal b: ', result

; Now compare two arrays of different lengths:
c = [1,2,3,4,5,5,4,3,2,1]
```

```
d = [0,2,4]
PRINT, 'c = ', c
PRINT, 'd = ', d

result=WHERE(c EQ d)
PRINT, 'Subscripts of c that equal d: ', result
```

IDL prints:

```
a =  1  2  3  4  5  5  4  3  2  1
b =  5
Subscripts of a that equal b:  4  5

c =  1  2  3  4  5  5  4  3  2  1
d =  0  2  4
Subscripts of c that equal d: 1
```

Note that WHERE found only one element in the array d that equals an element in array c. This is because only the first three elements of c were searched, since d has only three elements.

## Version History

Introduced: Original

## See Also

ARRAY_INDICES, UNIQ

# WHILE...DO

The WHILE...DO statement performs its subject statement(s) as long as the expression evaluates to true. The subject is never executed if the condition is initially false.

**Note**

For information on using WHILE...DO and other IDL program control statements, see Chapter 12, “Program Control” in the *Building IDL Applications* manual.

## Syntax

WHILE *expression* DO *statement*

or

WHILE *expression* DO BEGIN

*statements*

ENDWHILE

## Examples

```
i = 0
WHILE (i EQ 1) DO PRINT, i
```

Because the expression (which is false in this case) is evaluated before the subject statement is executed, this code yields no output.

## Version History

Introduced: Original

# WIDGET_ACTIVEX

The WIDGET_ACTIVEX function is used to incorporate an ActiveX control into an IDL widget hierarchy. IDL provides the same object method and property manipulation facilities for ActiveX controls as it does for COM objects incorporated using the IDLcomIDispatch object interface, but adds the ability to process events generated by the ActiveX control using IDL's widget event handling mechanisms.

**Note**

IDL can only incorporate ActiveX controls on Windows NT/2000/XP (and later) platforms.

When you use the WIDGET_ACTIVEX routine, IDL automatically creates an IDLcomActiveX object that encapsulates the ActiveX control. You can then call the ActiveX control's methods using IDL object syntax, as discussed in Chapter 5, "Using ActiveX Controls in IDL" in the *External Development Guide* manual. You should be familiar with the material in that chapter before attempting to incorporate ActiveX controls in your IDL programs.

**Note**

If the COM object you want to use in your IDL application is *not* an ActiveX control, use the IDLcomIDispatch object class.

## Syntax

*Result* = WIDGET_ACTIVEX( *Parent*, *COM_ID*, [, /ALIGN_BOTTOM | , /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT | , /ALIGN_TOP] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FUNC_GET_VALUE=*string*] [ID_TYPE=*value*] [, KILL_NOTIFY=*string*] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value is the widget ID of the ActiveX widget. Note that the *widget value* of the ActiveX widget is an object reference to the IDLcomActiveX object that encapsulates the specified ActiveX control.

# Arguments

## Parent

The widget ID of the parent widget of the new ActiveX control.

## COM_ID

A string value specifying the class or program ID of the COM object to create. Note that if you specify a COM program ID via this argument, you must also set the ID_TYPE keyword.

**Note**

The class or program ID must follow the standard Microsoft naming convention. See Chapter 5, "Using ActiveX Controls in IDL" in the *External Development Guide* manual for more on class and program IDs, and their use with WIDGET_ACTIVEX.

# Keywords

## ALIGN_BOTTOM

Set this keyword to align the new widget with the bottom of its parent base. To take effect, the parent must be a ROW base.

## ALIGN_CENTER

Set this keyword to align the new widget with the center of its parent base. To take effect, the parent must be a ROW or COLUMN base. In ROW bases, the new widget will be vertically centered. In COLUMN bases, the new widget will be horizontally centered.

## ALIGN_LEFT

Set this keyword to align the new widget with the left side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_RIGHT

Set this keyword to align the new widget with the right side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_TOP

Set this keyword to align the new widget with the top of its parent base. To take effect, the parent must be a ROW base.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## ID_TYPE

The type of COM object ID specified by the *COM_ID* parameter (class or program). If set to 0 (zero), the value is a class ID (the default). If set to 1 (one), the value is a program ID.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such callback procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_BASE or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such callback procedure. It can be removed by setting the routine to the null string ( ' '). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

The user value for a widget can be accessed and modified at any time by using the GET_UVALUE and SET_UVALUE keywords to the WIDGET_CONTROL procedure.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

## Keywords to WIDGET_CONTROL

The GET_VALUE keyword to the WIDGET_CONTROL procedure is used to retrieve an object reference to the IDLcomActiveX object that underlies the ActiveX widget. The object reference returned in this manner can be used to call the ActiveX control's native methods.

## Examples

For examples using WIDGET_ACTIVEX, see Chapter 5, “Using ActiveX Controls in IDL” in the *External Development Guide* manual.

## Version History

Introduced: 5.5

# WIDGET_BASE

The WIDGET_BASE function is used to create base widgets. Base widgets serve as containers for other widgets.

**Note**

In most cases, you will want let IDL determine the placement of widgets within the base widget. Do this by specifying either the COLUMN keyword or the ROW keyword. See "Positioning Child Widgets Within a Base" in the following section for details.

## Exclusive And Non-Exclusive Bases

If the EXCLUSIVE or NONEXCLUSIVE keywords are specified, the base only allows button widget children.

## Positioning Child Widgets Within a Base

The standard base widget does not impose any placement constraints on its child widgets. Children of a "bulletin board" base (a base that was created without setting the COLUMN or ROW keywords) have an offset of (0,0) unless an offset is explicitly specified via the XOFFSET or YOFFSET keywords. This means that if you do not specify any of COLUMN, ROW, XOFFSET, or YOFFSET keywords, child widgets will be placed one on top of the other in the upper left corner of the base.

However, laying out widgets using the XSIZE, YSIZE, XOFFSET, and YOFFSET keywords can be both tedious and error-prone. Also, if you want your widget application to display properly on different platforms, you should use the COLUMN and ROW keywords to influence child widget layouts instead of explicitly formatting your interfaces.

When the ROW or COLUMN keywords are specified, the base decides how to lay out its children, and any XOFFSET and YOFFSET keywords specified for such children are ignored.

## Positioning Top-Level Bases

When locating a new top level window, some window managers ignore the program's positioning requests and either choose a position or allow the user to choose. In such cases, the XOFFSET and YOFFSET keywords to WIDGET_BASE will not have an effect. The window manager may provide a way to disable this positioning style. The Motif window manager (mwm) can be told to honor positioning requests by placing the following lines in your `.Xdefaults` file:

```
Mwm*clientAutoPlace: False
Mwm*interactivePlacement: False
```

## Iconizing, Layering, and Destroying Groups of Top-Level Bases

Group membership (defined via the GROUP_LEADER keyword) controls the way top-level base widgets are iconized, layered, and destroyed.

**Note**

A group can contain sub-groups. Group behavior affects all members of a group and its sub-groups. For example, suppose we create three top-level base widgets with the following group hierarchy:

```
base1 = WIDGET_BASE()
base2 = WIDGET_BASE(GROUP_LEADER=base1)
base3 = WIDGET_BASE(GROUP_LEADER=base2)
```

Effectively, two groups are created. One group has `base2` as its leader and `base3` as its member. The other group has `base1` as its leader and both `base2` and `base3` as members. If `base1` is iconized, both `base2` and `base3` are iconized as well. If `base2` is iconized, `base3` is iconized but `base1` is not.

Widgets behave slightly differently when displayed on different platforms, and depending on whether they are floating or modal bases. The following rules apply to groups of widgets within a group leader/member hierarchy. Widgets that do not belong to the same group hierarchy cannot influence each other.

### Iconization and Mapping

Bases and groups of bases can be *iconized* (or *minimized*) by clicking the system minimize control. Bases and groups of bases can also be *mapped* (made visible) and *unmapped* (made invisible).

**Motif —** Mapping or unmapping a group leader has no effect on the mapped state of the group members. Iconifying or mapping a group member has no effect on the group leader. Modal bases cannot be unmapped.

Bases and groups of bases can be iconized (or minimized) by clicking the system minimize control. When a group leader is iconized, all members of the group are iconized as well. Similarly, when a group leader is restored, all members of the group are restored.

**Windows —** Mapping or unmapping a group leader has no effect on the mapped state of the group members. Iconifying or mapping a group member has no effect on the group leader. Modal bases cannot be unmapped.

Bases and groups of bases can be iconized (or minimized) by clicking the system minimize control. When a group leader is iconized, all members of the group are iconized as well. Similarly, when a group leader is restored, all members of the group are restored.

### Layering

*Layering* is the process by which groups of widgets seem to share the same plane on the display screen. Within a layer on the screen, widgets have a *Z-order*, or front-to-back order, that defines which widgets appear to be on top of other widgets.

**Motif —** All elements on the screen—widgets, the IDLDE, other Motif applications—share a single layer and have an arbitrary Z-order. There is no special layering of IDL widgets.

**Windows —** All non-floating and non-modal widgets within a group hierarchy share the same layer—that is, when one group member has the input focus, all members of the group hierarchy are displayed in a layer that appears in front of all other groups or applications. Within the layer, the widgets can have an arbitrary Z-order.

Widgets that are floating or modal always float above their group leaders.

### Destruction

When a group leader widget is destroyed, either programmatically or by clicking on the system “close” button, all members of the group and all sub-groups are destroyed as well.

If a modal base is on the display, it must be dismissed before any widget can be destroyed.

## Syntax

*Result* = WIDGET_BASE( [*Parent*] [, /ALIGN_BOTTOM | , /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT | , /ALIGN_TOP] [, /MBAR | , /MODAL] [, /BASE_ALIGN_BOTTOM | , /BASE_ALIGN_CENTER | , /BASE_ALIGN_LEFT | , /BASE_ALIGN_RIGHT | , /BASE_ALIGN_TOP] [, /COLUMN | , /ROW] [, /CONTEXT_EVENTS] [, /CONTEXT_MENU] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, /EXCLUSIVE | , /NONEXCLUSIVE] [, /FLOATING] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, /GRID_LAYOUT] [, GROUP_LEADER=*widget_id*{must specify for modal dialogs}] [, /KBRD_FOCUS_EVENTS] [, KILL_NOTIFY=*string*] [, /MAP{not for modal bases}] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SCROLL{not for modal bases}]

[, /SENSITIVE] [, SPACE=*value*{ignored if exclusive or nonexclusive}]
[, TITLE=*string*] [, TLB_FRAME_ATTR=*value*{top-level bases only}]
[, /TLB_ICONIFY_EVENTS{top-level bases only}]
[, /TLB_KILL_REQUEST_EVENTS{top-level bases only}]
[, /TLB_MOVE_EVENTS{top-level bases only}] [, /TLB_SIZE_EVENTS{top-level bases only}] [, /TOOLBAR] [, /TRACKING_EVENTS] [, UNAME=*string*]
[, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, XOFFSET=*value*]
[, XPAD=*value*{ignored if exclusive or nonexclusive}] [, XSIZE=*value*]
[, X_SCROLL_SIZE=*value*] [, YOFFSET=*value*] [, YPAD=*value*{ignored if exclusive or nonexclusive}] [, YSIZE=*value*] [, Y_SCROLL_SIZE=*value*] )

**X Windows Keywords:** [, DISPLAY_NAME=*string*]
[, RESOURCE_NAME=*string*] [, RNAME_MBAR=*string*]

# Return Value

The returned value of this function is the widget ID of the newly-created base.

# Arguments

## Parent

The widget ID of the parent widget. To create a *top-level* base, omit the *Parent* argument.

# Keywords

## ALIGN_BOTTOM

Set this keyword to align the new widget with the bottom of its parent base. To take effect, the parent must be a ROW base.

## ALIGN_CENTER

Set this keyword to align the new widget with the center of its parent base. To take effect, the parent must be a ROW or COLUMN base. In ROW bases, the new widget will be vertically centered. In COLUMN bases, the new widget will be horizontally centered.

## ALIGN_LEFT

Set this keyword to align the new widget with the left side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_RIGHT

Set this keyword to align the new widget with the right side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_TOP

Set this keyword to align the new widget with the top of its parent base. To take effect, the parent must be a ROW base.

**Warning**

You cannot specify both an APP_MBAR and an MBAR for the same top-level base widget. Doing so will cause an error.

To apply actions triggered by menu items to widgets other than the base that includes the menubar, use the KBRD_FOCUS_EVENTS keyword to keep track of which widget has (or last had) the keyboard focus.

## BASE_ALIGN_BOTTOM

Set this keyword to make all children of the new base align themselves with the bottom of the base by default. To take effect, you must also set the ROW keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

## BASE_ALIGN_CENTER

Set this keyword to make all children of the new base align themselves with the center of the base by default. To take effect, you must also set the COLUMN or ROW keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created. In ROW bases, child widgets will be vertically centered. In COLUMN bases, child widgets will be horizontally centered.

## BASE_ALIGN_LEFT

Set this keyword to make all children of the new base align themselves with the left side of the base by default. To take effect, you must also set the COLUMN keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

## BASE_ALIGN_RIGHT

Set this keyword to make all children of the new base align themselves with the right side of the base by default. To take effect, you must also set the COLUMN keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

## BASE_ALIGN_TOP

Set this keyword to make all children of the new base align themselves with the top of the base by default. To take effect, you must also set the ROW keyword for the new base. The default can be overridden for individual child widgets by setting a different ALIGN_XXX keyword when the child widget is created.

## COLUMN

If this keyword is included, the base lays out its children in columns. The value of this keyword specifies the number of columns to be used. The number of child widgets in each column is calculated by dividing the number of child widgets created by the number of columns specified. When one column is filled, a new one is started.

Specifying both the COLUMN and ROW keywords causes an error.

### Column Width

The width of each column is determined by the width of the widest widget in that column. If the GRID_LAYOUT keyword is set, all columns are as wide as the widest widget in the base.

### Horizontal Size of Widgets

If any of the BASE_ALIGN_* keywords to WIDGET_BASE is set, each widget has its “natural” width, determined either by the value of the widget or by the XSIZE keyword. Similarly, if any of the child widgets specifies one of the ALIGN_* keywords, that widget will have its “natural” width. If none of the BASE_ALIGN_* or (ALIGN_*) keywords are set, all widgets in the base are as wide as their column.

### Vertical Placement

Child widgets are placed vertically one below the other, with no extra space. If the GRID_LAYOUT keyword is set, each row is as high as its tallest member.

## CONTEXT_EVENTS

Set this keyword to cause context menu events (or simply context events) to be issued when the user clicks the right mouse button over the widget. Set the keyword to 0

(zero) to disable such events. Context events are intended for use with context-sensitive menus (also known as pop-up or shortcut menus); pass the context event ID to the WIDGET_DISPLAYCONTEXTMENU procedure within your widget program's event handler to display the context menu.

For more on detecting and handling context menu events, see"Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

## CONTEXT_MENU

Set this keyword to create a base widget that can be used as the base for a context-sensitive menu (also known as a pop-up or shortcut menu). A context menu base must have as its parent one of the following types of widgets: WIDGET_BASE, WIDGET_DRAW, WIDGET_TEXT, WIDGET_LIST.

For more on creating context menus, see "Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

## DISPLAY_NAME

Set this keyword equal to a string that specifies the name of the X Windows display on which the base should be displayed. This keyword has no effect on Microsoft Windows platforms.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

**Note**

If you are using XMANAGER to manage events for your widget application, you should not specify an event processing routine for the top-level base of the application using this keyword. Instead, specify the event processing routine using the EVENT_HANDLER keyword to XMANAGER.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

**Note**

If you are using XMANAGER to manage events for your widget application, you should not specify an event processing routine for the top-level base of the application using this keyword. Instead, specify the event processing routine using the EVENT_HANDLER keyword to XMANAGER.

## EXCLUSIVE

Set this keyword to specify that the base can have only button-widget children and that only one button can be set at a time. These buttons, unlike normal button widgets, have two states—set and unset.

When one exclusive button is pressed, any other exclusive buttons (in the same base) that are currently set are automatically released. Hence, only one button can ever be set at one time.

This keyword can be used to create exclusive button menus. See the CW_BGROUP and CW_PDMENU functions for high-level menu-creation utilities.

**Note**

If this keyword is set, the XOFFSET and YOFFSET keywords are ignored for any widgets in this base. Exclusive bases are always laid out in columns or rows. If neither the COLUMN nor ROW keyword is specified for an exclusive base, the base defaults to COLUMN layout.

## FLOATING

Set this keyword—along with the GROUP_LEADER keyword—to create a "floating" top-level base widget. If the windowing system provides Z-order control, floating base widgets appear above the base specified as their group leader. If the windowing system does not provide Z-order control, the FLOATING keyword has no effect.

The iconizing, layering, and destruction behavior of floating bases and their group leaders is discussed in "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 2128.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a hint to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GRID_LAYOUT

Set this keyword to force the base to have a grid layout, in which all rows have the same height, and all columns have the same width. The row heights and column widths are taken from the largest child widget.

## GROUP_LEADER

The widget ID of an existing widget that serves as "group leader" for the newly-created widget. Widget application hierarchies are defined by group membership relationships between top-level widget bases. When a group leader is killed, for any reason, all widgets in the group are also destroyed. Iconizing and layering behavior is discussed in "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 2128.

**Note**

If you specify a floating base (created with the FLOATING keyword) as a group leader, all member bases must also have either the FLOATING or MODAL keywords set. If you specify a modal base (created with the MODAL keyword) as a group leader, all member bases must have the MODAL keyword set as well.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KBRD_FOCUS_EVENTS

Set this keyword to make the base return keyboard focus events whenever the keyboard focus of the base changes. See the "Events Returned by Base Widgets" section below for more information.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

**Note**

A procedure specified via the CLEANUP keyword to XMANAGER will override a procedure specified for your application's top-level base with WIDGET_BASE, KILL_NOTIFY.

## MAP

Once a widget hierarchy has been realized, it can be mapped (visible) or unmapped (invisible). This keyword specifies the initial map state for the given base and its descendants. Specifying a non-zero value indicates that the base should be mapped when realized (the default). A zero value indicates that the base should be unmapped initially.

After the base is realized, its map state can be altered using the MAP keyword to the WIDGET_CONTROL procedure.

**Note**

Modal bases cannot be mapped and unmapped.

**Warning**

Under Microsoft Windows, when a hidden base is realized, then mapped, a Windows resize message is sent by the windowing system. This "extra" resize event is generated before any manipulation of the base widget by the user.

## MBAR

Set this keyword to a named variable to cause a menubar to be placed at the top of the base (the base must be a top-level base). The menubar is itself a special kind of base widget that can only have buttons as children. Upon return, the named variable contains the widget ID of the new menubar base. This widget ID can then be used to fill the menubar with pulldown menus. For example, the following widget creation commands first create a base with a menubar, then populate the menubar with a simple pulldown menu (CW_PDMENU could also have been used to construct the pulldown menu):

```
base = WIDGET_BASE(TITLE = 'Example', MBAR=bar)
file_menu = WIDGET_BUTTON(bar, VALUE='File', /MENU)
```

```
file_bttn1=WIDGET_BUTTON(file_menu, VALUE='Item 1',$
   UVALUE='FILE1')
file_bttn2=WIDGET_BUTTON(file_menu, VALUE='Item 2',$
   UVALUE='FILE2')
```

Note that to set X Window System resources for menubars created with this keyword, you must use the RNAME_MBAR keyword rather than the RESOURCE_NAME keyword.

If you use CW_PDMENU to create a menu for the menubar, be sure to set the MBAR keyword to that function as well.

Note also that the size returned by the GEOMETRY keyword to WIDGET_INFO does not include the size of the menubar.

**Warning**

You cannot specify both the MBAR and MODAL keywords for the same widget. Doing so will cause an error.

To apply actions triggered by menu items to widgets other than the base that includes the menubar, use the KBRD_FOCUS_EVENTS keyword to keep track of which widget has (or last had) the keyboard focus.

## MODAL

Set this keyword to create a modal dialog. Modal dialogs can have default and cancel buttons associated with them. Default buttons are highlighted by the window system and respond to a press on the “Return” or “Enter” keys as if they had been clicked on. Cancel buttons respond to a press on the “Escape” key as if they had been clicked on. See the DEFAULT_BUTTON and CANCEL_BUTTON keywords to WIDGET_CONTROL for details.

**Note**

Modal dialogs must have a group leader. Specify the group leader for a modal top-level base via the GROUP_LEADER keyword.

Modal dialogs cannot be scrollable, nor can they support menubars. Setting the SCROLL, MBAR, or APP_MBAR keywords in conjunction with the MODAL keyword will cause an error. Modal dialogs cannot be mapped or unmapped. Setting the MAP keyword on a modal base will cause an error.

**Note**

On Windows platforms, the group leader of a modal base must be realized before the modal base itself can be realized. If the group leader has not been realized, it will be realized automatically.

The iconizing, layering, and destruction behavior of modal bases and their group leaders is discussed in "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 2128.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a "set" operation (using the UVALUE keyword to WIDGET_BASE or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a "get" operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NONEXCLUSIVE

Set this keyword to specify that the base can only have button widget children. These buttons, unlike normal button widgets, have two states—set and unset. Non-exclusive bases allow any number of the toggle buttons to be set at one time.

**Note**

If this keyword is set, the XOFFSET and YOFFSET keywords are ignored for any widgets in this base. Non-exclusive bases are always laid out in columns or rows. If neither the COLUMN nor ROW keyword is specified for a non-exclusive base, the base defaults to COLUMN layout.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. Once defined, this name can be used in the user's `.Xdefaults` file to customize widget resources not directly supported via the IDL widget routines. This keyword is accepted by all widget creation routines. This keyword only works with the "X" device and is ignored on Microsoft Windows platforms.

RESOURCE_NAME allows unrestricted access to the underlying Motif widgets within the following limitations:

- Users must have the appropriate resources defined in their `.Xdefaults` or application default resource file, or IDL will not see the definitions and they will not take effect.
- Motif resources are documented in the *OSF/Motif Programmer's Reference Manual*. To use them with RESOURCE_NAME, the IDL programmer must determine the type of widget being used by IDL, and then look up the resources that apply to them. Hence, RESOURCE_NAME requires some programmer-level familiarity with Motif.
- Only resources that are not set within IDL can be modified using this mechanism. Although it is not an error to set resources also set by IDL, the IDL settings will silently override user settings. RSI does not document the resources used by IDL since the actual resources used may differ from release to release as the IDL widgets evolve. Therefore, you should set only those resources that are obviously not being set by IDL. Among the resources that are not being set by IDL are those that control colors, menu mnemonics, and accelerator keys.

### Example

The sample code below produces a pulldown menu named “Menu” with 2 entries named “Item 1” and “Item 2”.

Using the RESOURCE_NAME keyword in conjunction with X resource definitions, we can alter “Item 1” in several ways not possible through the standard IDL widgets interface. We’ll give Item 1 a red background color. We’ll also assign “I” as the keyboard mnemonic. Note that Motif automatically underlines the “I” in the title to indicate this. We’ll also select Meta-F4 as the keyboard accelerator for selecting “Item 1”. If Meta-F4 is pressed while the pointer is anywhere over this application, the effect will be as if the menu was pulled down and “Item 1” was selected with the mouse.

```
; Simple event handler:
PRO test_event, ev
   HELP, /STRUCTURE, ev
END

; Simple widget creation routine:
PRO test

   ; The base gets the resource name "test":
   a = WIDGET_BASE(RESOURCE_NAME = 'test')
   b = WIDGET_BUTTON(a, VALUE='Menu', /MENU)

   ; Assign the Item 1 button the resource name "item1":
   c = WIDGET_BUTTON(b, VALUE='Item 1', $
      RESOURCE_NAME='item1')
   c = WIDGET_BUTTON(b, VALUE='Item 2')
   WIDGET_CONTROL, /REALIZE, a
   XMANAGER, 'test', a
END
```

Note that we gave the overall application the resource name “test”, and the “Item 1” button the resource name “item1”. Now we can use these names in the following `.Xdefaults` file entries:

```
Idl*test*item1*mnemonic: I
Idl*test*item1*accelerator: Meta<Key>F4
Idl*test*item1*acceleratorText: Meta-F4
Idl*test*item1*background: red
```

### Note on Specifying Color Resources

If you wish to specify unique colors for your widgets, it is generally a good idea to use a color name (“red” or “lightblue”, for example) rather than specifying an exact color match with a color string (such as “#b1b122222020”). If IDL is not able to

allocate an exact color, the entire operation may fail. Specifying a named color implies “closest color match,” an operation that rarely fails.

If you need an exact color match and IDL fails to allocate the color, try modifying the `Idl.colors` resource in the `$IDL_DIR/resource/X11/lib/app-defaults/Idl` file.

## RNAME_MBAR

A string containing an X Window System resource name to be applied to the menubar created by the MBAR keyword. This keyword is identical to the RESOURCE_NAME keyword except that the resource it specifies applies only to the menubar.

## ROW

If this keyword is included, the base lays out its children in rows. The value of this keyword specifies the number of rows to be used. The number of child widgets in each row is calculated by dividing the number of child widgets created by the number of rows specified. When one row is filled, a new one is started.

Specifying both the COLUMN and ROW keywords causes an error.

### Row Height

The height of each row is determined by the height of the tallest widget in that row. If the GRID_LAYOUT keyword is set, all rows are as tall as the tallest widget in the base.

### Vertical Size of Widgets

If any of the BASE_ALIGN_* keywords to WIDGET_BASE is set, each widget has its “natural” height, determined either by the value of the widget or by the YSIZE keyword. Similarly, if any of the child widgets specifies one of the ALIGN_* keywords, that widget will have its “natural” height. If none of the BASE_ALIGN_* or (ALIGN_*) keywords are set, all widgets in the base are as tall as their row.

### Horizontal Placement

Child widgets are placed horizontally one next to the other, with no extra space. If the GRID_LAYOUT keyword is set, each column is as wide as its widest member.

## SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SCROLL

Set this keyword to give the widget scroll bars that allow viewing portions of the widget contents that are not currently on the screen.

**Warning**

You cannot specify both the SCROLL and MODAL keywords for the same widget. Doing so will cause an error.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## SPACE

The space, in units specified by the UNITS keyword (pixels are the default), between children of a row or column major base. This keyword is ignored if either the EXCLUSIVE or NONEXCLUSIVE keyword is present.

## TITLE

A string containing the title to be used for the widget. Base widgets use the title only if they are top-level widgets or if they are children of a tab widget. For top-level base widgets, the title appears in the “window dressing” at the top of the base widget; the appearance is platform-specific. For base widgets that have a tab widget as their parent widget, the title is used as the text of the tab.

Note that if the widget base is not wide enough to contain the specified title, the title may appear truncated. If you must be able to see the full title, you have several alternatives:

- Rearrange the widgets in the base so that the base becomes naturally wide enough. This is the best solution.
- Don’t worry about this issue. If the user needs to see the entire label, they can resize the window using the mouse.
- Create the base without using the COLUMN or ROW keywords. Instead, use the XSIZE keyword to explicitly set a usable width. This is an undesirable solution that can lead to strange-looking widget layouts.

For bases that are children of tab widgets, the title may be truncated depending on the width of the largest base that is a child of the tab widget. See the description of the MULTILINE keyword to WIDGET_TAB for additional details.

## TLB_FRAME_ATTR

Set this keyword to one of the values shown in the table below to suppress certain aspects of a top-level base’s window frame. This keyword applies only to top-level bases. The settings are merely hints to the window system and may be ignored by some window managers. Valid settings are:

| Value | Meaning |
|---|---|
| 1 | Base cannot be resized, minimized, or maximized. |
| 2 | Suppress display of system menu. |
| 4 | Suppress title bar. |
| 8 | Base cannot be closed. |
| 16 | Base cannot be moved. |

*Table 95: Valid Values for TLB_FRAME_ATTR Keyword*

This keyword is set bitwise, so multiple effects can be set by adding values together. For example, to make a base that has no title bar (value `4`) and cannot be moved (value `16`), set the TLB_FRAME_ATTR keyword to `20` (that is, `4+16`).

## TLB_ICONIFY_EVENTS

Set this keyword when creating a top-level base to make that base return an event when the base is iconified or restored by the user. See the "Events Returned by Base Widgets" section below for more information.

## TLB_KILL_REQUEST_EVENTS

Set this keyword, usable only with top-level bases, to send the top-level base a WIDGET_KILL_REQUEST event if a user tries to destroy the widget using the window manager (by default, widgets are simply destroyed). See the "Events Returned by Base Widgets" section below for more information.

Use this keyword to perform complex actions before allowing a widget application to exit. Note that widgets that have this keyword set are responsible for killing themselves after receiving a WIDGET_KILL_REQUEST event—they cannot be destroyed using the usual window system controls.

Use a call to TAG_NAMES with the STRUCTURE_NAME keyword set to differentiate a WIDGET_KILL_REQUEST event from other types of widget events. For example:

```
IF TAG_NAMES(event, /STRUCTURE_NAME) EQ $
   'WIDGET_KILL_REQUEST' THEN ...
```

## TLB_MOVE_EVENTS

Set this keyword when creating a top-level base to make that base return an event when the base is moved on the screen by the user. See the "Events Returned by Base Widgets" section below for more information.

## TLB_SIZE_EVENTS

Set this keyword, when creating a top-level base, to make that base return an event when the base is resized by the user. See the "Events Returned by Base Widgets" section below for more information.

## TOOLBAR

Set this keyword to indicate that the base is used to hold bitmap buttons that make up a toolbar.

**Note**

Setting this keyword does not cause any changes in behavior; its only affect is to slightly alter the appearance of the bitmap buttons on the base for cosmetic reasons.

**Note**

On Motif platforms, if bitmap buttons are on a toolbar base that is also EXCLUSIVE or NONEXCLUSIVE, they will not have a separate “toggle” indicator, they will be grouped closely together, and will have a two-pixel shadow border.

**Note**

This keyword has no effect on Windows platforms.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer *enters* or *leaves* the region covered by that widget. Widget tracking events are returned as structures with the following definition:

```
{ WIDGET_TRACKING, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

ID, TOP, and HANDLER are the standard fields found in every widget event. ENTER is 1 if the tracking event is an entry event, and 0 if it is an exit event.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

The user value for a widget can be accessed and modified at any time by using the GET_UVALUE and SET_UVALUE keywords to the WIDGET_CONTROL procedure.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## XPAD

The horizontal space, in units specified by the UNITS keyword (pixels are the default), between child widgets and the edges of a row or column major base. The default value of XPAD is platform dependent. This keyword is ignored if either the EXCLUSIVE or NONEXCLUSIVE keyword is present.

## XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

## X_SCROLL_SIZE

The XSIZE keyword always specifies the width of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the width of the visible area. The X_SCROLL_SIZE keyword allows you to set the width of the scrolling viewport independently of the actual width of the widget.

Use of the X_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when X_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify Y_SCROLL_SIZE when specifying X_SCROLL_SIZE.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## YPAD

The vertical space, in units specified by the UNITS keyword (pixels are the default), between child widgets and the edges of a row or column major base. The default value of YPAD is platform-dependent. This keyword is ignored if either the EXCLUSIVE or NONEXCLUSIVE keyword is present.

## YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

## Y_SCROLL_SIZE

The YSIZE keyword always specifies the height of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the height of the visible area. The Y_SCROLL_SIZE keyword allows you to set the height of the scrolling viewport independently of the actual height of the widget.

Use of the Y_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when Y_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify X_SCROLL_SIZE when specifying Y_SCROLL_SIZE.

## Obsolete Keywords

The following keywords are obsolete:

- APP_MBAR

For information on obsolete keywords, See Appendix I, "Obsolete Features".

# Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of base widgets. In addition to those keywords that affect all widgets, the following are particularly useful: CANCEL_BUTTON, CONTEXT_EVENTS, DEFAULT_BUTTON, KBRD_FOCUS_EVENTS, TLB_ICONIFY_EVENTS, TLB_MOVE_EVENTS, TLB_SIZE_EVENTS.

# Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to base widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: CONTEXT_EVENTS, KBRD_FOCUS_EVENTS, MODAL, TLB_ICONIFY_EVENTS, TLB_KILL_REQUEST_EVENTS, TLB_MOVE_EVENTS, TLB_SIZE_EVENTS.

# Events Returned by Base Widgets

## Resize Events

Top-level widget bases return the following event structure only when they are resized by the user and the base was created with the TLB_SIZE_EVENTS keyword set:

```
{ WIDGET_BASE, ID:0L, TOP:0L, HANDLER:0L, X:0L, Y:0L }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. The X and Y fields return the new width of the base, not including any frame provided by the window manager.

## Move Events

Top-level widget bases return the following event structure when the base is moved and the base was created with the TLB_MOVE_EVENTS keyword set:

```
{ WIDGET_TLB_MOVE, ID:0L, TOP:0L, HANDLER:0L, X:0L, Y:0L }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. X and Y are the new location of the top left corner of the base.

**Note**

On Windows, move events are generated while dragging. On UNIX, move events are generated only on the mouse-up.

**Note**

If both TLB_SIZE_EVENTS and TLB_MOVE_EVENTS are enabled, a user resize operation that causes the top left corner of the base to move will generate both a move event and a resize event.

## Iconify Events

Top-level widget bases return the following event structure when the base is iconified or restored and the base was created with the TLB_ICONIFY_EVENTS keyword set:

```
{ WIDGET_TLB_ICONIFY, ID:0L, TOP:0L, HANDLER:0L, ICONIFIED:0 }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. ICONIFIED is 1 (one) if the user iconified the base and 0 (zero) if the user restored the base.

## Keyboard Focus Events

Widget bases return the following event structure when the keyboard focus changes and the base was created with the KBRD_FOCUS_EVENTS keyword set:

```
{ WIDGET_KBRD_FOCUS, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. The ENTER field returns 1 (one) if the base is gaining the keyboard focus, or 0 (zero) if the base is losing the keyboard focus.

## Kill Request Events

Top-level widget bases return the following event structure only when a user tries to destroy the widget using the window manager and the base was created with the TLB_KILL_REQUEST_EVENTS keyword set:

```
{ WIDGET_KILL_REQUEST, ID:0L, TOP:0L, HANDLER:0L }
```

ID is the widget ID of the base generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine.

### Context Menu Events

Base widgets return the following event structure when the user clicks the right mouse button and the base widget was created with the CONTEXT_EVENTS keyword set:

```
{WIDGET_CONTEXT, ID:0L, TOP:0L, HANDLER:0L, X:0L, Y:0L}
```

The first three fields are the standard fields found in every widget event. The X and Y fields give the device coordinates at which the event occurred, measured from the upper left corner of the base widget.

## Version History

Introduced: Pre 4.0

TLB_ICONIFY_EVENTS, TLB_MOVE_EVENTS, TOOLBAR keywords; new event structures for inconify and move events: 5.6

## See Also

Chapter 25, “Widgets” in the *Building IDL Applications* manual.

# WIDGET_BUTTON

The WIDGET_BUTTON function creates button widgets.

## Exclusive And Non-Exclusive Bases

Buttons placed into exclusive or non-exclusive bases (created via the EXCLUSIVE or NONEXCLUSIVE keywords to WIDGET_BASE function) are created as two-state “toggle” buttons, which are controlled by such bases.

## Bitmap Button Labels

Widget buttons can have either a text label (specified as a string value to the VALUE keyword) or a graphic symbol in the form of a bitmap. Bitmap labels are specified in one of the following ways:

1. By setting the VALUE keyword equal to a string containing the name of an image file in BMP format, and setting the BITMAP keyword:

   ```
   button=WIDGET_BUTTON(base, VALUE='mybitmap.bmp', /BITMAP)
   ```

   For 16- and 256-color bitmap files, IDL uses the color of the pixel in the lower left corner as the transparent color. All pixels of this color become transparent, allowing the button color to show through.

   To modify the bitmap after creation, use the /BITMAP keyword with WIDGET_CONTROL:

   ```
   WIDGET_CONTROL, button, SET_VALUE='mybitmap2.bmp', /BITMAP
   ```

2. By setting the VALUE keyword equal to an *n* x *m* bitmap byte array in which each bit represents a pixel with a value of either zero or one. (Arrays of this type can be produced using the CVTTOBM function.) This method creates a black-and-white bitmap label:

   ```
   button=WIDGET_BUTTON(base, VALUE=bw_arr)
   ```

   To modify the bitmap after creation, simply set a new value using WIDGET_CONTROL:

   ```
   WIDGET_CONTROL, button, SET_VALUE=bw_array2
   ```

3. By setting the VALUE keyword equal to an *n* x *m* x 3 byte array that represents a 24-bit color image, interleaved by plane, with the planes in the order red, green, blue. This method creates a color bitmap label:

   ```
   button=WIDGET_BUTTON(base, VALUE=color_array)
   ```

To modify the bitmap after creation, simply set a new value using WIDGET_CONTROL:

```
WIDGET_CONTROL, button, SET_VALUE=color_array2
```

See "Using Button Widgets" in Chapter 27 of the *Building IDL Applications* manual for additional details on creating image files and arrays for use as button bitmaps.

# Syntax

*Result* = WIDGET_BUTTON( *Parent* [, /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT] [, /BITMAP] [, /CHECKED_MENU] [, /DYNAMIC_RESIZE] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, /HELP] [, KILL_NOTIFY=*string*] [, /MENU] [, /NO_COPY] [, /NO_RELEASE] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, /PUSHBUTTON_EVENTS] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, /SEPARATOR] [, TOOLTIP=*string*] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, X_BITMAP_EXTRA=*bits*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

**X Windows Keywords:** [, RESOURCE_NAME=*string*]

# Return Value

The returned value of this function is the widget ID of the newly-created button.

# Arguments

## Parent

The widget ID of the parent for the new button widget.

# Keywords

## ALIGN_CENTER

Set this keyword to center justify the button's text label.

## ALIGN_LEFT

Set this keyword to left justify the button's text label.

## ALIGN_RIGHT

Set this keyword to right justify the button's text label.

## BITMAP

Set this keyword to specify that the bitmap specified with the VALUE keyword is a color bitmap. The value of a widget button can be a bitmap as described in "Bitmap Button Labels" on page 2151. If you specify a color bitmap with the VALUE keyword, you must also set the /BITMAP keyword.

**Note**

The use of bitmap values for menu buttons may cause unexpected behavior and is not supported.

## CHECKED_MENU

Set this keyword on a menu entry button to enable the ability to place a check (Windows) or selection box (Motif) next to the menu entry. The parent widget of the button must be either a button widget created with the MENU keyword or a base widget created with the CONTEXT_MENU keyword.

On Windows systems, a menu item that has the checked menu feature enabled but which is unselected appears just like a "normal" menu item. On Motif systems, a menu item that has the checked menu feature enabled always displays a selection box, even if the box is not selected.

**Note**

Setting this keyword does not initially "select" the menu item; selection marks are displayed and removed via the SET_BUTTON keyword to WIDGET_CONTROL.

## DYNAMIC_RESIZE

Set this keyword to create a widget that resizes itself to fit its new value whenever its value is changed. Note that this keyword does not take effect when used with the SCR_XSIZE, SCR_YSIZE, XSIZE, or YSIZE keywords. If one of these keywords is also set, the widget will be sized as specified by the sizing keyword and will never resize itself dynamically.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## HELP

Set this keyword to tell the widget toolkit that this button is a “help” button for a menubar and should be given that appearance. For example, Motif specifies that the help menubar item is displayed on the far right of the menubar. This keyword is ignored in all other contexts and may be ignored by window managers that have no such special appearance defined.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (' ').

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## MENU

The presence of this keyword indicates that the button will be used to activate a pull-down menu. Such buttons can have button children that are then placed into a pull-down menu.

Under Motif, if the value specified for MENU is greater than 1, the button label is enclosed in a box to indicate that this button is a pull-down menu. See the CW_PDMENU function for a high-level pull-down menu creation utility.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would

otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_BUTTON or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NO_RELEASE

Set this keyword to make exclusive and non-exclusive buttons generate only *select* events. This keyword has no effect on regular buttons.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## PUSHBUTTON_EVENTS

Set this keyword to cause separate button events to be issued for the widget when the left mouse button is pressed and released, or when the spacebar is pressed and released.

**Note**

This keyword has no effect on exclusive or non-exclusive buttons.

When this keyword is *not* set and the button is selected, pressing and releasing either the left mouse button or the spacebar generates a single button event, with the SELECT field set equal to 1. When this keyword *is* set:

- Pressing the left mouse button generates a button event with the SELECT field set equal to 1.
- Releasing the left mouse button generates a button event with the SELECT field set equal to 0.

- Pressing the spacebar generates a button event with the SELECT field set equal to 1 immediately followed by a second button event with the SELECT field set equal to 0.
- Pressing and holding the spacebar generates a series of button events, with the value of the SELECT field alternating between 1 and 0. The rate at which events are generated is governed by the key-repeat settings of the operating system.

For the structure of button events, see "Events Returned by Button Widgets" on page 2161.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 2139 for a complete discussion of this keyword.

## SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## SEPARATOR

Set this keyword to tell the widget toolkit that this button is part of a pulldown menu pane and that a separator line should be added directly above this entry. This keyword is ignored in all other contexts.

## TOOLTIP

Set this keyword to a string that will be displayed when the cursor hovers over the widget. For UNIX platforms, this string must be non-zero in length.

**Note**

Tooltips cannot be created for menu sub-items. The topmost button on a menu can, however, have a tooltip.

**Note**

If your application uses hardware rendering and a RETAIN setting of either zero or one, tooltips will cause draw widgets to generate expose events if the tooltip obscures the drawable area. This is true even if the tooltip is associated with another widget.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a widget button is the label for that button. You can set VALUE to any of the following:

- a string value, which displays as text;
- an *n* x *m* byte array, which displays as a black-and-white bitmap image;
- an *n* x *m* x 3 byte array, which displays as a 24-bit color bitmap image;
- if the BITMAP keyword is also specified, the name of a bitmap image file that displays as a color bitmap image of the same depth as the image in the file.

See “Bitmap Button Labels” on page 2151 for additional details on using bitmap images as button labels.

**Note**

Under Microsoft Windows, including the ampersand character (&) in the value of a button widget causes the window manager to place an underline under the character following the ampersand. (This is a feature of Microsoft Windows, and is generally used to indicate which character is used as a keyboard accelerator for the button.) If you are designing an application that will run on different platforms, you should avoid the use of the ampersand in button value strings.

## X_BITMAP_EXTRA

When creating a bitmap button that is not of a “byte-aligned” size (i.e., a dimension is not a multiple of 8), this keyword specifies how many bits of the supplied bitmap must be ignored (within the end byte). For example, to create a 10 by 8 bitmap, you need to supply a 2 by 8 array of bytes and ignore the bottom 6 bits. Therefore, you would specify `X_BITMAP_EXTRA = 6`.

### XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

### YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of button widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DYNAMIC_RESIZE, DYNAMIC_RESIZE, GET_VALUE, INPUT_FOCUS, PUSHBUTTON_EVENTS, SET_BUTTON, SET_VALUE, TOOLTIP, X_BITMAP_EXTRA.

## Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO function return information that applies specifically to button widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: BUTTON_SET, DYNAMIC_RESIZE, PUSHBUTTON_EVENTS, TOOLTIP.

## Events Returned by Button Widgets

Pressing the mouse button while the mouse cursor is over a button widget causes the widget to generate an event. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_BUTTON, ID:0L, TOP:0L, HANDLER:0L, SELECT:0}
```

ID is the widget id of the button generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. SELECT is set to 1 if the button was set, and 0 if released. Unless the PUSHBUTTON_EVENTS keyword is set, normal buttons do not generate events when released, so SELECT will always be 1. Toggle buttons (children of either an exclusive or non-exclusive base) always return separate events for the set and release actions.

## Version History

Introduced: Pre 4.0

CHECKED_MENU and TOOLTIP keywords added: 5.6

PUSHBUTTON_EVENTS keyword added: 6.0

## See Also

CW_BGROUP, CW_PDMENU

# WIDGET_COMBOBOX

The WIDGET_COMBOBOX function creates combobox widgets, which are similar to droplist widgets. The main difference between the combobox widget and the droplist widget is that the combobox widget can be created in such a way that the text field is editable, allowing the user to enter a value that is not on the list.

A combobox widget displays a text field and an arrow button. If the combobox is not editable, selecting either the text field or the button reveals a list of options from which to choose. When the user selects a new option from the list, the list disappears and the text field displays the currently-selected option. This action generates an event containing the index of the selected item, which ranges from zero to the number of elements in the list minus one.

If the combobox is editable, text can be entered in the text box without causing the list to drop down. This action causes an event in which the index field is set to -1, allowing you to distinguish this event from list selections.

The text of the current selection is returned in the STR field of the WIDGET_COMBOBOX event structure. See "Widget Events Returned by Combobox Widgets" on page 2169 for details.

**Note**

WIDGET_COMBOBOX is not currently available on Compaq True64 UNIX platforms due to that platform's lack of support for the necessary Motif libraries.

## Syntax

*Result* = WIDGET_COMBOBOX( *Parent* [, /DYNAMIC_RESIZE] [, /EDITABLE] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*] [, FRAME=*value*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created combobox widget.

# Arguments

## Parent

The widget ID of the parent widget for the new combobox widget.

# Keywords

## DYNAMIC_RESIZE

Set this keyword to create a widget that resizes itself to fit its new value whenever its value is changed.

**Note**

This keyword does not take effect when used with the SCR_XSIZE, SCR_YSIZE, XSIZE, or YSIZE keywords. If one of these keywords is also set, the widget will be sized as specified by the sizing keyword and will never resize itself dynamically.

## EDITABLE

Set this keyword to create an editable combobox. If the combobox is editable, users can enter or modify in the text field. Changes in the combobox text field will cause combobox events with the INDEX field of the event structure set to -1. The current text will be ‘ in the STR field of the event structure.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a device font (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 in the *IDL Reference Guide* for

details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget.

**Note**

This keyword is only a hint to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as group leader for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. You cannot remove a widget from an existing group.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such callback procedure. This callback procedure can be removed by setting the routine name to the null string ( ' ').

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are

disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique works well for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copying the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. Upon a set operation (using the UVALUE keyword to WIDGET_COMBOBOX or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. Upon a get operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string containing the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single callback procedure. This callback procedure can be removed by setting the routine name to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See “RESOURCE_NAME” on page 2139 in the *IDL Reference Guide* for a complete discussion of this keyword.

## SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget.

**Note**

Some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string, which is used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The user value to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a combobox widget is a scalar string or array of strings that contains the text of the list items (one list item per array element). Combobox widgets are sized based on the length (in characters) of the longest item specified in the array of values for the VALUE keyword.

**Note**

Null strings are not allowed in the combobox widget item list.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. You should avoid using this style of widget programming.

### XSIZE

The desired width of the combobox widget area, in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword does not control the size of the combobox button or of the dropped list. Instead, it controls the size around the combobox button and, as such, is not particularly useful.

### YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. You should avoid using this style of widget programming.

### YSIZE

The desired height of the widget, in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword does not control the size of the combobox button or of the dropped list. Instead, it controls the size around the combobox button and, as such, is not particularly useful.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL affect the behavior of combobox widgets. In addition to those keywords that affect all widgets, the following keywords are particularly useful: COMBOBOX_ADDITEM, COMBOBOX_DELETEITEM, COMBOBOX_INDEX, DYNAMIC_RESIZE, GET_VALUE, SET_COMBOBOX_SELECT, SET_VALUE.

## Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO return information that applies specifically to combobox widgets. In addition to those keywords that apply to all widgets, the following keywords are particularly useful: COMBOBOX_GETTEXT, COMBOBOX_NUMBER, DYNAMIC_RESIZE.

## Widget Events Returned by Combobox Widgets

Pressing the mouse button while the mouse pointer is over an element of a combobox widget causes the widget to change the text field on the combobox and to generate an event. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_COMBOBOX, ID:0L, TOP:0L, HANDLER:0L, INDEX:0L, STR:""}
```

The first three fields are the standard fields found in every widget event. INDEX returns the index of the selected item. This can be used to index the array of names originally used to set the widget's value. If the event was caused by text changes in an editable combobox, the INDEX field will be set to -1. If you are using an editable combobox, it is important to check for the value of -1 prior to using the value of the INDEX field as an index into the array if items. The text of the current selection is returned in the STR field, which may eliminate the need to use the index field in many cases.

**Note**

Platform-specific UI toolkits behave differently if a combobox widget has only a single element. On some platforms, selecting that element again does not generate an event. Events are always generated if the list contains multiple items.

## Version History

Introduced: 5.6

## See Also

CW_PDMENU, WIDGET_BUTTON, WIDGET_DROPLIST, WIDGET_LIST

# WIDGET_CONTROL

The WIDGET_CONTROL procedure is used to realize, manage, and destroy widget hierarchies. It is often used to change the default behavior or appearance of previously-realized widgets.

## Syntax

WIDGET_CONTROL [, *Widget_ID*]

**Keywords that apply to all widgets:** [, BAD_ID=*variable*] [, /CLEAR_EVENTS] [, DEFAULT_FONT=*string*{do not specify *Widget_ID*}] [, /DELAY_DESTROY{do not specify *Widget_ID*}] [, /DESTROY] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FUNC_GET_VALUE=*string*] [, GET_UVALUE=*variable*] [, GROUP_LEADER=*widget_id*] [, /HOURGLASS{do not specify *Widget_ID*}] [, KILL_NOTIFY=*string*] [, /MAP] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, /REALIZE] [, /RESET{do not specify *Widget_ID*}] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, SEND_EVENT=*structure*] [, /SENSITIVE] [, SET_UNAME=*string*] [, SET_UVALUE=*value*] [, /SHOW] [, TIMER=*value*] [, TLB_GET_OFFSET=*variable*] [, TLB_GET_SIZE=*variable*] [, /TLB_KILL_REQUEST_EVENTS] [, TLB_SET_TITLE=*string*] [, TLB_SET_XOFFSET=*value*] [, TLB_SET_YOFFSET=*value*] [, /TRACKING_EVENTS] [, UNITS={0 | 1 | 2}] [, /UPDATE] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*]

**Keywords that apply to widgets created with WIDGET_ACTIVEX:** [, GET_VALUE=*value*]

**Keywords that apply to widgets created with WIDGET_BASE:** [, BASE_SET_TITLE=*string*] [, CANCEL_BUTTON=*widget_id*{for modal bases}] [, /CONTEXT_EVENTS] [, DEFAULT_BUTTON=*widget_id*{for modal bases}] [, /ICONIFY] [, /KBRD_FOCUS_EVENTS] [, /TLB_ICONIFY_EVENTS] [, /TLB_KILL_REQUEST_EVENTS] [, /TLB_MOVE_EVENTS] [, /TLB_SIZE_EVENTS]

**Keywords that apply to widgets created with WIDGET_BUTTON:** [, /BITMAP] [, /DYNAMIC_RESIZE] [, GET_VALUE=*value*] [, /INPUT_FOCUS] [, /PUSHBUTTON_EVENTS] [, /SET_BUTTON] [, SET_VALUE=*val*ue] [, TOOLTIP=*string*] [, X_BITMAP_EXTRA=*bits*]

**Keywords that apply to widgets created with WIDGET_COMBOBOX:**
[, COMBOBOX_ADDITEM=*string*] [, COMBOBOX_DELETEITEM=*integer*]
[, COMBOBOX_INDEX=*integer*] [, ./DYNAMIC_RESIZE]
[, GET_VALUE=*value*] [, SET_COMBOBOX_SELECT=*integer*]
[, SET_VALUE=*value*]

**Keywords that apply to widgets created with WIDGET_DRAW:**
[, /DRAW_BUTTON_EVENTS] [, /DRAW_EXPOSE_EVENTS]
[, DRAW_KEYBOARD_EVENTS={0 | 1 | 2}] [, /DRAW_MOTION_EVENTS]
[, /DRAW_VIEWPORT_EVENTS] [, DRAW_XSIZE=*integer*]
[, DRAW_YSIZE=*integer*] [, GET_DRAW_VIEW=*variable*]
[, GET_UVALUE=*variable*] [, GET_VALUE=*variable*] [, /INPUT_FOCUS]
[, SET_DRAW_VIEW=*[x, y]*] [, TOOLTIP=*string*]

**Keywords that apply to widgets created with WIDGET_DROPLIST:**
[, /DYNAMIC_RESIZE] [, GET_VALUE=*variable*]
[, SET_DROPLIST_SELECT=*integer*] [, SET_VALUE=*value*]

**Keywords that apply to widgets created with WIDGET_LABEL:**
[, /DYNAMIC_RESIZE] [, GET_VALUE=*value*] [, SET_VALUE=*value*]

**Keywords that apply to widgets created with WIDGET_LIST:**
[, /CONTEXT_EVENTS] [, SET_LIST_SELECT=*value*]
[, SET_LIST_TOP=*integer*] [, SET_VALUE=*value*]

**Keywords that apply to widgets created with WIDGET_PROPERTYSHEET:**
[, REFRESH_PROPERTY=*string*, *array of strings*, or *integer*]

**Keywords that apply to widgets created with WIDGET_SLIDER:**
[, GET_VALUE=*value*] [, SET_SLIDER_MAX=*value*]
[, SET_SLIDER_MIN=*value*] [, SET_VALUE=*value*]

**Keywords that apply to widgets created with WIDGET_TAB:**
[, SET_TAB_CURRENT=*index*] [, SET_TAB_MULTILINE=*value*]

**Keywords that apply to widgets created with WIDGET_TABLE:**
[, ALIGNMENT={0 | 1 | 2}] [, /ALL_TABLE_EVENTS] [, AM_PM=*[string, string]*] [, COLUMN_LABELS=*string_array*] [, COLUMN_WIDTHS=*array*]
[, DAYS_OF_WEEK=*string_array*{7 names}] [, /DELETE_COLUMNS{not for row_major mode}] [, /DELETE_ROWS{not for column_major mode}]
[, /EDITABLE] [, EDIT_CELL=*[integer, integer]*] [, FORMAT=*value*]
[, GET_VALUE=*variable*] [, INSERT_COLUMNS=*value*]
[, INSERT_ROWS=*value*] [, /KBRD_FOCUS_EVENTS]
[, MONTHS=*string_array*{12 names}] [, ROW_LABELS=*string_array*]
[, ROW_HEIGHTS=*array*] [, SET_TABLE_SELECT=*[left, top, right, bottom]*]
[, SET_TABLE_VIEW=*[integer, integer]*] [, SET_TEXT_SELECT=*[integer,*

*integer]*] [, SET_VALUE=*value*] [, /TABLE_BLANK=*cells*]
[, /TABLE_DISJOINT_SELECTION] [, TABLE_XSIZE=*columns*]
[, TABLE_YSIZE=*rows*] [, /USE_TABLE_SELECT | ,
USE_TABLE_SELECT=*[left, top, right, bottom]*] [, /USE_TEXT_SELECT]

**Keywords that apply to widgets created with WIDGET_TEXT:**
[, /ALL_TEXT_EVENTS] [, /APPEND] [, /CONTEXT_EVENTS] [, /EDITABLE]
[, GET_VALUE=*variable*] [, /INPUT_FOCUS] [, /KBRD_FOCUS_EVENTS]
[, /NO_NEWLINE] [, SET_TEXT_SELECT=*[integer, integer]*]
[, SET_TEXT_TOP_LINE=*line_number*] [, SET_VALUE=*value*]
[, /USE_TEXT_SELECT]

**Keywords that apply to widgets created with WIDGET_TREE:**
[, SET_TREE_BITMAP=*array*] [, /SET_TREE_EXPANDED]
[, SET_TREE_SELECT={0 | 1 | *widget ID* | *array of widget IDs*}]
[, /SET_TREE_VISIBLE]

# Arguments

## Widget_ID

The widget ID of the widget to be manipulated. This argument is required by all operations, unless the description of the specific keyword states otherwise. Note that if *Widget_ID* is not provided for a keyword that needs it, that keyword is quietly ignored.

# Keywords

Not all keywords to WIDGET_CONTROL apply to all combinations of widgets. In the following list, descriptions of keywords that affect only certain types of widgets include a list of the widgets for which the keyword is useful.

## ALIGNMENT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a scalar, 2-D array, or 1-D array specifying the alignment of the contents of each cell. An alignment of 0 (the default) aligns the left edge of the text with the left edge of the cell. An alignment of 2 right-justifies the text, while 1 results in text centered within the cell.

If the USE_TABLE_SELECT keyword is not set:

- If ALIGNMENT is set equal to a scalar, all table cells are aligned as specified. If ALIGNMENT is set equal to a 2-D array, the alignment of each table cell is governed by the corresponding element of the array.

If the USE_TABLE_SELECT keyword is set:

- In standard selection mode, if ALIGNMENT is set equal to a scalar, all cells in the selection are aligned as specified. If ALIGNMENT is set equal to a 2-D array, the alignment of each selected cell is governed by the corresponding element of the array.
- In disjoint selection mode, if ALIGNMENT is set equal to a scalar, all cells in the selection are aligned as specified. If ALIGNMENT is set equal to a 1-D array, the alignment of each selected cell is governed by the corresponding element of the array.

## ALL_TABLE_EVENTS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to cause to the table widget to generate events whenever the user changes the contents of a table cell.

**Note**

If the EDITABLE keyword is set, an insert character event (TYPE=0) is generated when the user presses the RETURN or ENTER key in the text widget, even if the ALL_EVENTS keyword is not set. End-of-line events such as these could be used by the programmer as an indication to check the cell value or to set the currently selected cell to the next cell. See the table below for details on the interaction between ALL_TABLE_EVENTS and EDITABLE.

| Keywords | | Effects | |
|---|---|---|---|
| **ALL_TABLE_EVENTS** | **EDITABLE** | **Input changes widget contents?** | **Type of events generated** |
| Not set | Not set | No | None |
| Not set | Set | Yes | End-of-line insertion |

*Table 96: Effects of using the ALL_TABLE_EVENTS and EDITABLE keywords*

| Keywords | | Effects | |
|---|---|---|---|
| **ALL_TABLE_EVENTS** | **EDITABLE** | **Input changes widget contents?** | **Type of events generated** |
| Set | Not set | No | All events |
| Set | Set | Yes | All events |

*Table 96: Effects of using the ALL_TABLE_EVENTS and EDITABLE keywords*

## ALL_TEXT_EVENTS

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to cause to the text widget to generate events whenever the user changes the contents of the text area.

**Note**

If the EDITABLE keyword is set, an insert character event (TYPE=0) is generated when the user presses the RETURN or ENTER key in the text widget, even if the ALL_EVENTS keyword is not set. See the table below for details on the interaction between ALL_TEXT_EVENTS and EDITABLE.

| Keywords | | Effects | |
|---|---|---|---|
| **ALL_TEXT_EVENTS** | **EDITABLE** | **Input changes widget contents?** | **Type of events generated** |
| Not set | Not set | No | None |
| Not set | Set | Yes | End-of-line insertion |
| Set | Not set | No | All events |
| Set | Set | Yes | All events |

*Table 97: Effects of using the ALL_TEXT_EVENTS and EDITABLE keywords*

## AM_PM

This keyword applies to widgets created with the WIDGET_TABLE function.

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

## APPEND

This keyword applies to widgets created with the WIDGET_TEXT function.

When using the SET_VALUE keyword to set the contents of a text widget (as created with the WIDGET_TEXT procedure), setting this keyword indicates that the supplied text should be appended to the existing contents of the text widget rather than replace it.

## BAD_ID

This keyword applies to all widgets.

If *Widget_ID* is not a valid widget identifier, this WIDGET_CONTROL normally issues an error and causes program execution to stop. However, if BAD_ID is present and specifies a named variable, the invalid ID is stored into the variable, and this routine quietly returns. If no error occurs, a zero is stored.

## BASE_SET_TITLE

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to a scalar string to change the title of the specified base widget. If the parent of the base widget is a tab widget, the title of the corresponding tab in the tab widget is changed to the provided string. If the parent is not a tab control, this keyword behaves like the keyword TLB_SET_TITLE.

## CANCEL_BUTTON

This keyword applies to widgets created with the WIDGET_BASE function using the MODAL keyword.

Set this keyword equal to the widget ID of a button widget that will be the cancel button on a modal base widget.

On Motif and Windows platforms, selecting **Close** from the system menu (generally located at the upper left of the base widget) generates a button event for the **Cancel** button.

## CLEAR_EVENTS

This keyword applies to all widgets.

If set, any events generated by the widget hierarchy rooted at *Widget_ID* which have arrived but have not been processed (via the WIDGET_EVENT procedure) are discarded.

## COLUMN_LABELS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to an array of strings to be used as labels for the columns of the table. If no label is specified for a column, it receives the default label "*n*" where *n* is the column number. If this keyword is set to the empty string (''), all column labels are set to be empty.

## COLUMN_WIDTHS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a one-dimensional array of widths for the columns of the table widget. The widths are given in the units specified with the UNITS keyword. If no width is specified for a column, that column is set to the default size, which varies by platform. If COLUMN_WIDTHS is set to a scalar value, all of the column widths are set to that value.

If the USE_TABLE_SELECT keyword is set (in either standard or disjoint selection mode), the indices of the elements of an array specified as the value of the COLUMN_WIDTHS keyword are interpreted as indices into the list of selected columns. For example, if the table is in disjoint selection mode, the current selection includes cells from columns `0`, `1`, `2`, `5`, `6`, and `7`, USE_TABLE_SELECT is set equal to one, and the COLUMN_WIDTHS keyword is set equal to a four-element array `[20, 35, 30, 35]`, the widths of columns `0`, `1`, `2`, and `5` would be modified. Similarly, if the table is in standard selection mode and the USE_TABLE_SELECT keyword is set equal to the array `[0, 1, 0, 0]`, and the COLUMN_WIDTHS keyword is set equal to a four-element array `[20, 35, 30, 35]`, only the width of the first column would be altered.

## COMBOBOX_ADDITEM

This keyword applies to widgets created with the WIDGET_COMBOBOX function.

Set this keyword to a non-null string that specifies a new item to add to the list of the combobox. By default, the item will be added to the end of the list. The item can be added to a specified position in the list by setting the COMBOBOX_INDEX keyword in the same call to WIDGET_CONTROL.

## COMBOBOX_DELETEITEM

This keyword applies to widgets created with the WIDGET_COMBOBOX function.

Set this keyword to an integer that specifies the zero-based index of the combobox element to be deleted from the list. If the specified element is outside the range of existing elements, no element is deleted.

## COMBOBOX_INDEX

This keyword applies to widgets created with the WIDGET_COMBOBOX function.

Set this keyword to an integer that specifies the zero-based index of the position at which a new item will be added to the list when using the COMBOBOX_ADDITEM keyword. The value -1 is a special case that indicates the item should be added to the end of the list. Note that this special case is provided for convenience, and that an item can also be added to the end of the list by omitting the COMBOBOX_INDEX keyword entirely. If the supplied index is not -1, and is outside the range of zero to the length of the existing list, the item is not added to the list.

**Note**

You can retrieve the length of the existing list using the COMBOBOX_NUMBER keyword to WIDGET_INFO function.

## CONTEXT_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function, WIDGET_LIST, and WIDGET_TEXT function.

Set this keyword to cause *context menu events* (or simply *context events*) to be issued when the user clicks the right mouse button over the widget. Set the keyword to 0 (zero) to disable such events. Context events are intended for use with context-sensitive menus (also known as pop-up or shortcut menus); pass the context event ID to the WIDGET_DISPLAYCONTEXTMENU procedure within your widget program's event handler to display the context menu.

**Note**

You can also capture right mouse button events generated within draw widgets. See the BUTTON_EVENTS keyword to WIDGET_DRAW function for details.

For more on detecting and handling context menu events, see "Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

## DAYS_OF_WEEK

This keyword applies to widgets created with the WIDGET_TABLE function.

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

## DEFAULT_BUTTON

This keyword applies to widgets created with the WIDGET_BASE function using the MODAL keyword.

Set this keyword equal to the widget ID of a button widget that will be the default button on a modal base widget. The default button is highlighted by the window system.

## DEFAULT_FONT

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword.

A string containing the name of the default font to be used.

If the font to be used for a given widget is not explicitly specified (via the FONT keyword to the widget creation function), a default supplied by the window system or server is used. Use this keyword to change the default. See "About Device Fonts" on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## DELAY_DESTROY

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword.

Normally, when the user destroys a widget hierarchy using the window manager, it is immediately removed. This can cause problems for applications that use the background task facility provided by the XMANAGER procedure if the hierarchy is destroyed while a background task is using it.

If DELAY_DESTROY is set, attempts to destroy the hierarchy are delayed until the next attempt to obtain an event for it. Setting DELAY_DESTROY to zero restores the default behavior.

XMANAGER uses this keyword automatically when managing background tasks. It is not expected that applications will need to use it directly.

## DELETE_COLUMNS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to delete columns that contain selected cells. If a selection is specified via the USE_TABLE_SELECT keyword (in either standard or disjoint mode), the columns that contain cells specified in the selection array are deleted. If the USE_TABLE_SELECT keyword is *either* absent or set equal to 1, the columns that contain selected cells are deleted.

**Warning**

You cannot delete columns from a table which displays structure data in /ROW_MAJOR mode (the default).

## DELETE_ROWS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to delete rows that contain selected cells. If a selection is specified via the USE_TABLE_SELECT keyword (in either standard or disjoint mode), the rows that contain cells specified in the selection array are deleted. If the USE_TABLE_SELECT keyword is *either* absent or set equal to 1, the columns that contain selected cells are deleted.

**Warning**

You cannot delete rows from a table which displays structure data in /COLUMN_MAJOR mode.

## DESTROY

This keyword applies to all widgets.

Set this keyword to destroy the widget and any child widgets in its hierarchy. Any further attempts to use the IDs for these widgets will cause an error.

## DRAW_BUTTON_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable button press events for draw widgets. Setting a zero value disables such events.

**Note**

You can use button events generated by draw widgets to simulate the functionality of the CONTEXT_EVENTS keyword to WIDGET_BASE, WIDGET_LIST, and WIDGET_TEXT. See the BUTTON_EVENTS keyword to WIDGET_DRAW for details.

## DRAW_EXPOSE_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable viewport expose events for draw widgets. Setting a zero value disables such events.

**Note**

You must explicitly disable backing store (by setting the RETAIN keyword to WIDGET_DRAW equal to zero) in order to generate expose events.

## DRAW_KEYBOARD_EVENTS

This keyword applies to widgets created with WIDGET_DRAW.

Set this keyword equal to 1 (one) or 2 to make the draw widget generate an event when it has the keyboard focus and a key is pressed or released. (The method by which a widget receives the keyboard focus is dependent on the window manager in use.) The value of the key pressed is reported in either the `CH` or the `KEY` field of the event structure, depending on the type of key pressed. See “Widget Events Returned by Draw Widgets” on page 2224 for details.

- If this keyword is set equal to 1, the draw widget will generate an event when a “normal” key is pressed. “Normal” keys include all keys except function keys and the modifier keys: SHIFT, CONTROL, CAPS LOCK, and ALT. If a modifier key is pressed at the same time as a normal key, the value of the modifier key is reported in the `MODIFIERS` field of the event structure.
- If this keyword is set equal to 2, the draw widget will generate an event when *either* a normal key or a modifier key is pressed. Values for modifier keys are reported in the `KEY` field of the event structure, and the `MODIFIERS` field contains zero.

**Note**

Keyboard events are never generated for function keys.

## DRAW_MOTION_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable motion events for draw widgets. Setting a zero value disables such events.

## DRAW_VIEWPORT_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to enable viewport motion events for draw widgets. Setting a zero value disables such events.

## DRAW_XSIZE

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to an integer that specifies the new horizontal size for the graphics region (the *virtual size*) of a draw widget in units specified by the UNITS keyword (pixels are the default). For non-scrollable draw widgets, setting this keyword is the same as setting SCR_XSIZE or XSIZE. However, for scrolling draw widgets DRAW_XSIZE is the only way to change the width of the drawable area (XSIZE sets the viewport size).

## DRAW_YSIZE

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to an integer that specifies the new vertical size for the graphics region (the *virtual size*) of a draw widget in units specified by the UNITS keyword (pixels are the default). For non-scrollable draw widgets, setting this keyword is the same as setting SCR_YSIZE or YSIZE. However, for scrolling draw widgets DRAW_YSIZE is the only way to change the height of the drawable area (YSIZE sets the viewport size).

## DYNAMIC_RESIZE

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_COMBOBOX, WIDGET_DROPLIST, and WIDGET_LABEL functions.

Set this keyword to activate (if set to 1) or deactivate (if set to 0) dynamic resizing of the specified WIDGET_BUTTON, WIDGET_LABEL, or WIDGET_DROPLIST

widget (see the documentation for the DYNAMIC_RESIZE keyword to those procedures for more information about dynamic widget resizing).

## EDITABLE

This keyword applies to widgets created with the WIDGET_TABLE and WIDGET_TEXT functions.

Set this keyword to allow direct user editing of the contents of a text or table widget. Normally, the text in text and table widgets is read-only. See the descriptions of the ALL_TABLE_EVENTS and ALL_TEXT_EVENTS keywords for additional details.

## EDIT_CELL

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a two-element integer array containing the y (row) and x (column) coordinates of a table cell to put that cell into edit mode. For example, to put the top cell in the third column (x index=2) into edit mode, use the following commands:

```
row=0
col=2
WIDGET_CONTROL, table, EDIT_CELL=[row, col]
```

where *table* is the Widget ID of the table widget.

## EVENT_FUNC

This keyword applies to all widgets.

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy given by *Widget_ID*.

This keyword overwrites any event routine supplied by previous uses of the EVENT_FUNC or EVENT_PRO keywords. To specify no event routine, set this keyword to a null string (`''`).

## EVENT_PRO

This keyword applies to all widgets.

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy given by *Widget_ID*.

This keyword overwrites any event routine supplied by previous uses of the EVENT_FUNC or EVENT_PRO keywords. To specify no event routine, set this keyword to a null string (' ').

## FORMAT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a single string or a one- or two-dimensional array of strings that specify the format of data displayed within table cells. The string(s) are of the same form as used by the FORMAT keyword to the PRINT procedure, and the default format is the same as that used by the PRINT/PRINTF procedures.

If the USE_TABLE_SELECT keyword is set equal to one, the format is changed only for the currently selected cells. If USE_TABLE_SELECT is set equal to an array, the format is changed for the specified cells.

- In standard selection mode, FORMAT can be set either to a single string or to a two-dimensional array of strings of the same size as the selected area.
- In disjoint selection mode, FORMAT can be set either to a single string or to a one-dimensional array of strings with the same number of elements as the selected area.

## FUNC_GET_VALUE

This keyword applies to all widgets.

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. The function specified by FUNC_GET_VALUE is called with the widget ID as an argument. The function specified by FUNC_GET_VALUE should return a value for a widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GET_DRAW_VIEW

This keyword applies to widgets created with the WIDGET_DRAW function.

Specifies a named variable which will be assigned the current position of a draw widget viewport. The position is returned as a 2-element integer array giving the X and Y position relative to the lower left corner of the graphics area.

## GET_UVALUE

This keyword applies to all widgets.

Set this keyword to a named variable to contain the current user value of the widget.

Each widget can contain a user set value of any data type and organization. This value is not used by the widget in any way, and exists entirely for the convenience of the IDL programmer. This keyword allows you to obtain the current user value.

The user value of a widget can be set with the SET_UVALUE keyword to this routine, or with the UVALUE keyword to the routine that created it.

To improve the efficiency of the data transfer, consider using the NO_COPY keyword (described below) with GET_UVALUE.

## GET_VALUE

This keyword applies to widgets created with the WIDGET_ACTIVEX, WIDGET_BUTTON, WIDGET_COMBOBOX, WIDGET_DRAW, WIDGET_DROPLIST, WIDGET_LABEL, WIDGET_SLIDER, WIDGET_TABLE, and WIDGET_TEXT functions.

**Note**

If you would like information about the values returned for a specific compound widget—beginning with the prefix “CW_”—please refer to the description of the compound widget, which may also include a section titled, “Keywords to WIDGET_CONTROL and WIDGET_INFO”. Compound widgets are described in the *Reference Guide*.

Set this keyword to a named variable to contain the current value of the widget. The type of value returned depends on the widget type:

- ActiveX: An object reference to the IDLcomActiveX object that underlies the ActiveX widget. See Chapter 5, “Using ActiveX Controls in IDL” in the *External Development Guide* manual for details.
- Button: If the button label is text, it is returned as a string. Attempts to obtain the value of a button with a bitmap label is an error.
- Combobox: The contents of the list of the combobox widget are returned as a string or string array.
- Draw: The value of a draw widget depends on whether the draw widget uses IDL Direct Graphics or IDL Object Graphics. (The type of graphics used is specified by the GRAPHICS_LEVEL keyword to WIDGET_DRAW.) The two possibilities are:

  A. By default, draw widgets use IDL Direct Graphics. In this case, the value of a draw widget is the IDL window ID for the drawing area. This ID is

used with procedures such as WSET, WSHOW, etc., to direct graphics to the widget. The window ID is assigned to drawing area widgets at the time they are realized. If the widget has not yet been realized, a value of -1 is returned.

B. If the draw widget uses IDL Object Graphics (that is, if the GRAPHICS_LEVEL keyword to WIDGET_DRAW is set equal to 2), the value of the draw widget is the object reference of the window object used in the draw widget.

- Droplist: The contents of the droplist widget's list are returned as a string or string array.
- Label: The label text is returned as a string.
- Property Sheet: Retrieves the component object(s) that the property sheet is associated with. Use the GET_VALUE keyword to WIDGET_CONTROL.
- Slider: The current value of the slider is returned as an integer.
- Table: Normally, the data for the whole table are returned as a two dimensional array or a vector of structures.

  If the USE_TABLE_SELECT keyword is set, the value returned is a subset of the whole data.

  - If the table is in standard selection mode and the table data is of a single type, the value returned is a two dimensional array. If the table contains structure data, the value returned is a vector of (possibly anonymous) structures.
  - If the table is in disjoint selection mode and the table data is a single type, the value returned is a one-dimensional array of values. If the table contains structure data, the value returned is a single structure in which each field corresponds to a selected cell. In either case, use the TABLE_SELECT keyword to WIDGET_INFO to get the row and column indices of the disjoint values.

  If the USE_TEXT_SELECT keyword is set, the value returned is a string corresponding to the currently-selected text in the currently-selected cell.
- Text: The current contents of the text widget are returned as a string array. If the USE_TEXT_SELECT keyword is also specified, only the contents of the current selection are returned.
- Widget types not listed above do not return a value. Attempting to retrieve the value of such a widget causes an error.

The value of a widget can be set with the SET_VALUE keyword to this routine, or with the VALUE keyword to the routine that created it.

## GROUP_LEADER

This keyword applies to all widgets.

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## HOURGLASS

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword.

Set this keyword to turn on an “hourglass-shaped” cursor for all IDL widgets and graphics windows. The hourglass remains in place until the WIDGET_EVENT function attempts to process the next event. Then the previous cursor is reinstated. If an application starts a time-intensive calculation inside an event-handling routine, the hourglass cursor should be used to indicate that the system is not currently responding to events.

## ICONIFY

This keyword applies to all widgets.

Set this keyword to a non-zero value to cause the specified widget to become iconified. Set this keyword to zero to open an iconified widget.

## INPUT_FOCUS

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_DRAW, and WIDGET_TEXT functions.

If *Widget_ID* is a text widget, you can set this keyword to cause the widget to receive the keyboard focus. If *Widget_ID* is a button widget, set this keyword to position the mouse pointer over the button (on Motif), or set the focus to the button so that it can be “pushed” with the spacebar (on Windows). This keyword has no effect for other widget types.

**Note**

You cannot assign the input focus to an unrealized widget.

## INSERT_COLUMNS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to the number of columns to be added to the right of the rightmost column of the table. If the USE_TABLE_SELECT keyword is set equal to one, the columns are inserted to the left of the current selection. If USE_TABLE_SELECT is set equal to an array, the columns are inserted to the left of the specified selection.

**Warning**

You cannot insert columns into a table which displays structure data in /ROW_MAJOR (default) mode because it would change the structure.

## INSERT_ROWS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to the number of rows to be added below the bottommost row of the table. If the USE_TABLE_SELECT keyword is set equal to one, the rows are inserted above the current selection. If USE_TABLE_SELECT is set equal to an array, the rows are inserted above the specified selection.

**Warning**

You cannot insert rows into a table which displays structure data in /COLUMN_MAJOR mode because it would change the structure.

## KBRD_FOCUS_EVENTS

This keyword applies to widgets created with the WIDGET_BASE, WIDGET_TABLE, and WIDGET_TEXT functions.

Set this keyword to cause widget keyboard focus events to be issued for the widget whenever the keyboard focus of that widget changes. See the KBRD_FOCUS_EVENTS keywords to WIDGET_BASE, WIDGET_TABLE, and WIDGET_TEXT for details.

## KILL_NOTIFY

This keyword applies to all widgets.

Use this keyword to change or remove a previously-specified callback procedure for *Widget_ID*. A previously-defined callback can be removed by setting this keyword to the null string ( ' ').

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

For a top-level base widget in a widget application, the CLEANUP keyword to XMANAGER can also be used to specify a procedure that will be called when the base widget dies. Note that the *last* call to any of:

- WIDGET_BASE, KILL_NOTIFY
- XMANAGER, CLEANUP
- WIDGET_CONTROL, KILL_NOTIFY

determines the procedure that is executed when the specified top-level base widget dies. Calling XMANAGER with the CLEANUP keyword overrides any previous setting of KILL_NOTIFY. Similarly, calling WIDGET_CONTROL with KILL_NOTIFY overrides any previous setting of CLEANUP.

## MANAGED

This keyword applies to all widgets.

This keyword is used by the XMANAGER procedure to mark those widgets that it is currently managing. User applications should not use this keyword directly.

## MAP

This keyword applies to all widgets.

Set this keyword to zero to unmap the widget hierarchy rooted at the widget specified by *Widget_ID*. The hierarchy disappears from the screen, but still exists.

The mapping operation applies only to base widgets. If the specified widget is not a base, IDL searches upward in the widget hierarchy until it finds the closest base widget. The map operation is applied to that base.

Set MAP to a nonzero value to re-map the widget hierarchy and make it visible. Normally, the widget is automatically mapped when it is realized, so use of the MAP keyword is not required.

## MONTHS

This keyword applies to widgets created with the WIDGET_TABLE function.

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

## NO_COPY

This keyword applies to all widgets.

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

**Note**

The NO_COPY keyword increases efficiency when sending event structures using the SEND_EVENT keyword to WIDGET_CONTROL.

## NO_NEWLINE

This keyword applies to widgets created with the WIDGET_TEXT function.

When setting the value of a multi-line text widget, newline characters are automatically appended to the end of each line of text. The NO_NEWLINE keyword suppresses this action.

## NOTIFY_REALIZE

This keyword applies to all widgets.

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once

(because widgets are realized only once). Each widget is allowed a single such "callback" procedure. A previously-set callback routine can be removed by setting this keyword to the null string ( ' ' ). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

This keyword applies to all widgets.

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. The procedure specified by PRO_SET_VALUE is called with 2 arguments— a widget ID and a value. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## PUSHBUTTON_EVENTS

This keyword applies to widgets created with the WIDGET_BUTTON function.

Set this keyword to a non-zero value to enable pushbutton events for the widget specified by *Widget_ID*. Set the keyword to 0 to disable pushbutton events for the specified widget. For a description of pushbutton events, see "PUSHBUTTON_EVENTS" on page 2156 in the documentation for WIDGET_BUTTON.

## REALIZE

This keyword applies to all widgets.

If set, the widget hierarchy is realized. Until the realization step, the widget hierarchy exists only within IDL. Realization is the step of actually creating the widgets on the screen (and mapping them if necessary).

When a previously-realized widget gets a new child widget, the new child is automatically realized.

**Tip**

Under Microsoft Windows, when a hidden base is realized, then mapped, a Windows resize message is sent by the windowing system. This "extra" resize event is generated before any manipulation of the base widget by the user.

## REFRESH _PROPERTY

This keyword applies to widgets created with the WIDGET_PROPERTYSHEET function. Set this keyword to a property identifier or array of property identifiers to

have just those properties synchronized with their values in the component(s). Recall that property identifiers are strings that uniquely determine a property. The keyword can also be set to a numeric value—non-zero values refresh all properties. The REFRESH_PROPERTY keyword also updates with respect to a property's sensitivity and visibility.

When all properties need synchronizing, it is more efficient to use /REFRESH_PROPERTY than WIDGET_CONTROL's SET_VALUE keyword to reload the property sheet.

## RESET

This keyword applies to all widgets. Do not specify a *Widget ID* when using this keyword. Set the RESET keyword to destroy every currently active widget. This keyword should be used with caution.

## ROW_LABELS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to an array of strings to be used as labels for the rows of the table. If no label is specified for a row, it receives the default label "*n*" where *n* is the row number. If this keyword is set to the empty string (''), all row labels are set to be empty.

## ROW_HEIGHTS

This keyword applies to widgets created with the WIDGET_TABLE function.

**Note**

This keyword is not supported under Microsoft Windows.

Set this keyword equal to a one-dimensional array of heights for the rows of the table widget. The heights are given in the units specified with the UNITS keyword. If no height is specified for a row, that row is set to the default size, which varies by platform. If ROW_HEIGHTS is set to a scalar value, all of the row heights are set to that value.

If the USE_TABLE_SELECT keyword is set (in either standard or disjoint selection mode), the indices of the elements of the specified array are interpreted as indices into the list of selected columns. For example, if the table is in disjoint selection mode, the current selection includes cells from rows `0`, `1`, `2`, `5`, `6`, and `7`, USE_TABLE_SELECT is set equal to one, and the ROW_HEIGHTS keyword is set equal to a four-element array `[20, 35, 30, 35]`, the height of rows `0`, `1`, `2`, and `5` would be modified. Similarly, if the table is in standard selection mode and the

USE_TABLE_SELECT keyword is set equal to the array `[0, 1, 0, 0]`, and the ROW_HEIGHTS keyword is set equal to a four-element array `[20, 35, 30, 35]`, only the height of the first row would be altered.

## SCR_XSIZE

This keyword applies to all widgets.

Set this keyword to an integer value that represents the widget's new horizontal size, in units specified by the UNITS keyword (pixels are the default). Attempting to change the size of a widget that is part of a menubar or pulldown menu causes an error. This keyword is useful for resizing table, text, list, and scrolling widgets. Note that [XY]SIZE sets client area and SCR_[XY]SIZE sets total area (title bar, borders, menu, client area).

## SCR_YSIZE

This keyword applies to all widgets.

Set this keyword to an integer value that represents the widget's new vertical size, in units specified by the UNITS keyword (pixels are the default). Attempting to change the size of a widget that is part of a menubar or pulldown menu causes an error. This keyword is useful for resizing table, text, list, and scrolling widgets. Note that [XY]SIZE sets client area and SCR_[XY]SIZE sets total area (title bar, borders, menu, client area).

## SEND_EVENT

This keyword applies to all widgets.

Set this keyword to a structure containing a valid widget event to be sent to the specified widget. The value of SEND_EVENT *must* be a structure and the first three fields must be ID, TOP, and HANDLER (all of LONG type). Additional fields can be of any type.

To improve the efficiency of the data transfer, consider using the NO_COPY keyword with SEND_EVENT.

## SENSITIVE

Set this keyword to control the sensitivity state of a widget after creation. This keyword applies to all widgets. Use the SENSITIVE keyword with the widget creation function to control the initial sensitivity state.

When a widget is sensitive, it has normal appearance and can receive user input. For instance, a sensitive button widget can be activated by moving the mouse cursor over

it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, and ignores any input directed at it. If SENSITIVE is zero, the widget hierarchy becomes insensitive. If nonzero, it becomes sensitive.

Sensitivity can be used to control when a user is allowed to manipulate a widget. It should be noted that some widgets do not change their appearance when they are made insensitive, and simply cease generating events.

## SET_BUTTON

This keyword applies to widgets created with the WIDGET_BUTTON function.

This keyword changes the current state of toggle buttons. If set equal to zero, every toggle button in the hierarchy specified by *Widget_ID* is set to the unselected state. If set to a nonzero value, the action depends on the type of base holding the buttons:

- For a non-exclusive base:
  - If a single button is specified by *Widget_ID*, that button is set to the selected state, leaving the state of other buttons in the base unchanged.
  - If the base itself is specified by *Widget_ID*, all buttons are set to the selected state.
- For an exclusive base:
  - If a single button is specified by *Widget_ID*, that button is set to the selected state, and all other buttons in the base are set to the unselected state.
  - If the base itself is specified by *Widget_ID*, IDL generates an error, since an exclusive base can contain at most one selected button.

If the specified *Widget_ID* is a button widget that was created using the CHECKED_MENU keyword, the checked state of the menu item is modified. If the keyword value is nonzero, the menu button is placed in a checked state. If the keyword value is zero, the button is placed in a un-checked state.

## SET_COMBOBOX_SELECT

This keyword applies to widgets created with the WIDGET_COMBOBOX function.

Set this keyword to an integer that specifies the zero-based index of the combobox list element to be displayed. If the specified element is outside the range of existing elements, the selection remains unchanged.

## SET_DRAW_VIEW

This keyword applies to widgets created with the WIDGET_DRAW function.

A scrollable draw widget provides a large graphics area which is viewed through a smaller viewport. This keyword allows changing the current position of the viewport. The desired position is specified as a 2-element integer array giving the X and Y position in units specified by the UNITS keyword (pixels are the default) relative to the lower left corner of the graphics area. For example, to position the viewport to the lower left corner of the image:

```
WIDGET_CONTROL, widget, SET_DRAW_VIEW=[0, 0]
```

## SET_DROPLIST_SELECT

This keyword applies to widgets created with the WIDGET_DROPLIST function.

Set this keyword to an integer that specifies the droplist element to be current (i.e., the element that is displayed on the droplist button). Positions start at zero. If the specified element is outside the possible range, no new selection is set.

## SET_LIST_SELECT

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to an integer scalar or vector that specifies the list element or elements to be highlighted. The previous selection (if there is a selection) is cleared. Positions start at zero. If the specified element is outside the possible range, no new selection in set. Note that the MULTIPLE keyword to WIDGET_LIST must have been set in more than a single list element is specified.

If the selected position is not currently on the screen, the list widget automatically move the current scrolling viewport to make it visible. The resulting topmost visible element is toolkit specific. If you wish to ensure a certain element is at the top of the list, use the SET_LIST_TOP keyword (described below) to explicitly set the viewport.

## SET_LIST_TOP

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to an integer that specifies the element of the list widget to the positioned at the top of the scrolling list. If the specified element is outside the range of list elements, nothing happens.

## SET_SLIDER_MAX

This keyword applies to widgets created with the WIDGET_SLIDER function.

Set this keyword to a new maximum value for the specified slider widget.

**Note**

This keyword does not apply to floating-point sliders created with the CW_FSLIDER function.

## SET_SLIDER_MIN

This keyword applies to widgets created with the WIDGET_SLIDER function.

Set this keyword to a new minimum value for the specified slider widget.

**Note**

This keyword does not apply to floating-point sliders created with the CW_FSLIDER function.

## SET_TAB_CURRENT

This keyword applies to widgets created with the WIDGET_TAB function.

Set this keyword equal to the zero-based index of the tab to be set as the current (visible) tab. If the index value is invalid, the value is quietly ignored.

## SET_TAB_MULTILINE

This keyword applies to widgets created with the WIDGET_TAB function.

This keyword controls how tabs appear on the tab widget when all of the tabs do not fit on the widget in a single row. This keyword behaves differently on Windows and UNIX systems.

### Windows

Set this keyword to cause tabs to be organized in a multi-line display when the width of the tabs exceeds the width of the largest child base widget. If possible, IDL will create tabs that display the full tab text.

If MULTILINE=0 and LOCATION=0 or 1, tabs that exceed the width of the largest child base widget are shown with scroll buttons, allowing the user to scroll through the tabs while the base widget stays immobile.

If LOCATION=1 or 2, a multiline display is always used if the tabs exceed the height of the largest child base widget.

**Note**

The width or height of the tab widget is based on the width or height of the largest base widget that is a child of the tab widget. The text of the tabs (the titles of the tab widget's child base widgets) may be truncated even if the MULTILINE keyword is set.

**UNIX**

Set this keyword equal to an integer that specifies the maximum number of tabs to display per row in the tab widget. If this keyword is not specified (or is explicitly set equal to zero) all tabs are placed in a single row.

**Note**

The width or height of the tab widget is based on the width or height of the largest base widget that is a child of the tab widget. The text of the tabs (the titles of the tab widget's child base widgets) is never truncated in order to make the tabs fit the space available. (Tab text may be truncated if the text of a single tab exceeds the space available, however.) This means that if MULTILINE is set to any value other than one, some tabs may not be displayed.

## SET_TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

- In standard selection mode, specify a four-element array, of the form [ *left, top, right, bottom* ] specifying the of cells to act upon.
- In disjoint selection mode, specify a 2 x *n* element array of column/row pairs specifying the cells to act upon.

Specifications for cell locations are zero-based (that is, the first data column is column number zero). The value -1 is used to refer to the title row or title column.

See "USE_TABLE_SELECT" on page 2206 for details on the selection modes.

**Note**

To remove a table selection programmatically, set this keyword to either `[-1, -1, -1, -1]` (in standard selection mode) or `[[-1, -1]]` (in disjoint selection mode).

If the selected position is not currently on the screen, the table widget automatically moves the current scrolling viewport to make a portion of it visible. The resulting top-left visible cell is toolkit specific. If you wish to ensure a certain element is at the top of the list, use the SET_TABLE_VIEW keyword to explicitly set the viewport.

## SET_TABLE_VIEW

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to a two-element array of zero-based cell indices that specifies the cell of the table widget to the positioned at the top-left of the widget. If the specified cell is outside the range of valid cells, nothing happens.

## SET_TEXT_SELECT

This keyword applies to widgets created with the WIDGET_TABLE and WIDGET_TEXT functions.

Use this keyword to clear any current selection in the specified table cell or text widget, and either set a new selection, or simply set the text insertion point. To set a selection, specify a two-element integer array containing the starting position and the length of the selection. For example, to set a selection covering characters 3 though 23:

```
WIDGET_CONTROL, widgetID, SET_TEXT_SELECT=[3, 20]
```

To move the text insertion point without setting a selection, omit the second element, or set it to zero.

## SET_TEXT_TOP_LINE

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to the zero-based line number of the line to be positioned on the topmost visible line in the text widget's viewport. No horizontal scrolling is performed. Note that this is a line number, not a character offset.

## SET_TREE_BITMAP

This keyword applies to widgets created with the WIDGET_TREE function.

Set this keyword equal to a 16x16x3 array representing an RGB image that will be displayed next to the node in the tree widget.

Set this keyword equal to zero to revert to the appropriate default system bitmap.

## SET_TREE_EXPANDED

This keyword applies to widgets created with the WIDGET_TREE function.

Set this keyword equal to a nonzero value to expand the specified tree widget folder. Set this keyword equal to zero to collapse the specified tree widget folder.

## SET_TREE_SELECT

This keyword applies to widgets created with the WIDGET_TREE function.

This keyword has two modes of operation, depending on the widget ID passed to WIDGET_CONTROL:

- If the specified widget ID is for the root node of the tree widget (the tree widget whose *Parent* is a base widget):
  - If the tree widget is in multiple-selection mode and SET_TREE_SELECT is set to an array of widget IDs corresponding to tree widgets that are nodes in the tree, those nodes are selected.
  - If the tree widget is *not* in multiple-selection mode and SET_TREE_SELECT is set to a single widget ID corresponding to a tree widget that is a node in the tree, that node is selected.
  - If the keyword is set to zero, all selections in the tree widget are cleared.
- If the specified widget ID is a tree widget that is a node in a tree:
  - If the keyword is set to a nonzero value, the specified node is selected.
  - If the keyword is set to zero, the specified node is deselected.

**Note**

If the tree widget is in multiple-selection mode, the selection changes made to the tree widget via this keyword are additive — that is, the current selections are retained and any additional nodes specified by SET_TREE_SELECT are also selected.

## SET_TREE_VISIBLE

This keyword applies to widgets created with the WIDGET_TREE function and whose parent widget was also created using the WIDGET_TREE function (that is, tree widgets that are nodes of another tree).

Set this keyword to make the specified tree node *visible* to the user. Setting this keyword has two possible effects:

1. If the specified node is inside a collapsed folder, the folder and all folders above it are expanded to reveal the node.
2. If the specified node is in a portion of the tree that is not currently visible because the tree has scrolled within the parent base widget, the tree view scrolls so that the selected node is at the top of the base widget.

**Note**

Use of this keyword does not affect the tree widget selection state.

## SET_UNAME

This keyword applies to all widgets.

Set this keyword to a string that can be used to identify the widget. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID. You can set the name at creation time, using the UNAME keyword with the creation function.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## SET_UVALUE

This keyword applies to all widgets.

Each widget can contain a user-set value. This value is not used by IDL in any way, and exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value.

To improve the efficiency of the data transfer, consider using the NO_COPY keyword with SET_UVALUE.

## SET_VALUE

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_COMBOBOX, WIDGET_DROPLIST, WIDGET_LABEL, WIDGET_LIST, WIDGET_SLIDER, WIDGET_TABLE, and WIDGET_TEXT functions.

Sets the value of the specified widget. The meaning of the value differs between widget types:

- Button: The label to be used for the button. This value can be either a scalar string, or a 2D byte array containing a bitmap.
- Combobox: The contents of the combobox widget (string or string array).
- Droplist: The contents of the droplist widget (string or string array).
- Label: The text to be displayed by the label widget.
- List: The contents of the list widget (string or string array).
- Property Sheet: Associates one or more component objects with a property sheet. Any existing associations are lost and the property sheet is reloaded with the new list of properties. Use the SET_VALUE keyword to WIDGET_CONTROL. Use the return value of OBJ_NEW() to clear out a property sheet.
- Slider: The current position of the slider (integer).
- Table: Normally, the data for the whole table is changed to the specified data, which must be of the form of a two dimensional array or a vector of structures. In this form, the table is resized to fit the given data (unless the TABLE_XSIZE or TABLE_YSIZE keywords are given).

  If the USE_TABLE_SELECT keyword is set, the value given is treated as a subset of the whole data, and only the given range of cells are updated. Used in this form, the type of data stored in the table cannot be changed. The data passed in is converted, as appropriate, to the type of the selected cells. If less data is passed in than fits in the current selection, the cells outside the range of data (but inside the selection) are left unchanged. If more data is passed in than fits in the current selection, the extra data is ignored.

  - If the table is in standard selection mode, the data should be a two-dimensional array of values for a single-type table, or a vector of structures for a table that contains structure data.
  - If the table is in disjoint selection mode, the data should be a one-dimensional array of values for a single-type table, or a single structure with each field corresponding to a cell for a table that contains structure data.

  If the USE_TEXT_SELECT keyword is present, the value must be a string, which replaces the currently-selected text in the currently-selected cell.
- Text: The text to be displayed. If the APPEND keyword is also specified, the text is appended to the current contents instead of instead of completely replacing it (string or string array). If the USE_TEXT_SELECT keyword is

specified, the new string replaces only the currently-selected text in the text widget.

- Widget types not listed above do not allow the setting of a value. Attempting to set the value of such a widget causes an error.

The value of a widget can also be set with the VALUE keyword to the routine that created it.

## SHOW

This keyword applies to all widgets.

Controls the visibility of a widget hierarchy. If set to zero, the hierarchy containing *Widget_ID* is pushed behind any other windows on the screen. If nonzero, the hierarchy is pulled in front.

## TABLE_BLANK

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to a nonzero value to cause the specified cells to be blank. Set this keyword equal to zero to cause the specified cells to display values as usual.

**Note**

Hiding cell contents using this keyword is a *display-only operation*. The cell contents are not actually removed from the table, they are simply hidden from view. Any operation that evaluates or changes the value of a cell will operate in the same way on a cell whose contents are hidden as it will on a cell whose contents are visible.

If the USE_TABLE_SELECT keyword is set equal to one, the currently selected cells are blanked or restored. If USE_TABLE_SELECT is set equal to an array, the specified cells are blanked or restored. If USE_TABLE_SELECT is not set, the entire table is hidden or displayed.

## TABLE_DISJOINT_SELECTION

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to enable the ability to select multiple rectangular regions of cells.

## TABLE_XSIZE

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to the number of data columns in the table widget. Note that if the table widget was created with row titles enabled (that is, if the NO_HEADERS keyword to WIDGET_TABLE was *not* set), the table will contain one column more than the number specified by TABLE_XSIZE.

If the table is made smaller as a result of the application of the TABLE_XSIZE keyword, the data outside the new range persists, but the number of columns and/or rows changes as expected. If the table is made larger, the data type of the cells in the new columns is set according to the following rules:

1. If the table was not created with either the ROW_MAJOR or COLUMN_MAJOR keywords set (if the table is an array rather than a vector of structures), the new cells have the same type as all the original cells.
2. If the SET_VALUE keyword is given, the types of all columns are set according to the new structure.
3. If the table was created with the ROW_MAJOR keyword set, and the SET_VALUE keyword is not specified, the cells in the new columns inherit their type from the cells to their left.
4. ²If the table was created with the COLUMN_MAJOR keyword set, and the SET_VALUE keyword is not specified, any new columns default to type INT.

## TABLE_YSIZE

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword equal to the number of data rows in the table widget. Note that if the table widget was created with column titles enabled (that is, if the NO_HEADERS keyword to WIDGET_TABLE was *not* set), the table will contain one row more than the number specified by TABLE_YSIZE.

If the table is made smaller as a result of the application of the TABLE_YSIZE keyword, the data outside the new range persists, but the number of columns and/or rows changes as expected. If the table is made larger, the data type of the cells in the new rows is set according to the following rules:

1. If the table was not created with either the ROW_MAJOR or COLUMN_MAJOR keywords set (if the table is an array rather than a vector of structures), the new cells have the same type as all the original cells.
2. If the SET_VALUE keyword is given, the types of all rows are set according to the new structure.

3. If the table was created with the COLUMN_MAJOR keyword set, and the SET_VALUE keyword is not specified, the cells in the new rows inherit their type from the cells above.
4. If the table was created with the ROW_MAJOR keyword set, and the SET_VALUE keyword is not specified, any new rows default to type INT.

## TIMER

This keyword applies to all widgets.

If this keyword is present, a WIDGET_TIMER event is generated. Set this keyword to a floating-point value that represents the number of seconds before the timer event arrives. Note that this event is identical to any other widget event except that it contains only the 3 standard event tags. These event structures are defined as:

```
{ WIDGET_TIMER, ID:0L, TOP:0L, HANDLER:0L }
```

It is left to the caller to tell the difference between standard widget events and timer events. The standard way to do this is to use a widget that doesn't normally generate events (e.g., a base or label). Alternately, the TAG_NAMES function can be called with the STRUCTURE_NAME keyword to differentiate a WIDGET_TIMER event from other types of events. For example:

```
IF TAG_NAMES(event, /STRUCTURE_NAME) EQ $
   'WIDGET_TIMER' THEN ...
```

Using the TIMER keyword is more efficient than the background task functionality found in the XMANAGER procedure because it doesn't "poll" like the original background task code. RSI will eventually eliminate the background task functionality from XMANAGER. We encourage all users to modify their code to use the TIMER keyword instead.

## TLB_GET_OFFSET

This keyword applies to all widgets.

Set this keyword to a named variable in which the offset of the top-level base of the specified widget is returned, in units specified by the UNITS keyword (pixels are the default). The offset is measured in device coordinates relative to the upper-left corner of the screen.

## TLB_GET_SIZE

This keyword applies to all widgets.

Set this keyword to a named variable in which the size of the top-level base of the specified widget is returned, in units specified by the UNITS keyword (pixels are the

default). The size is returned as a two-element vector that contains the horizontal and vertical size of the base in device coordinates.

## TLB_ICONIFY_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to make the top-level base return an event when the base is iconified or restored by the user.

## TLB_KILL_REQUEST_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Use this keyword to set or clear kill request events for the specified top-level base. For more information on these events see "TLB_KILL_REQUEST_EVENTS" on page 2144.

## TLB_MOVE_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to make the top-level base return an event when the base is moved by the user. Note that if TLB_SIZE_EVENTS are also enabled, a user resize operation that causes the top left corner of the base widget to move will generate both a move event and a resize event.

## TLB_SET_TITLE

This keyword applies to all widgets.

Set this keyword to a scalar string to change the title of the specified top-level base after it has been created.

## TLB_SET_XOFFSET

This keyword applies to all widgets.

Use this keyword to set the horizontal position of the top level base of the specified widget. The offset is measured from the upper-left corner of the screen to the upper-left corner of the base, in units specified by the UNITS keyword (pixels are the default).

## TLB_SET_YOFFSET

This keyword applies to all widgets.

Use this keyword to set the vertical position of the top-level base of the specified widget. The offset is measured from the upper-left corner of the screen to the upper-left corner of the base, in units specified by the UNITS keyword (pixels are the default).

## TLB_SIZE_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to make the top-level base return an event when the base is resized by the user. Note that if TLB_MOVE_EVENTS are also enabled, a user resize operation that causes the top left corner of the base widget to move will generate both a move event and a resize event.

## TOOLTIP

This keyword applies to widgets created with the WIDGET_BUTTON and WIDGET_DRAW functions.

Set this keyword to a string that will be displayed when the cursor hovers over the specified widget. For UNIX platforms, this string must be non-zero in length, which means that a tooltip can be modified but not be removed on UNIX versions of IDL.

**Note**

Tooltips cannot be created for menu sub-items. The topmost button on a menu can, however, have a tooltip.

**Note**

If your application uses hardware rendering and a RETAIN setting of either zero or one, tooltips will cause draw widgets to generate expose events if the tooltip obscures the drawable area. This is true even if the tooltip is associated with another widget.

## TRACKING_EVENTS

This keyword applies to all widgets.

Set this keyword to a non-zero value to enable tracking events for the widget specified by *Widget_ID*. Set the keyword to 0 to disable tracking events for the specified widget. For a description of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNITS

This keyword applies to all widgets.

Use this keyword to specify the unit of measurement used for most widget sizing operations. Set UNITS equal to 0 to specify that all measurements are in pixels (this is the default), to 1 to specify that all measurements are in inches, or to 2 to specify that all measurements are in centimeters.

**Note**

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords to WIDGET_LIST, WIDGET_TABLE, or WIDGET_TEXT functions.

## UPDATE

This keyword applies to all widgets.

Use this keyword to enable (if set to 1) or disable (if set to 0) screen updates for the widget hierarchy to which the specified widget belongs. This keyword is useful for preventing unwanted intermediate screen updates when changing the values of many widgets at once or when adding several widgets to a previously-realized widget hierarchy. When first realized, widget hierarchies are set to update.

**Note**

Do not attempt to resize a widget on the Windows platform while UPDATE is turned off. Doing so may prevent IDL from updating the screen properly when UPDATE is turned back on.

## USE_TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to modify the behavior of the ALIGNMENT, COLUMN_WIDTHS, DELETE_COLUMNS, DELETE_ROWS, FORMAT, GET_VALUE, INSERT_COLUMNS, INSERT_ROWS, ROW_HEIGHTS, SET_VALUE, and TABLE_BLANK keywords. If USE_TABLE_SELECT is set, these other keywords only apply to the currently-selected cells. Normally, these keywords apply to the entire contents of a table widget.

**Note**

If either the title row or the title column of the table is selected, this keyword only modifies the behavior of the ROW_HEIGHTS or COLUMN_WIDTHS keywords.

**Warning**

The Microsoft Windows platform does not support the ROW_HEIGHTS keyword. Selecting the title row of a table via USE_TABLE_SELECT has no effect.

### Selection Modes

The table widget supports two *selection modes*:

- In *standard selection mode*, only a single selection can be created at a given time. Creating a new selection causes the existing selection to disappear.
- In *disjoint selection mode*, multiple selections can be created at one time. Creating a new selection does not cause the existing selection(s) to disappear. A table can be created in disjoint selection mode using either the DISJOINT_SELECTION keyword to WIDGET_TABLE or the TABLE_DISJOINT_SELECTION keyword to WIDGET_CONTROL.

The keywords listed above to generate different output or expect different input based on the selection mode. See the description of each keyword for details. For more information on table selection modes, see "Selection Modes" in Chapter 27 of the *Building IDL Applications* manual

### Specifying Selections Programmatically

In many cases, your code will use a selection created by the user manually, with the mouse. You can also create selections programmatically, by setting USE_TABLE_SELECT equal to an array.

- In standard selection mode, specify a four-element array, of the form [ *left, top, right, bottom* ] specifying the of cells to act upon.
- In disjoint selection mode, specify a 2 x *n* element array of column/row pairs specifying the cells to act upon.

Specifications for cell locations are zero-based (that is, the first data column is column number zero). The value -1 is used to refer to the title row or title column.

**Note**

Setting USE_TABLE_SELECT equal to an array does *not* change the current table selection. Operations affect the specified cells without changing the current selection.

is equivalent to first calling WIDGET_CONTROL and setting the SET_TABLE_SELECT keyword equal to an array, and then calling WIDGET_CONTROL with USE_TABLE_SELECT set equal to one.

### Example

To change the column widths of the title column and the first five data columns of a table widget named `wTable`, leaving the widths of the other columns unchanged:

```
WIDGET_CONTROL, wTable, USE_TABLE_SELECT=[-1,0,4,0], $
    COLUMN_WIDTHS=50
```

For additional examples, see "Using Table Widgets" in Chapter 27 of the *Building IDL Applications* manual.

## USE_TEXT_SELECT

This keyword applies to widgets created with the WIDGET_TABLE and WIDGET_TEXT functions.

Set this keyword to modify the behavior of the GET_VALUE and SET_VALUE keywords. If USE_TEXT_SELECT is set, GET_VALUE and SET_VALUE apply only to the current text selection. Normally, these keywords apply to the entire contents of a text widget.

## X_BITMAP_EXTRA

This keyword applies to widgets created with the WIDGET_BUTTON function.

When the value of a button widget is a bitmap, the usual width is taken to be 8 times the number of columns in the source byte array. This keyword can be used to indicate the number of bits in the last byte of each row that should be ignored. The value can range between 0 and 7.

## XOFFSET

This keyword applies to all widgets.

Set this keyword to an integer value that specifies the widget's new horizontal offset, in units specified by the UNITS keyword (pixels are the default). Attempting to change the offset of a widget that is the child of a ROW or COLUMN base or a widget that is part of a menubar or pulldown menu causes an error.

## XSIZE

This keyword applies to all widgets.

Set this keyword to an integer or floating-point value that represents the widget's new horizontal size.

- Text and List widgets: Size is specified in characters. The UNITS keyword is ignored.

- Table widgets: Size is specified in columns. The width of the row labels is automatically added to this value. The UNITS keyword is ignored.
- All other widgets: If the UNITS keyword is present, size is in the units specified. If the UNITS keyword is not present, the size is specified in pixels.

Note that [XY]SIZE sets client area and SCR_[XY]SIZE sets total area (title bar, borders, menu, client area). For scrollable widgets (e.g., scrolling bases and scrolling draw widgets), this keyword adjusts the *viewport* size. Use the DRAW_XSIZE keyword to change the width of the drawing area in scrolling draw widgets. Attempting to resize a widget that is part of a menubar or pulldown menu causes an error.

## YOFFSET

This keyword applies to all widgets.

Set this keyword to an integer value that specifies the widget's new vertical offset, in units specified by the UNITS keyword (pixels are the default). Attempting to change the offset of a widget that is the child of a ROW or COLUMN base or a widget that is part of a menubar or pulldown menu causes an error.

## YSIZE

This keyword applies to all widgets.

Set this keyword to an integer or floating-point value that represents the widget's new vertical size

- Text and List widgets: Size is specified in lines. The UNITS keyword is ignored.
- Table widgets: Size is specified in rows. The height of the column labels is automatically added to this value. The UNITS keyword is ignored.
- All other widgets: If the UNITS keyword is present, size is in the units specified. If the UNITS keyword is not present, the size is specified in pixels.

Note that [XY]SIZE sets client area and SCR_[XY]SIZE sets total area (title bar, borders, menu, client area). For scrollable widgets (e.g., scrolling bases and scrolling draw and table widgets), this keyword adjusts the *viewport* size. Use the DRAW_YSIZE keyword to change the height of the drawing area in scrolling draw widgets. Attempting to resize a widget that is part of a menubar or pulldown menu causes an error.

## Version History

Introduced: Pre 4.0

COMBOBOX_ADDITEM, COMBOBOX_DELETEITEM, COMBOBOX_INDEX, DRAW_KEYBOARD_EVENTS, SET_BUTTON, SET_COMBOBOX_SELECT, SET_TAB_CURRENT, SET_TAB_MULTILINE, SET_TREE_BITMAP, SET_TREE_EXPANDED, SET_TREE_SELECT, SET_TREE_VISIBLE, TABLE_BLANK, TABLE_DISJOINT_SELECTION, TLB_ICONIFY_EVENTS, TLB_MOVE_EVENTS, TLB_SIZE_EVENTS, TOOLTIP keywords added: 5.6

PUSHBUTTON_EVENTS keyword added: 6.0

## See Also

Chapter 27, “Widget Application Techniques” in the *Building IDL Applications* manual.

# WIDGET_DISPLAYCONTEXTMENU

The WIDGET_DISPLAYCONTEXTMENU procedure displays a *context-sensitive menu* (also known as a *pop-up* or *shortcut* menu). Context-sensitive menus appear when the user clicks the right mouse button over a widget for which a context menu is defined. Because the widget programmer must explicitly detect the right-mouse button click and call WIDGET_DISPLAYCONTEXTMENU to display the context menu, a widget can have any number of associated context menus, which can be displayed under different circumstances.

Context menus are created by placing one or more button widgets on a base widget constructed with the CONTEXT_MENU keyword set. The context menu's base widget must have as its parent a base, draw, list, or text widget; in the case of all but draw widgets, the parent widget must be configured to generate context menu events via the CONTEXT_EVENTS keyword. Draw widgets that support context menus must have the BUTTON_EVENTS keyword set.

The widget application's event handler routine must detect the presence of a context menu event (base, list, and text widgets) or the right mouse-button event (draw and property sheet widgets) and call WIDGET_DISPLAYCONTEXTMENU to display the context menu. Events generated when the user clicks on the context menu's buttons are handled in the normal way. If the user clicks outside the context menu, it is dismissed and no event is generated.

## Syntax

WIDGET_DISPLAYCONTEXTMENU, *Parent, X, Y, ContextBase_ID*

## Arguments

### Parent

The widget ID of the parent widget of the context menu widget.

**Note**

The parent widget must be either a base, list, or text widget with the CONTEXT_EVENTS keyword set or a draw widget with the BUTTON_EVENTS keyword set. In most cases the parent widget can be identified via the ID field of the WIDGET_CONTEXT or WIDGET_DRAW event structure.

### X

The x location, relative to the parent widget, at which the menu should be displayed. (In most cases this will be the x location of the user's right mouse-button click, as reported in the X field of the WIDGET_CONTEXT or WIDGET_DRAW event structure.)

### Y

The y location, relative to the parent widget, at which the menu should be displayed. (In most cases this will be the y location of the user's right mouse-button click, as reported in the Y field of the WIDGET_CONTEXT or WIDGET_DRAW event structure.)

### ContextBase_ID

The widget ID of the context menu base widget that contains the context menu to be displayed. Use the CONTEXT_MENU keyword to WIDGET_BASE to create a context menu base.

**Note**

The context menu base must be a child of the widget specified by the *Parent* argument.

## Keywords

None.

## Examples

For examples using WIDGET_DISPLAYCONTEXTMENU, see "Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

## Version History

Introduced: 5.5

# WIDGET_DRAW

The WIDGET_DRAW function is used to create draw widgets. Draw widgets are rectangular areas that IDL treats as standard graphics windows. Draw widgets can use either IDL Direct graphics or IDL Object graphics, depending on the value of the GRAPHICS_LEVEL keyword. Any graphical output that can be produced by IDL can be directed to a draw widget. Draw widgets can have optional scroll bars to allow viewing a larger graphics area than could otherwise be displayed in the widget's visible area.

The returned value of this function is the widget ID of the newly-created draw widget.

**Note**

On some systems, when backing store is provided by the window system (RETAIN=1), reading data from a window using TVRD( ) may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (RETAIN=2) ensures that the window contents will be read properly.

For a more detailed discussion of the draw widget, along with examples, see "Using Draw Widgets" in Chapter 27 of the *Building IDL Applications* manual.

## Syntax

*Result* = WIDGET_DRAW(*Parent* [, /APP_SCROLL] [, /BUTTON_EVENTS] [, /COLOR_MODEL] [, COLORS=*integer*] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, /EXPOSE_EVENTS] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, GRAPHICS_LEVEL=2] [, GROUP_LEADER=*widget_id*] [, KEYBOARD_EVENTS={1 | 2}] [, KILL_NOTIFY=*string*] [, /MOTION_EVENTS] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, RENDERER={0 | 1}] [, RESOURCE_NAME=*string*] [, RETAIN={0 | 1 | 2}] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SCROLL] [, /SENSITIVE] [, TOOLTIP=*string*] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, /VIEWPORT_EVENTS] [, XOFFSET=*value*] [, XSIZE=*value*] [, X_SCROLL_SIZE=*width*] [, YOFFSET=*value*] [, YSIZE=*value*] [, Y_SCROLL_SIZE=*height*] )

# Arguments

## Parent

The widget ID of the parent widget of the new draw widget.

# Keywords

## APP_SCROLL

Set this keyword to create a scrollable draw widget with horizontal and vertical scrollbars that allow the user to view portions of the widget contents that are not currently on the screen.

The drawable area of a draw widget created with the APP_SCROLL keyword is the same size as the viewable area (the *viewport*). This is useful for displaying very large images, because the memory used by a draw widget is directly related to the size of the drawable area. A draw widget created with the APP_SCROLL keyword also has the concept of a *virtual drawable area*, which is the size of the entire image. The fact that only a portion of the entire image is held in memory means that you must capture events generated when the user adjusts the scroll bars and display the correct portion of the image in your event-handling code.

**Note**

If the image you are displaying is relatively small or memory is not a concern, consider using the SCROLL keyword rather than APP_SCROLL. With SCROLL, the drawable area is the size of the entire image; this allows IDL to display the appropriate portions of the image automatically when the user adjusts the scroll bars. See "SCROLL" on page 2220 and "Scrolling Draw Widgets" in Chapter 27 of the *Building IDL Applications* manual for details.

Specify the size of the viewport using the X_SCROLL_SIZE and Y_SCROLL_SIZE keywords, and the size of the virtual drawable area using the XSIZE and YSIZE keywords. If APP_SCROLL is set, the application generates viewport events even if the VIEWPORT_EVENTS keyword is not set.

If the drawable area uses Direct Graphics (that is, if GRAPHICS_LEVEL is *not* set equal to 2), system backing store is used by default and the viewport is automatically restored after it has been obscured. If you prefer to manually restore the viewport in an event-handling routine, set RETAIN=0 and EXPOSE_EVENTS=1; this allows you to redraw the virtual canvas when your application receives expose events.

If the drawable area uses Object Graphics (that is, if the GRAPHICS_LEVEL keyword is set equal to 2), the application will *not* automatically restore the viewport, and will generate expose events as if RETAIN=0 and EXPOSE_EVENTS=1 had been set.

## BUTTON_EVENTS

Set this keyword to make the draw widget generate events when the mouse buttons are pressed or released (and the mouse pointer is in the draw widget). Normally, draw widgets do not generate events.

You can use the event structure generated when the BUTTON_EVENTS keyword is set to emulate the functionality of the CONTEXT_EVENTS keyword to WIDGET_BASE, WIDGET_LIST, and WIDGET_TEXT. To determine whether the user clicked the right mouse button, use the test:

```
IF (event.release EQ 4)
```

where `event` holds the widget event structure.

For more on detecting and handling context menu events, see "Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

## COLOR_MODEL

Set this keyword equal to 1 (one) to cause the draw widget's associated IDLgrWindow object to use indexed color. If the COLOR_MODEL keyword is not set, or is set to a value other than one, the draw widget will use RGB color.

This keyword is only valid when the draw widget uses IDL Object Graphics. (The graphics type used by a draw widget is determined by setting the GRAPHICS_LEVEL keyword to WIDGET_DRAW.)

## COLORS

The maximum number of color table indices to be used. This parameter has effect *only* if it is supplied when the *first* IDL graphics window is created.

If COLORS is not specified when the first window is created, all or most of the available color indices are allocated, depending upon the window system in use.

To use monochrome windows on a color display, set COLORS equal to 2 when creating the first window. One color table is maintained for all IDL windows. A negative value for COLORS specifies that all but the given number of colors from the shared color table should be used.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EXPOSE_EVENTS

Set this keyword to make the draw widget generate event when the visibility of the draw widget changes. This may occur when the widget is hidden behind something else on the screen, brought to the foreground, or when the scroll bars are moved. Normally, draw widgets do not generate events.

If this keyword is set, expose events will be generated only when IDL is unable to restore the contents of the window itself. After the initial draw, expose events are not issued when GRAPHICS_LEVEL=2 and the software renderer is being used (RENDERER=1). In such cases, expose events are not issued because IDL can internally refresh the window itself. On platforms for which OpenGL support is not offered, the software renderer is always being used, and therefore, expose events are not issued after the initial draw.

**Note**

When using hardware rendering, you must explicitly disable backing store (by setting RETAIN=0) in order to generate expose events. Additional expose events may be generated if both EXPOSE_EVENTS and RETAIN=1 are turned on.

**Warning**

Large numbers of events may be generated when EXPOSE_EVENTS is specified. You may wish to compress the events (perhaps using a timer) and only act on a subset.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a hint to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GRAPHICS_LEVEL

Set this keyword equal to 2 (two) to use IDL Object Graphics in the draw widget. If the GRAPHICS_LEVEL keyword is not set, or is set to a value other than two, the draw widget will use IDL Direct Graphics.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KEYBOARD_EVENTS

Set this keyword equal to 1 (one) or 2 to make the draw widget generate an event when it has the keyboard focus and a key is pressed or released. (The method by which a widget receives the keyboard focus is dependent on the window manager in use.) The value of the key pressed is reported in either the `CH` or the `KEY` field of the event structure, depending on the type of key pressed. See “Widget Events Returned by Draw Widgets” on page 2224 for details.

- If this keyword is set equal to 1, the draw widget will generate an event when a “normal” key is pressed. “Normal” keys include all keys except function keys and the modifier keys: SHIFT, CONTROL, CAPS LOCK, and ALT. If a modifier key is pressed at the same time as a normal key, the value of the modifier key is reported in the `MODIFIERS` field of the event structure.
- If this keyword is set equal to 2, the draw widget will generate an event when *either* a normal key or a modifier key is pressed. Values for modifier keys are reported in the `KEY` field of the event structure, and the `MODIFIERS` field contains zero.

**Note**

Keyboard events are never generated for function keys.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## MOTION_EVENTS

Set this keyword to make the draw widget generate events when the mouse cursor moves across the widget. Normally, draw widgets do not generate events.

Draw widgets that return motion events can generate a large number of events that can result in poor performance on slower machines.

Note that it is possible to generate motion events with coordinates outside the draw widget. If you position the mouse cursor inside the draw widget, press the mouse button, and drag the cursor out of the draw widget, the X and Y fields of the widget event will specify coordinates outside the draw widget.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a "set" operation (using the UVALUE keyword to WIDGET_DRAW or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a "get" operation (GET_UVALUE

keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RENDERER

Set this keyword to an integer value indicating which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation

By default, your platform's native OpenGL implementation is used. If your platform does not have a native OpenGL implementation, IDL's software implementation is used regardless of the value of this property. See "Hardware vs. Software Rendering" in Chapter 34 of the *Using IDL* manual for details. Your choice of renderer may also affect the maximum size of a draw widget. See "IDLgrWindow" on page 3705 for details.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 2139 for a complete discussion of this keyword.

## RETAIN

Set this keyword to 0, 1, or 2 to specify how backing store should be handled for the draw widget. RETAIN=0 specifies no backing store. RETAIN=1 requests that the server or window system provide backing store. RETAIN=2 specifies that IDL provide backing store directly. See "Backing Store" on page 2228 for details on the

use of RETAIN with Direct Graphics. For more information on the use of RETAIN with Object Graphics, see “IDLgrWindow::Init” on page 3729.

## SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SCROLL

Set this keyword to create a scrollable draw widget with horizontal and vertical scrollbars that allow the user to view portions of the widget contents that are not currently on the screen.

Specify the size of the viewport using the X_SCROLL_SIZE and Y_SCROLL_SIZE keywords, and the size of the entire drawable area using the XSIZE and YSIZE keywords.

**Note**

While the viewport of a draw widget created with the SCROLL keyword may be smaller than the entire image, the drawable area itself is the same size as the image, and uses memory commensurately. If you want to display a portion of a very large image, consider using the APP_SCROLL keyword rather than SCROLL. The drawable area of a draw widget created with APP_SCROLL is the same size as the viewport. This saves memory when the displayed image is large, but requires extra work on the programmer’s part to handle viewport events and display the appropriate portion of the image. See “APP_SCROLL” on page 2214 and “Scrolling Draw Widgets” in Chapter 27 of the *Building IDL Applications* manual for details.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse

cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## TOOLTIP

Set this keyword to a string that will be displayed when the cursor hovers over the widget. For UNIX platforms, this string must be non-zero in length.

**Note**

If your application uses hardware rendering and a RETAIN setting of either zero or one, tooltips will cause draw widgets to generate expose events if the tooltip obscures the drawable area. This is true even if the tooltip is associated with another widget.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a draw widget is the IDL window number for use with Direct Graphics routines, such as WSET. For Object Graphics routines, it is the draw window object reference. This value cannot be set or modified by the user.

To obtain the window number for a newly-created draw widget, use the GET_VALUE keyword to WIDGET_CONTROL *after* the draw widget has been realized. Draw widgets do not have a window number assigned to them until they are realized. For example, to return the window number of a draw widget in the variable *win_num*, use the command:

```
WIDGET_CONTROL, my_drawwidget, GET_VALUE = win_num
```

where *my_drawwidget* is the widget ID of the desired draw widget.

When using Object Graphics for the widget draw, the following command returns an object reference to the draw window:

```
WIDGET_CONTROL, my_drawwidget, GET_VALUE = oWindow
```

where *oWindow* is a window object.

## VIEWPORT_EVENTS

Set this keyword to enable viewport motion events for draw widgets.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a “hint” to the toolkit and may be ignored in some situations. By default, draw widgets are 100 pixels wide by 100 pixels high.

## X_SCROLL_SIZE

The XSIZE keyword always specifies the width of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the width of the visible area. The X_SCROLL_SIZE keyword allows you to set the width of the scrolling viewport independently of the actual width of the widget.

Use of the X_SCROLL_SIZE keyword implies SCROLL.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a hint to the toolkit and may be ignored in some situations. By default, draw widgets are 100 pixels wide by 100 pixels high.

## Y_SCROLL_SIZE

The YSIZE keyword always specifies the height of a widget. When the SCROLL keyword is specified, this size is not necessarily the same as the height of the visible area. The Y_SCROLL_SIZE keyword allows you to set the height of the scrolling viewport independently of the actual height of the widget.

Use of the Y_SCROLL_SIZE keyword implies SCROLL.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of draw widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DRAW_BUTTON_EVENTS, DRAW_EXPOSE_EVENTS, DRAW_KEYBOARD_EVENTS, DRAW_MOTION_EVENTS, DRAW_VIEWPORT_EVENTS, DRAW_XSIZE, DRAW_YSIZE, GET_DRAW_VIEW, GET_VALUE, INPUT_FOCUS, SET_DRAW_VIEW, TOOLTIP.

## Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to draw widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: DRAW_BUTTON_EVENTS, DRAW_EXPOSE_EVENTS, DRAW_KEYBOARD_EVENTS, DRAW_MOTION_EVENTS, DRAW_VIEWPORT_EVENTS, TOOLTIP.

## Widget Events Returned by Draw Widgets

By default, draw widgets do not generate events. If the BUTTON_EVENTS keyword is set when the widget is created, pressing or releasing any mouse button while the mouse cursor is over the draw widget causes events to be generated. Specifying the MOTION_EVENTS keyword causes events to be generated *continuously* as the mouse cursor moves across the draw widget. Specifying the EXPOSE_EVENTS keyword causes events to be generated whenever the visibility of any portion of the draw window (or viewport) changes. Specifying the KEYBOARD_EVENTS keyword causes events to be generated when the draw widget has keyboard focus and a keyboard key is pressed.

The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_DRAW, ID:0L, TOP:0L, HANDLER:0L, TYPE: 0, X:0L, Y:0L,
   PRESS:0B, RELEASE:0B, CLICKS:0, MODIFIERS:0L, CH:0, KEY:0L }
```

**Note**

If you defined your own {WIDGET_DRAW} structures prior to the IDL 5.3 release before the structure was defined by an internal call, the MODIFIERS field will break the existing user code.

**Note**

If you defined your own {WIDGET_DRAW} structures prior to the IDL 5.6 release before the structure was defined by an internal call, the CH and KEY fields will break the existing user code.

ID, TOP, and HANDLER are the three standard fields found in every widget event. TYPE returns a value that describes the type of draw widget interaction that generated an event. The values for TYPE are shown in the table below.

| Value | Meaning |
|---|---|
| 0 | Button Press |
| 1 | Button Release |
| 2 | Motion |
| 3 | Viewport Moved (Scrollbars) |
| 4 | Visibility Changed (Exposed) |
| 5 | Key Press (ASCII character value reported in CH field) |
| 6 | Key Press (Non-ASCII key value reported in KEY field) |

*Table 98: Values for the TYPE field*

The X and Y fields give the device coordinates at which the event occurred, measured from the lower left corner of the drawing area.

For button and “viewport moved” events (that is, when the TYPE field contains 0, 1, or 3), PRESS and RELEASE are bitmasks that represent which of the left, center, or right mouse button was pressed:

| Bitmask | Mouse Button |
|---|---|
| 1 | Left |
| 2 | Middle |
| 4 | Right |

*Table 99: Bitmask for the PRESS and RELEASE Fields during Button Events*

For motion events, both PRESS and RELEASE are zero. For keyboard events, PRESS contains 1 (one) if the key is down and 0 (zero) if it is up; RELEASE contains 0 (zero) if the key is down and 1 (one) if it is up.

**Note**

IDL obtains information about which mouse button was pressed from the operating system, not from the mouse hardware itself. This means that if the operating system or some extension thereof remaps the mouse buttons, IDL may receive information that one button was pressed even if a different physical button was pressed. For example, if a user remaps the mouse buttons to reverse left and right, and then presses the right physical mouse button, the widget event structure will reflect a left mouse button press.

The CLICKS field is set to either 1 or 2 if the if the event is a button press event. If the time interval between two button-press events is less than the time interval for a double-click event for the platform, the CLICKS field returns 2. If the time interval between button-press events is greater than the time interval for a double-click event for the platform, the CLICKS field returns 1. This means that if you are writing a widget application that requires the user to double-click on a draw widget, you will need to handle two events. The CLICKS field will return a 1 on the first click and a 2 on the second click. If the event is not a button press event, the CLICKS field contains a 0.

The MODIFIERS field is valid for button press, button release, motion, and “normal” keyboard events. It is a bitmask which returns the current state of several keyboard modifier keys at the time the event was generated. If a bit is zero, the key is up. If the bit is set, the key is depressed.

**Note**

“Normal” keyboard events are generated when the KEYBOARD_EVENTS keyword is set equal to one. If KEYBOARD_EVENTS is set equal to two, the keypress event for a modifier key contains zero in the `MODIFIERS` field and the key value is reported in the `KEY` field; see below.

The value in the MODIFIERS field is generated by OR-ing the following values together if a key is depressed.

| Bitmask | Modifier Key |
|---|---|
| 1 | Shift |
| 2 | Control |
| 4 | Caps Lock |
| 8 | Alt (See Note following this table.) |

*Table 100: Bitmask for the MODIFIERS Field*

**Note**

Under UNIX, the Alt key is the currently mapped MOD1 key.

Keyboard events are generated with the value of the TYPE field equal to 5 or 6. If the event was generated by an ASCII keyboard character, the TYPE field will be set to 5 and the ASCII value of the key will be returned in the CH field. (Note that ASCII values can be converted to the string representing the character using the IDL STRING routine.) If the event was generated due to a non-ASCII keyboard character, the type of the event will be set to 6 and a numeric value representing the key will be returned in the KEY field. The following table lists the possible values of the KEY field.

Note that for the key values reported in the KEY field for the SHIFT, CONTROL, CAPS LOCK, and ALT keys are not the same as those reported in the MODIFIER field bit mask, since the KEY field is not a bitmask.

| Key Field Value | Keyboard Key |
|---|---|
| 1 | Shift |
| 2 | Control |
| 3 | Caps Lock |
| 4 | Alt |
| 5 | Left |

*Table 101: Modifier key values reported in the KEY field.*

| Key Field Value | Keyboard Key |
|---|---|
| 6 | Right |
| 7 | Up |
| 8 | Down |
| 9 | Page Up |
| 10 | Page Down |
| 11 | Home |
| 12 | End |

*Table 101: Modifier key values reported in the KEY field. (Continued)*

### Note on using CURSOR

Note that the CURSOR procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain the cursor position and button state information from a draw widget, examine the X, Y, PRESS, and RELEASE fields in the structures returned by the draw widget in response to cursor events.

## Backing Store

Draw widgets with scroll bars rely on backing store to repaint the visible area of the window as it is moved. Their performance is best on systems that provide backing store. However, if your system does not automatically provide backing store, you can make IDL supply it with the statement:

```
DEVICE, RETAIN=2
```

or by using the RETAIN keyword to WIDGET_DRAW.

**Note**

If you are using graphics acceleration, you may wish to turn off backing store entirely and enable expose events (via the EXPOSE_EVENTS keyword) and redraw the draw widget's contents manually. However, because the number of events generated may be quite high, you may wish to enable a timer as well and only redraw the draw widget periodically.

## Version History

Introduced: Pre 4.0

KEYBOARD_EVENTS, TOOLTIP keywords added: 5.6

## See Also

SLIDE_IMAGE, WINDOW

# WIDGET_DROPLIST

The WIDGET_DROPLIST function creates “droplist” widgets. A droplist widget displays a text field and an arrow button. Selecting either the text field or the button reveals a list of options from which to choose. When the user selects a new option from the list, the list disappears and the text field displays the currently-selected option. This action generates an event containing the index of the selected item, which ranges from 0 to the number of elements in the list minus one.

**Note**

The WIDGET_COMBOBOX function creates a similar widget that optionally allows users to edit the text displayed by the droplist. The combobox widget is intended to replace the droplist widget; RSI recommends that new code use WIDGET_COMBOBOX rather than WIDGET_DROPLIST.

## Syntax

*Result* = WIDGET_DROPLIST( *Parent* [, /DYNAMIC_RESIZE]
[, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*]
[, FRAME=*value*] [, FUNC_GET_VALUE=*string*]
[, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, /NO_COPY]
[, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, /SENSITIVE] [, TITLE=*string*] [, /TRACKING_EVENTS] [, UNAME=*string*]
[, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*]
[, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created droplist widget.

## Arguments

### Parent

The widget ID of the parent widget for the new droplist widget.

# Keywords

## DYNAMIC_RESIZE

Set this keyword to create a widget that resizes itself to fit its new value whenever its value is changed. Note that this keyword does not take effect when used with the SCR_XSIZE, SCR_YSIZE, XSIZE, or YSIZE keywords. If one of these keywords is also set, the widget will be sized as specified by the sizing keyword and will never resize itself dynamically.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a hint to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_DROPLIST or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation

(GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 2139 for a complete discussion of this keyword.

## SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## TITLE

Set this keyword to a string to be used as the title for the droplist widget.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a droplist widget is a scalar string or array of strings that contains the text of the list items—one list item per array element. List widgets are sized based on the length (in characters) of the longest item specified in the array of values for the VALUE keyword.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

## XSIZE

The desired width of the droplist widget area, in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword does not control the size of the droplist button or of the dropped list. Instead, it controls the size “around” the droplist button and, as such, is not particularly useful.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

## YSIZE

The desired height of the widget, in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword does not control the size of the droplist button or of the dropped list. Instead, it controls the size “around” the droplist button and, as such, is not particularly useful.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of droplist widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DYNAMIC_RESIZE, GET_VALUE, SET_DROPLIST_SELECT, SET_VALUE.

## Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to droplist widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: DROPLIST_NUMBER, DROPLIST_SELECT, DYNAMIC_RESIZE.

## Widget Events Returned by Droplist Widgets

Pressing the mouse button while the mouse cursor is over an element of a droplist widget causes the widget to change the label on the droplist button and to generate an event. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{ WIDGET_DROPLIST, ID:0L, TOP:0L, HANDLER:0L, INDEX:0L }
```

The first three fields are the standard fields found in every widget event. INDEX returns the index of the selected item. This can be used to index the array of names originally used to set the widget's value.

**Note**

Platform-specific UI toolkits behave differently if a droplist widget has only a single element. On some platforms, selecting that element again does not generate an event. Events are always generated if the list contains multiple items.

## Version History

Introduced: 4.0

## See Also

CW_PDMENU, WIDGET_BUTTON, WIDGET_COMBOBOX, WIDGET_LIST

# WIDGET_EVENT

The WIDGET_EVENT function returns events for the widget hierarchy rooted at *Widget_ID*. Widgets communicate information by generating events. Events are generated when a button is pressed, a slider position is changed, and so forth.

**Note**

Widget applications should use the XMANAGER procedure in preference to calling WIDGET_EVENT directly. See "Widget Event Processing" in Chapter 26 of the *Building IDL Applications* manual.

## Event Processing

Events for a given widget are processed in the order that they are generated. The event processing performed by WIDGET_EVENT consists of the following steps, applied iteratively:

1. Wait for an event from one of the specified widgets to arrive.
2. Starting with the widget that generated the event, move up the widget hierarchy looking for a widget that has an associated event-handling procedure or function. Event-handling routines are associated with a widget via the EVENT_PRO and EVENT_FUNC keywords to the widget creation functions or the WIDGET_CONTROL procedure.
3. If an event-handling *procedure* is found, it is called with the event as its argument. The `HANDLER` field of the event is set to the widget ID of the widget associated with the handling procedure. When the procedure returns, WIDGET_EVENT returns to the first step above and starts searching for events. Hence, event-handling procedures are said to "swallow" events.
4. If an event-handling *function* is found, it is called with the event as its argument. The `HANDLER` field of the event is set to the widget ID of the widget associated with the handling function.

   When the function returns, its value is examined. If the value is not a structure, it is discarded and WIDGET_EVENT returns to the first step. This behavior allows event-handling functions to selectively act like event-handling procedures and "swallow" events.

   If the returned value is a structure, it is checked to ensure that it has the standard first three fields: `ID`, `TOP`, and `HANDLER`. If any of these fields is missing, IDL issues an error. Otherwise, the returned value replaces the event found in the first step and WIDGET_EVENT continues moving up the widget

hierarchy looking for another event handler routine, as described in step 2, above.

In situations where an event structure is returned, event functions are said to "rewrite" events. This ability to rewrite events is the basis of *compound widgets*, which combine several widgets to give the appearance of a single, more complicated widget. Compound widgets are an important widget programming concept. For more information, see "Compound Widgets" in Chapter 26 of the *Building IDL Applications* manual.

5. If an event reaches the top of a widget hierarchy without being swallowed by an event handler, it is returned as the value of WIDGET_EVENT.
6. If WIDGET_EVENT was called without an argument, and there are no widgets left on the screen that are being managed (as specified via the MANAGED keyword to the WIDGET_CONTROL procedure) and could generate events, WIDGET_EVENT ends the search and returns an *empty event* (a standard widget event structure with the top three fields set to zero).

**Note**

Do not interrupt the event loop by placing a STOP or EXIT command in the event-handler or other callback routine. The presence of either command will cause the widget routine to exit with an error.

# Syntax

*Result* = WIDGET_EVENT([*Widget_ID*]) [, BAD_ID=*variable*] [, /NOWAIT] [, /SAVE_HOURGLASS]

**UNIX Keywords:** [, /YIELD_TO_TTY]

# Return Value

A widget event is returned in a structure. The exact contents of this structure vary depending upon the type of widget involved. The first three elements of this structure, however, are always the same.

```
{ WIDGET, ID:0L, TOP:0L, HANDLER:0L, ... }
```

Any other elements vary from widget type to type. The three fixed elements are:

| Value | Meaning |
|---|---|
| ID | The widget ID of the widget that generated the event. |
| TOP | The widget ID of the top level base for the widget hierarchy containing `ID`. |
| HANDLER | When an event is passed as the argument to an event handling procedure or function, as discussed in the previous section, this field contains the identifier of the widget associated with the handler routine. When an event is returned from WIDGET_EVENT, this value is always zero to indicate that no handler routine was found. |

*Table 102: Common Event Structure Fields*

# Arguments

## Widget_ID

*Widget_ID* specifies the widget hierarchy for which events are desired. The first available event for the specified widget or any of its children is returned. If this argument is not specified, WIDGET_EVENT processes events for all existing widgets.

*Widget_ID* can also be an array of widget identifiers, in which case all of the specified widget hierarchies are searched.

**Note**

Attempting to obtain events for a widget hierarchy which is not producing events will hang IDL, unless the NOWAIT keyword is used.

# Keywords

## BAD_ID

If one of the values supplied via *Widget_ID* is not a valid widget identifier, this function normally issues an error and causes program execution to stop. However, if BAD_ID is present and specifies a named variable, the invalid ID is stored into the variable, and this routine quietly returns. If no error occurs, a zero is stored.

This keyword can be used to handle the situation in which IDL is waiting within WIDGET_EVENT when the user kills the widget hierarchy.

This keyword has meaning only if *Widget_ID* is explicitly specified.

### NOWAIT

When no events are currently available for the specified widget hierarchy, WIDGET_EVENT normally waits until one is available and then returns it. However, if NOWAIT is set and no events are present, it immediately returns. In this case, the ID field of the returned structure will be zero.

### SAVE_HOURGLASS

Set this keyword to prevent the hourglass cursor from being cleared by WIDGET_EVENT. This keyword can be of use if a program has to poll a widget periodically during a long computation.

### YIELD_TO_TTY (UNIX Only)

Unless the NOWAIT keyword is specified, WIDGET_EVENT does not return until the asked for event is available. If the user should enter a line of input from the keyboard, it cannot be processed until WIDGET_EVENT returns. If the YIELD_TO_TTY keyword is specified and the user enters a line of input, WIDGET_EVENT returns immediately. In this case, the ID field of the returned structure will be zero.

**Note**

This keyword is supported under UNIX only, and there are no plans to extend it to other operating systems. Do not use it if you intend to use non-UNIX systems.

## Version History

Introduced: Pre 4.0

## See Also

XMANAGER

# WIDGET_INFO

The WIDGET_INFO function is used to obtain information about the widget subsystem and individual widgets. The specific area for which information is desired is selected by setting the appropriate keyword.

## Syntax

*Result* = WIDGET_INFO( [*Widget_ID*] )

**Keywords that apply to all widgets:** [, /ACTIVE] [, /CHILD] [, /EVENT_FUNC] [, /EVENT_PRO] [, FIND_BY_UNAME=*string*] [, /FONTNAME] [, /GEOMETRY] [, /KBRD_FOCUS_EVENTS] [, /MANAGED] [, /MAP] [, /NAME] [, /PARENT] [, /REALIZED] [, /SENSITIVE] [, /SIBLING] [, /SYSTEM_COLORS] [, /TRACKING_EVENTS] [, /TYPE] [, UNITS={0 | 1 | 2}] [, /UNAME] [, /UPDATE] [, /VALID_ID] [, /VERSION] [, /VISIBLE]

**Keywords that apply to widgets created with WIDGET_BASE:** [, /CONTEXT_EVENTS] [, /MODAL] [, /TLB_ICONIFY_EVENTS] [, /TLB_KILL_REQUEST_EVENTS] [, /TLB_MOVE_EVENTS] [, /TLB_SIZE_EVENTS]

**Keywords that apply to widgets created with WIDGET_BUTTON:** [, /BUTTON_SET] [, /DYNAMIC_RESIZE] [, /PUSHBUTTON_EVENTS] [, /TOOLTIP]

**Keywords that apply to widgets created with WIDGET_COMBOBOX:** [, /COMBOBOX_GETTEXT] [, /COMBOBOX_NUMBER] [, /DYNAMIC_RESIZE]

**Keywords that apply to widgets created with WIDGET_DRAW:** [, /DRAW_BUTTON_EVENTS] [, /DRAW_EXPOSE_EVENTS] [, DRAW_KEYBOARD_EVENTS={0 | 1 | 2}] [, /DRAW_MOTION_EVENTS] [, /DRAW_VIEWPORT_EVENTS] [, /TOOLTIP]

**Keywords that apply to widgets created with WIDGET_DROPLIST:** [, /DROPLIST_NUMBER] [, /DROPLIST_SELECT] [, /DYNAMIC_RESIZE]

**Keywords that apply to widgets created with WIDGET_LABEL:** [, /DYNAMIC_RESIZE]

**Keywords that apply to widgets created with WIDGET_LIST:** [, /CONTEXT_EVENTS] [, /LIST_MULTIPLE] [, /LIST_NUMBER] [, /LIST_NUM_VISIBLE] [, /LIST_SELECT] [, /LIST_TOP]

**Keywords that apply to widgets created with WIDGET_PROPERTYSHEET:**
[, COMPONENT=*objref*] [, /PROPERTY_VALID] [, /PROPERTY_VALUE]

**Keywords that apply to widgets created with WIDGET_SLIDER:**
[, /SLIDER_MIN_MAX]

**Keywords that apply to widgets created with WIDGET_TAB:**
[, /TAB_CURRENT] [, /TAB_MULTILINE] [, /TAB_NUMBER]

**Keywords that apply to widgets created with WIDGET_TABLE:**
[, /COLUMN_WIDTHS] [, /ROW_HEIGHTS{not supported in Windows}]
[, /TABLE_ALL_EVENTS] [, /TABLE_DISJOINT_SELECTION]
[, /TABLE_EDITABLE] [, /TABLE_EDIT_CELL] [, /TABLE_SELECT]
[, /TABLE_VIEW] [, /USE_TABLE_SELECT]

**Keywords that apply to widgets created with WIDGET_TEXT:**
[, /CONTEXT_EVENTS] [, /TEXT_ALL_EVENTS] [, /TEXT_EDITABLE]
[, /TEXT_NUMBER] [, TEXT_OFFSET_TO_XY=*integer*] [, /TEXT_SELECT]
[, /TEXT_TOP_LINE] [, TEXT_XY_TO_OFFSET=*[column, line]*]

**Keywords that apply to widgets created with WIDGET_TREE:**
[, /TREE_EXPANDED] [, /TREE_ROOT] [, /TREE_SELECT]

# Return Value

Returns the specified information for the given widget ID. If the SYSTEM_COLORS keyword is specified, a structure is returned. See "The WIDGET_SYSTEM_COLORS Structure" on page 2259 for details.

# Arguments

## Widget_ID

Usually this argument should be the widget ID of the widget for which information is desired. If the ACTIVE or VERSION keywords are specified, this argument is not required.

*Widget_ID* can also be an array of widget identifiers, in which case the result is an array with the same structure in which information on all the specified widgets is returned.

# Keywords

Not all keywords to WIDGET_INFO apply to all combinations of widgets. In the following list, descriptions of keywords that affect only certain types of widgets include a list of the widgets for which the keyword is useful.

## ACTIVE

This keyword applies to all widgets.

Set this keyword to return 1 if there is at least one realized, managed, top-level widget on the screen. Otherwise, 0 is returned.

## BUTTON_SET

This keyword applies to widgets created with the WIDGET_BUTTON function.

Set this keyword to return the “set” state of a widget button. If the button is currently set, 1 (one) is returned. If the button is currently not set, 0 (zero) is returned. This keyword is intended for use with exclusive, non-exclusive and checked menu buttons.

## CHILD

This keyword applies to all widgets.

Set this keyword to return the widget ID of the first child of the widget specified by *Widget_ID*. If the widget has no children, 0 is returned.

## COLUMN_WIDTHS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return an array of long integers giving the width of each column in the table. If USE_TABLE_SELECT is set equal to one, only the column widths for columns that contain currently-selected cells are returned. If USE_TABLE_SELECT is set equal to an array, only the column widths for columns that contain specified cells are returned.

## COMBOBOX_GETTEXT

This keyword applies to widgets created with the WIDGET_COMBOBOX function.

Set this keyword to return the current text from the text box of the specified combobox widget. Note that when using an editable combobox, the text displayed in the text box may not be an item from the list of values in the combobox list. To obtain

the index of the selected item, inspect the INDEX field of the event structure returned by the combobox widget.

## COMBOBOX_NUMBER

This keyword applies to widgets created with the WIDGET_COMBOBOX function.

Set this keyword to return the number of elements currently contained in the list of the specified combobox widget.

## COMPONENT

This keyword applies to widgets created with the WIDGET_PROPERTYSHEET function. Set this keyword to an object reference to indicate which object to query. This is most useful when the property sheet references multiple objects. If this keyword is not specified, the first (possibly only) object is queried.

## CONTEXT_EVENTS

This keyword applies to widgets created with the WIDGET_BASE, WIDGET_LIST, or WIDGET_TEXT functions.

Set this keyword to return 1 (one) if the widget specified by *Widget_ID* is configured to generate context events (that is, the widget was created with the CONTEXT_EVENTS keyword). Otherwise, 0 (zero) is returned.

## DRAW_BUTTON_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the BUTTON_EVENTS attribute set. Otherwise, 0 is returned.

## DRAW_EXPOSE_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the EXPOSE_EVENTS attribute set. Otherwise, 0 is returned.

## DRAW_KEYBOARD_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return an integer specifying the type of keyboard events currently generated by the draw widget specified by *Widget_ID*. Possible values are:

- 0: No keyboard events are generated

- 1: Keyboard events are generated for “normal” keys (all keys except function keys and modifier keys: SHIFT, CONTROL, CAPS LOCK, and ALT).
- 2: Keyboard events are generated for “normal” keys and modifier keys.

**Note**

Keyboard events are never generated for function keys.

## DRAW_MOTION_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the MOTION_EVENTS attribute set. Otherwise, 0 is returned.

## DRAW_VIEWPORT_EVENTS

This keyword applies to widgets created with the WIDGET_DRAW function.

Set this keyword to return 1 if *Widget_ID* is a draw widget with the VIEWPORT_EVENTS attribute set. Otherwise, 0 is returned.

## DROPLIST_NUMBER

This keyword applies to widgets created with the WIDGET_DROPLIST function.

Set this keyword to return the number of elements currently contained in the specified droplist widget.

## DROPLIST_SELECT

This keyword applies to widgets created with the WIDGET_DROPLIST function.

Set this keyword to return the zero-based number of the currently-selected element (i.e., the currently-displayed element) in the specified droplist widget.

## DYNAMIC_RESIZE

This keyword applies to widgets created with the WIDGET_BUTTON, WIDGET_COMBOBOX, WIDGET_DROPLIST, and WIDGET_LABEL functions.

Set this keyword to return a True value (1) if the widget specified by *Widget_ID* is a button, droplist, or label widget that has had its DYNAMIC_RESIZE attribute set. Otherwise, False (0) is returned.

## EVENT_FUNC

This keyword applies to all widgets.

Set this keyword to return a string containing the name of the event handler function associated with *Widget_ID*. A null string is returned if no event handler function exists.

## EVENT_PRO

This keyword applies to all widgets.

Set this keyword to return a string containing the name of the event handler procedure associated with *Widget_ID*. A null string is returned if no event handler procedure exists.

## FIND_BY_UNAME

This keyword applies to all widgets.

Set this keyword to a UNAME value that will be searched for in the widget hierarchy, and if a widget with the given UNAME is in the hierarchy, its ID is returned. The search starts in the hierarchy with the given widget ID and travels down, and this keyword returns the widget ID of the first widget that has the specified UNAME value.

If a widget is not found, 0 is returned.

## FONTNAME

This keyword applies to all widgets.

Set this keyword to return a string containing the name of the font being used by the specified widget. The returned name can then be used when creating other widgets or with the SET_FONT keyword to the DEVICE procedure. If fonts are not supported by the specified widget, an empty string is returned.

Note that you can use this keyword to retrieve the name of the *default* font used by one type of widget and use the same font in other contexts. For example, the following code retrieves the default font used for buttons and writes into the drawable area of a draw widget using the same font:

```
wBase = WIDGET_BASE(/ROW)
wButton = WIDGET_BUTTON(wBase, VALUE="Button")
wDraw = WIDGET_DRAW(wBase, XSIZE=200, YSIZE=100)
WIDGET_CONTROL, wBase, /REALIZE
strFont = WIDGET_INFO(wButton, /FONTNAME)
DEVICE, SET_FONT=strFont
```

```
WIDGET_CONTROL, wDraw, GET_VALUE=iWindow
WSET, iWindow
XYOUTS, 100, 50, 'Same Font as Button', FONT=0, /DEVICE, $
   ALIGNMENT=.5
```

This method allows you to synchronize the fonts in several widgets without knowing in advance which font is in use.

The format of the returned font name is platform dependent. See "About Device Fonts" on page 3962 for additional details.

## GEOMETRY

This keyword applies to all widgets.

**Note**

Some widgets have no geometry values of their own. For example, only the root node of a tree widget hierarchy has associated geometry values. Similarly, buttons created on a pop-up menu have no geometry. Widgets with no intrinsic geometry values will return a WIDGET_GEOMETRY structure containing all zeroes.

Set this keyword to return a WIDGET_GEOMETRY structure that describes the offset and size information for the widget specified by *Widget_ID*. This structure has the following definition:

```
{ WIDGET_GEOMETRY,
   XOFFSET:0.0,
   YOFFSET:0.0,
   XSIZE:0.0,
   YSIZE:0.0,
   SCR_XSIZE:0.0,
   SCR_YSIZE:0.0,
   DRAW_XSIZE:0.0,
   DRAW_YSIZE:0.0,
   MARGIN:0.0,
   XPAD:0.0,
   YPAD:0.0,
   SPACE:0.0 }
```

With the exception of MARGIN, all of the structure's fields correspond to the keywords of the same name to the various widget routines. MARGIN is the width of any frame added to the widget, in units specified by the UNITS keyword (pixels are the default). Therefore, the actual width of any widget is:

```
SCR_XSIZE + (2* MARGIN)
```

The actual height of any widget is:

```
SCR_YSIZE + (2 * MARGIN)
```

**Note**

Different window managers may use different *window dressing* (borders, margins, scrollbars, *etc*.). As a result, running a given segment of widget code on different platforms may yield different geometry.

## KBRD_FOCUS_EVENTS

This keyword applies to all widgets.

Set this keyword to return the keyboard focus events status of the widget specified by *Widget ID*. WIDGET_INFO returns 1 (one) if keyboard focus events are currently enabled for the widget, or 0 (zero) if they are not. Only base, table, and text widgets can generate keyboard focus events.

## LIST_MULTIPLE

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword equal to a named variable that will contain a non-zero value if the list widget supports multiple item selections. See the MULTIPLE keyword to WIDGET_LIST for more on multiple item selections.

## LIST_NUMBER

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the number of elements currently contained in the specified list widget.

## LIST_NUM_VISIBLE

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the number of elements that can be visible in the scrolling viewport of the specified list widget. Note that this value can be larger than the total number of elements actually in the list.

## LIST_SELECT

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the index or indices of the currently-selected (highlighted) element or elements in the specified list widget. Note that this offset is zero-based. If no element is currently selected, -1 is returned.

## LIST_TOP

This keyword applies to widgets created with the WIDGET_LIST function.

Set this keyword to return the zero-based offset of the topmost element currently visible in the specified list widget.

## MANAGED

This keyword applies to all widgets.

Set this keyword to return 1 if the specified widget is managed, or 0 otherwise. If no widget ID is specified in the call to WIDGET_INFO, the return value will be an array containing the widget IDs of all currently-managed widgets.

## MAP

This keyword applies to all widgets.

Set this keyword to return True (1) if the widget specified by *Widget_ID* is mapped (visible), or False (0) otherwise. Note that when a base widget is unmapped, all of its children are unmapped. If WIDGET_INFO reports that a particular widget is unmapped, it may be because a parent in the widget hierarchy has been unmapped.

## MODAL

This keyword applies to widgets created with the WIDGET_BASE function and the MODAL keyword.

If this keyword is set, WIDGET_INFO will return True (1) if the base widget specified by *Widget_ID* is a modal base widget, or False (0) otherwise.

## NAME

This keyword applies to all widgets.

Set this keyword to return the widget type name of the widget specified by *Widget_ID*. The returned value will be one of the following strings: “BASE”, “BUTTON”, “COMBOBOX”, “DRAW”, “DROPLIST”, “LABEL”, “LIST”, “PROPERTYSHEET”, “SLIDER”, “TAB”, “TABLE”, “TEXT”, or “TREE”. Set the TYPE keyword to return the widget’s type code.

## PARENT

This keyword applies to all widgets.

Set this keyword to return the widget ID of the parent of the widget specified by *Widget_ID*. If the widget is a top-level base (i.e., it has no parent), 0 is returned.

## PROPERTY_VALID

This keyword applies to widgets created with the WIDGET_PROPERTYSHEET function. Set this keyword to a string to determine if the string identifies a property. Valid identifiers return 1 and invalid strings return 0. Comparisons are case insensitive.

Operations are performed on properties through unique identifiers. This operation is not required when processing a change event because the identifier returned in the event structure can be assumed to be correct.

## PROPERTY_VALUE

This keyword applies to widgets created with the WIDGET_PROPERTYSHEET function. Retrieves the value of an identified property from a property sheet and returns it as a temporary IDL variable. Set this keyword to a string that is a valid property identifier in order to return the value of the specified property. This value can then be used to set the actual value of the component's property—the property sheet does not automatically do this. When there are multiple components, use the COMPONENT keyword to indicate which component should be queried. The match is case insensitive. An invalid identifier throws an error.

This keyword is very often used in response to property sheet change events. This is because the property sheet does not change the underlying component; it only informs the widget program which of its own values have changed. The IDL programmer can use PROPERTY_VALUE to retrieve the user's desired value (as cached in the property sheet) and then apply it to the component. The following snippet of code handles property sheet change events:

```
PRO prop_event, e

; get the value of e.component's property identified by
; e.identifier
value = WIDGET_INFO( e.id, $
COMPONENT = e.component, $
PROPERTY_VALUE = e.identifier )

; set the component's property's value
e.component -> SetPropertyByIdentifier, $
   e.identifier, value

END
```

## PUSHBUTTON_EVENTS

This keyword applies to widgets created with the WIDGET_BUTTON function.

Set this keyword to return the pushbutton events status for the widget specified by *Widget_ID*. WIDGET_INFO returns 1 if pushbutton events are currently enabled for the widget, or 0 otherwise.

## REALIZED

This keyword applies to all widgets.

Set this keyword to return 1 if the widget specified by *Widget_ID* has been realized. If the widget has not been realized, 0 is returned.

## ROW_HEIGHTS

This keyword applies to widgets created with the WIDGET_TABLE function.

**Note**

This keyword is not supported under Microsoft Windows.

Set this keyword to return an array of long integers giving the height of each row in the table. If USE_TABLE_SELECT is set equal to one, only the row heights for rows that contain currently-selected cells are returned. If USE_TABLE_SELECT is set equal to an array, only the row heights for rows that contain specified cells are returned.

## SENSITIVE

This keyword applies to all widgets.

Set this keyword to return True (1) if the widget specified by *Widget_ID* is sensitive (enabled), or False (0) otherwise. Note that when a base is made insensitive, all its children are made insensitive. If WIDGET_INFO reports that a particular widget is insensitive, it may be because a parent in the widget hierarchy has been made insensitive.

## SIBLING

This keyword applies to all widgets.

Set this keyword to return the widget ID of the first sibling of the widget specified by *Widget_ID*. If the widget is the last sibling in the chain, 0 is returned.

## SLIDER_MIN_MAX

This keyword applies to widgets created with the WIDGET_SLIDER function.

Set this keyword to return the current minimum and maximum values of the specified slider as a two-element integer array. Element 0 is the minimum value and element 1 is the maximum value.

## SYSTEM_COLORS

This keyword applies to all widgets.

Set this keyword and supply the widget ID of any widget to cause WIDGET_INFO to return an IDL structure that contains RGB values used for 25 IDL display elements.

For more detailed information on the WIDGET_SYSTEM_COLORS structure fields and their meaning see the "The WIDGET_SYSTEM_COLORS Structure" on page 2259.

## TAB_CURRENT

This keyword applies to widgets created with the WIDGET_TAB function.

Set this keyword to return the zero-based index of the current tab in the tab widget.

## TAB_MULTILINE

This keyword applies to widgets created with the WIDGET_TAB function.

Set this keyword to return the current setting of the multi-line mode for the tab widget.

## TAB_NUMBER

This keyword applies to widgets created with the WIDGET_TAB function.

Set this keyword to return the number of tabs contained in the tab widget.

## TABLE_ALL_EVENTS

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return 1 (one) if *Widget_ID* is a table widget with the ALL_EVENTS attribute set. Otherwise, 0 (zero) is returned.

## TABLE_DISJOINT_SELECTION

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return 1 (one) if the widget specified by *Widget_ID* has disjoint selection enabled. Otherwise, 0 (zero) is returned.

## TABLE_EDITABLE

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return 1 (one) if *Widget_ID* is a table widget that allows user editing of its contents. Otherwise, 0 (zero) is returned.

## TABLE_EDIT_CELL

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return a two-element integer array containing the row and column coordinates of the currently editable cell. If none of the cells in the table widget is currently editable, the array [-1, -1] is returned.

## TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return the currently-selected (highlighted) cells in the specified table widget.

- In standard selection mode, this keyword returns an array of the form [ *left*, *top*, *right*, *bottom* ] containing the zero-based indices of the columns and rows that define the selection.
- In disjoint selection mode (enabled by setting the DISJOINT_SELECTION keyword to WIDGET_TABLE), this keyword returns a 2 x *n* array of column/row pairs containing the zero-based indices the selected cells.

## TABLE_VIEW

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to return a two-element array of the form [*left*, *top*] containing the zero-based offsets of the top-left cell currently visible in the specified table widget.

## TEXT_ALL_EVENTS

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return 1 if *Widget_ID* is a text widget with the ALL_EVENTS attribute set. Otherwise, 0 is returned.

## TEXT_EDITABLE

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return 1 if *Widget_ID* is a text widget that allows user editing of its contents. Otherwise, 0 is returned.

## TEXT_NUMBER

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return the number of characters currently contained in the specified text widget, including end-of-line characters.

**Note**

On Windows platforms, Carriage Return/Line Feed pairs count as a single character.

## TEXT_OFFSET_TO_XY

This keyword applies to widgets created with the WIDGET_TEXT function.

Use this keyword to translate a text widget character offset into column and line form. The value of this keyword should be set to the character offset (an integer) to be translated. WIDGET_INFO returns a two-element integer array giving the column (element 0) and line (element 1) corresponding to the offset. If the offset specified is out of range, the array [-1,-1] is returned.

## TEXT_SELECT

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return the starting character offset and length (in characters) of the selected (highlighted) text in the specified text widget. WIDGET_INFO returns a two-element integer array containing the starting position of the highlighted text as an offset from character zero of the text in the widget (element 0), and length of the current selection (element 1).

## TEXT_TOP_LINE

This keyword applies to widgets created with the WIDGET_TEXT function.

Set this keyword to return the zero-based line number of the line currently at the top of a text widget's display viewport. Note that this value is different from the zero-based character offset of the characters in the line. The character offset can be calculated from the line offset via the TEXT_XY_TO_OFFSET keyword.

## TEXT_XY_TO_OFFSET

This keyword applies to widgets created with the WIDGET_TEXT function.

Use this keyword to translate a text widget position given in line and column form into a character offset. The value of this keyword should be set to a two-element integer array specifying the column (element 0) and line (element 1) position. WIDGET_INFO returns the character offset (as a longword integer) corresponding to the position. If the position specified is out of range, -1 is returned.

## TLB_ICONIFY_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to return 1 if the top-level base widget specified by *Widget_ID* is set to return iconify events. Otherwise, 0 is returned.

## TLB_KILL_REQUEST_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to return 1 if the top-level base widget specified by *Widget_ID* is set to return kill request events. Otherwise, 0 is returned.

## TLB_MOVE_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to return 1 if the top-level base widget specified by *Widget_ID* is set to return move events. Otherwise, 0 is returned.

## TLB_SIZE_EVENTS

This keyword applies to widgets created with the WIDGET_BASE function.

Set this keyword to return 1 if the top-level base widget specified by *Widget_ID* is set to return resize events. Otherwise, 0 is returned.

## TOOLTIP

This keyword applies to widgets created with the WIDGET_BUTTON and WIDGET_DRAW functions.

Set this keyword to have the WIDGET_INFO function return the text of the tooltip of the widget. If the widget does not have a tooltip, a null string will be returned.

## TRACKING_EVENTS

This keyword applies to all widgets.

Set this keyword to return the tracking events status for the widget specified by *Widget_ID*. WIDGET_INFO returns 1 if tracking events are currently enabled for the widget. Otherwise, 0 is returned.

## TREE_EXPANDED

This keyword applies to widgets created with the WIDGET_TREE function.

Set this keyword to return 1 (one) if the specified tree widget node is a folder that is expanded, or 0 (zero) if the specified node is a folder that is collapsed.

**Note**

Only tree widget nodes created with the FOLDER keyword can be expanded or collapsed. This keyword will always return 0 (zero) if the specified tree widget node is not a folder.

## TREE_ROOT

This keyword applies to widgets created with the WIDGET_TREE function.

Set this keyword to return the widget ID of the *root node* of the tree widget hierarchy of which *Widget ID* is a part. The root node is the tree widget whose parent is a base widget.

## TREE_SELECT

This keyword applies to widgets created with the WIDGET_TREE function.

Set this keyword to return information about the nodes selected in the specified tree widget. This keyword has two modes of operation, depending on the widget ID passed to WIDGET_INFO:

- If the specified widget ID is for the root node of the tree widget (the tree widget whose *Parent* is a base widget), this keyword returns either the widget ID of the selected node or (if multiple nodes are selected) an array of widget IDs of the selected nodes. If no nodes are selected, -1 is returned.
- If the specified widget ID is a tree widget that is a node in a tree, this keyword returns 1 (one) if the node is selected or 0 (zero) if it is not selected.

## TYPE

This keyword applies to all widgets.

Set this keyword to return the type code of the specified *Widget_ID*. Possible values are given the following table. Note that you can set the NAME keyword to return string names instead.

| Value | Type |
|---|---|
| 0 | Base |
| 1 | Button |
| 2 | Slider |
| 3 | Text |
| 4 | Draw |
| 5 | Label |
| 6 | List |
| 8 | Droplist |
| 9 | Table |
| 10 | Tab |
| 11 | Tree |
| 12 | Combobox |

*Table 103: Widget Type Codes*

## UNAME

This keyword applies to all widgets.

Set this keyword to have the WIDGET_INFO function return the user name of the widget.

## UNITS

This keyword applies to all widgets.

Use this keyword to specify the unit of measurement used when returning dimensions for most widget types. Set UNITS equal to 0 (zero) to specify that all measurements

are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

**Note**

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when retrieving the XSIZE or YSIZE of a WIDGET_LIST, WIDGET_TABLE, or WIDGET_TEXT functions.

## UPDATE

This keyword applies to all widgets.

Set this keyword to return 1 if the widget hierarchy that contains *Widget_ID* is set to display updates. Otherwise, 0 is returned. See "UPDATE" on page 2206.

## USE_TABLE_SELECT

This keyword applies to widgets created with the WIDGET_TABLE function.

Set this keyword to modify the behavior of the COLUMN_WIDTHS and ROW_HEIGHTS keywords. If USE_TABLE_SELECT is set, the COLUMN_WIDTHS and ROW_HEIGHTS keywords only apply to the currently-selected cells. Normally, these keywords apply to the entire contents of a table widget.

The USE_TABLE_SELECT keyword can also be specified as a four-element array, of the form [*left*, *top*, *right*, *bottom*], giving the group of cells to act on. In this usage, the value -1 is used to refer to the row or column titles.

## VALID_ID

This keyword applies to all widgets.

Set this keyword to return 1 if *Widget_ID* represents a currently-valid widget. Otherwise, 0 is returned.

## VERSION

This keyword applies to all widgets.

Set this keyword to return a structure that gives information about the widget implementation. This structure has the following definition:

```
{ WIDGET_VERSION, STYLE:'', TOOLKIT:'', RELEASE:'' }
```

`STYLE` is the style of widget toolkit used. `TOOLKIT` is the implementation of the toolkit. `RELEASE` is the version level of the toolkit. This field can be used to

distinguish between different releases of a given toolkit, such as Motif 1.0 and Motif 1.1.

### VISIBLE

This keyword applies to all widgets.

Set this keyword to return True (1) if the widget specified by *Widget_ID* is visible, or False (0) otherwise. A widget is visible if:

- it has been realized,
- it and all of its ancestors are mapped.

**Note**

The value returned by WIDGET_INFO when this keyword is set is not affected if the widget is minimized or obscured by another window. Widgets that are visible in the sense of this keyword may not be immediately apparent to a person viewing a particular display device.

## The WIDGET_SYSTEM_COLORS Structure

When the SYSTEM_COLORS keyword is specified in a call to WIDGET_INFO, IDL returns a WIDGET_SYSTEM_COLORS structure. This allows application developers to determine what colors are used in IDL application widgets, so they can design widgets for their application with the same look and feel as the supplied IDL widgets.

The WIDGET_SYSTEM_COLORS structure consists of 25 fields, each containing a three-element vector corresponding to the Red, Green, and Blue color values used for various widget elements. The vector elements are integers ranging between 0 and 255 if a color value is available (vector elements contain –1 if the color value is unavailable). The field names and meaning on the Windows and UNIX operating systems are shown in the following table.

| Field Names | Windows Platform | UNIX Platform |
|---|---|---|
| DARK_SHADOW_3D | Dark shadow color for 3D display elements. | N/A |

*Table 104: WIDGET_SYSTEM_COLORS Structure Fields*

| Field Names | Windows Platform | UNIX Platform |
|---|---|---|
| FACE_3D | Face color for 3D display elements and dialog boxes. | Base background color for all widgets. |
| LIGHT_EDGE_3D | Highlight color for 3D edges that face the light source. | Color of top and left edges of 3D widgets. |
| LIGHT_3D | Light color for 3D display elements. | Color of highlight rectangle around widgets with the keyboard focus. |
| SHADOW_3D | Color for 3D edges that face away from the light source. | Color of bottom and right edges of 3D widgets. |
| ACTIVE_BORDER | Active window's border color. | Push button background color when button is armed. |
| ACTIVE_CAPTION | Active window's caption color. | N/A |
| APP_WORKSPACE | Background color of MDI applications. | N/A |
| DESKTOP | Desktop color. | N/A |
| BUTTON_TEXT | Text color on push buttons. | Widget text color. |
| CAPTION_TEXT | Color of text in caption, size box, and scroll bar arrow box. | Widget text color. |
| GRAY_TEXT | Color of disabled text. | N/A |
| HIGHLIGHT | Color of item(s) selected in a widget. | Toggle button fill color. |

*Table 104: WIDGET_SYSTEM_COLORS Structure Fields (Continued)*

| Field Names | Windows Platform | UNIX Platform |
|---|---|---|
| HIGHLIGHT_TEXT | Color of text of item(s) selected in a widget. | N/A |
| INACTIVE_BORDER | Inactive window's border color. | N/A |
| INACTIVE_CAPTION | Inactive window's caption color. | N/A |
| INACTIVE_CAPTION_TEXT | Inactive window's caption text color. | N/A |
| TOOLTIP_BK | Background color for tooltip controls. | N/A |
| TOOLTIP_TEXT | Text color for tooltip controls. | N/A |
| MENU | Menu background color. | N/A |
| MENU_TEXT | Menu text color. | N/A |
| SCROLLBAR | Color of scroll bar "gray" area. | Color of scroll bar "gray" area. |
| WINDOW_BK | Window background color. | Base background color for all widgets. |
| WINDOW_FRAME | Window frame color. | Widget border color. |
| WINDOW_TEXT | Text color in windows. | Widget text color. |

*Table 104: WIDGET_SYSTEM_COLORS Structure Fields (Continued)*

## Version History

Introduced: Pre 4.0

BUTTON_SET, COMBOBOX_GETTEXT, COMBOBOX_NUMBER, FONTNAME, MAP, SENSITIVE, TAB_CURRENT, TAB_MULTILINE, TAB_NUMBER, TABLE_DISJOINT_SELECTION, TLB_ICONIFY_EVENTS, TLB_MOVE_EVENTS, TLB_SIZE_EVENTS, TOOLTIP, TREE_EXPANDED, TREE_ROOT, TREE_SELECT, and VISIBLE keywords added: 5.6

PUSHBUTTON_EVENTS keyword added: 6.0

## See Also

Chapter 26, “Creating Widget Applications” in the *Building IDL Applications* manual.

# WIDGET_LABEL

The WIDGET_LABEL function is used to create label widgets.

## Syntax

*Result* = WIDGET_LABEL( *Parent* [, /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT] [, /DYNAMIC_RESIZE] [, FONT=*string*] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, /SUNKEN_FRAME] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created label widget.

## Arguments

### Parent

The widget ID of the parent widget for the new label widget.

## Keywords

### ALIGN_CENTER

Set this keyword to center justify the label text.

### ALIGN_LEFT

Set this keyword to left justify the label text.

### ALIGN_RIGHT

Set this keyword to right justify the label text.

## DYNAMIC_RESIZE

Set this keyword to create a widget that resizes itself to fit its new value whenever its value is changed. Note that this keyword cannot be used with the SCR_XSIZE, SCR_YSIZE, XSIZE, or YSIZE keywords. If one of these keywords is also set, the widget will be sized as specified by the sizing keyword and will never resize itself dynamically.

## FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_LABEL or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See “RESOURCE_NAME” on page 2139 for a complete discussion of this keyword.

## SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## SUNKEN_FRAME

Set this keyword to create a three dimensional, bevelled border around the label widget. The resulting frame gives the label a “sunken” appearance, similar to what is often seen in application status bars.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a widget label is a string containing the text for the label.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

### YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of label widgets. In addition to those keywords that affect all widgets, the following are particularly useful: DYNAMIC_RESIZE, GET_VALUE, SET_VALUE.

## Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO function return information that applies specifically to label widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: DYNAMIC_RESIZE.

## Widget Events Returned by Label Widgets

Label widgets do not return an event structure.

## Version History

Introduced: Pre 4.0

SUNKEN_FRAME keyword added: 5.6

## See Also

CW_FIELD, WIDGET_TEXT

# WIDGET_LIST

The WIDGET_LIST function is used to create list widgets. A list widget offers the user a list of text elements from which to choose. The user can select an item by pointing at it with the mouse cursor and pressing a button. This action generates an event containing the index of the selected item, which ranges from 0 to the number of elements in the list minus one.

The returned value of this function is the widget ID of the newly-created list widget.

## Syntax

*Result* = WIDGET_LIST( *Parent* [, /CONTEXT_EVENTS]
[, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*]
[, FRAME=*width*] [, FUNC_GET_VALUE=*string*]
[, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, /MULTIPLE]
[, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*]
[, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created list widget.

## Arguments

### Parent

The widget ID of the parent widget for the new list widget.

## Keywords

### CONTEXT_EVENTS

Set this keyword to cause context menu events (or simply context events) to be issued when the user clicks the right mouse button over the widget. Set the keyword to 0 (zero) to disable such events. Context events are intended for use with context-sensitive menus (also known as pop-up or shortcut menus); pass the context event ID

to the WIDGET_DISPLAYCONTEXTMENU procedure within your widget program's event handler to display the context menu.

For more on detecting and handling context menu events, see "Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a "device font" (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See "About Device Fonts" on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a "hint" to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## MULTIPLE

Set this keyword to allow the user to select more than one item from the list in a single operation. Multiple selections are handled using the platform’s native mechanism:

### Motif

Holding down the Shift key and clicking an item selects the range from the previously selected item to the new item. Holding down the mouse button when selecting items also selects a range. Holding down the Control key and clicking an item toggles that item between the selected and unselected state.

### Windows

Holding down the Shift key and clicking an item selects the range from the previously selected item to the new item. Holding down the Control key and clicking an item toggles that item between the selected and unselected state.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL

makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_LIST or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See “RESOURCE_NAME” on page 2139 for a complete discussion of this keyword.

## SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

**Note**

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords to WIDGET_LIST.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a list widget is a scalar string or array of strings that contains the text of the list items—one list item per array element. List widgets are sized based on the length (in characters) of the longest item specified in the array of values for the VALUE keyword.

Note that the value of a list widget can only be set. It cannot be retrieved using WIDGET_CONTROL.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

## XSIZE

The desired width of the widget, in characters. Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. Note that the final size of the widget may be adjusted to include space for scrollbars (which are not always visible), so your widget may be slightly larger than specified.

### YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### YSIZE

The desired height of the widget, in number of list items visible. Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. Note that the final size of the widget may be adjusted to include space for scrollbars (which are not always visible), so your widget may be slightly larger than specified.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of list widgets. In addition to those keywords that affect all widgets, the following are particularly useful: CONTEXT_EVENTS, SET_LIST_SELECT, SET_LIST_TOP, SET_VALUE.

## Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to list widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: CONTEXT_EVENTS, LIST_MULTIPLE, LIST_NUMBER, LIST_NUM_VISIBLE, LIST_SELECT, LIST_TOP.

## Widget Events Returned by List Widgets

Pressing the mouse button while the mouse cursor is over an element of a list widget causes the widget to highlight the appearance of that element and to generate an event. The appearance of any previously selected element is restored to normal at the same time. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_LIST, ID:0L, TOP:0L, HANDLER:0L, INDEX:0L, CLICKS:0L}
```

The first three fields are the standard fields found in every widget event. INDEX returns the index of the selected item. This index can be used to subscript the array of names originally used to set the widget's value. The CLICKS field returns either 1 or 2, depending upon how the list item was selected. If the list item is double-clicked, CLICKS is set to 2.

**Note**

If you are writing a widget application that requires the user to double-click on a list widget, you will need to handle two events. The CLICKS field will return a 1 on the first click and a 2 on the second click.

### Context Menu Events

List widgets return the following event structure when the user clicks the right mouse button and the list widget was created with the CONTEXT_EVENTS keyword set:

```
{WIDGET_CONTEXT, ID:0L, TOP:0L, HANDLER:0L, X:0L, Y:0L}
```

The first three fields are the standard fields found in every widget event. The X and Y fields give the device coordinates at which the event occurred, measured from the upper left corner of the list widget.

## Version History

Introduced: Pre 4.0

## See Also

CW_BGROUP, WIDGET_COMBOBOX, WIDGET_DROPLIST

# WIDGET_PROPERTYSHEET

The WIDGET_PROPERTYSHEET function creates a property sheet widget, which exposes the *properties* of an IDL object subclassed from the IDLitComponent class in a graphical interface. The property sheet widget must be a child of a base or tab widget, and it cannot be the parent of any other widget.

The property sheet widget exposes the properties of an IDL object that subclasses from the IDLitComponent class, which was designed for use by the IDL iTools system. As a result, all IDLit* objects subclass from IDLitComponent, so properties of object classes written for the IDL iTools system can be displayed in a property sheet. In addition, all IDLgr* objects subclass from IDLitComponent, which means that properties of standard IDL graphics objects can be displayed in a property sheet even if the rest of the iTools framework is not in use.

In order to be shown in a property sheet, object properties must be *registered* and *visible*. In addition, in order for property values shown in a property sheet to be editable by the user, the property must be *sensitive*. For information on registering properties, see "Registering Properties" in Chapter 4 of the *iTool Developer's Guide* manual. For information on making properties visible and sensitive, see "Property Attributes" in Chapter 4 of the *iTool Developer's Guide* manual.

## Syntax

*Result* = WIDGET_PROPERTYSHEET(*Parent* [, /ALIGN_BOTTOM
|, /ALIGN_CENTER |, /ALIGN_LEFT |, /ALIGN_RIGHT |, /ALIGN_TOP]
[, /CONTEXT_EVENTS] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*]
[, FONT=*string*] [, FUNC_GET_VALUE=*string*] [, KILL_NOTIFY=*string*]
[, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE]
[, /TRACKING_EVENTS] [, UNAME=*string*] [,UNITS={0 | 1 | 2}]
[, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*]
[, YOFFSET=*value*] [, YSIZE=*value*])

## Return Value

The returned value of this function is the widget ID of the newly-created property sheet widget.

# Arguments

## Parent

The widget ID of the parent for the new property sheet widget. *Parent* must be a base or tab widget.

# Keywords

## ALIGN_BOTTOM

Set this keyword to align the new widget with the bottom of its parent base. To take effect, the parent must be a ROW base.

## ALIGN_CENTER

Set this keyword to align the new widget with the center of its parent base. To take effect, the parent must be a ROW or COLUMN base. In ROW bases, the new widget will be vertically centered. In COLUMN bases, the new widget will be horizontally centered.

## ALIGN_LEFT

Set this keyword to align the new widget with the left side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_RIGHT

Set this keyword to align the new widget with the right side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_TOP

Set this keyword to align the new widget with the top of its parent base. To take effect, the parent must be a ROW base.

## CONTEXT_EVENTS

Set this keyword to cause *context menu events* (or simply *context events*) to be issued when the user clicks the right mouse button over the widget. Set the keyword to 0 (zero) to disable such events. Context events are intended for use with context-sensitive menus (also known as pop-up or shortcut menus); pass the context event ID to the WIDGET_DISPLAYCONTEXTMENU procedure within your widget program’s event handler to display the context menu.

For more on detecting and handling context menu events, see “Context-Sensitive Menus” in Chapter 26 of the *Building IDL Applications* manual.

**Note**

With regard to /CONTEXT_EVENTS, the Motif and Windows version of the property sheet differ very slightly. In the Motif version, individually desensitized cells cannot generate context events, though their row label can.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a device font (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” in Appendix I of the *IDL Reference Guide* manual for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

**Note**

A procedure specified via the CLEANUP keyword to XMANAGER will override a procedure specified for your application's top-level base with WIDGET_BASE, KILL_NOTIFY.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. During a set operation (using the UVALUE keyword to WIDGET_BASE or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. During a get operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such callback procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently

## SCR_XSIZE

Set this keyword to the desired screen width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired screen height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget.

**Note**

Some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” in the *IDL Reference Guide* manual in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The user value to be assigned to the widget. Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

The user value for a widget can be accessed and modified at any time by using the GET_UVALUE and SET_UVALUE keywords to the WIDGET_CONTROL procedure.

## VALUE

Set this keyword to the object reference or array of object references to objects that subclass from the IDLitComponent class. Registered properties of the specified objects will be displayed in the property sheet.

If a single object reference is supplied, the property sheet will have a single column containing the object's properties. If an array of object references is supplied, the property sheet will have multiple columns.

**Note**

Due to limitations of the user interface controls that underlie the property sheet widget, a property sheet can display properties for at most 100 component objects.

**Note**

All object references must be to objects of the same type.

If no object references are supplied, the property sheet will initially be empty. Object references can be loaded into an existing property sheet using the SET_VALUE keyword to WIDGET_CONTROL.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a bulletin board base widget. Note that it is best to avoid using this style of widget layout.

## XSIZE

The desired width, in average character widths, for the widget's font, not including a possible vertical scrollbar and any frame thickness. If neither XSIZE nor SCR_XSIZE is specified, then the property sheet widget will use a default width. This default width is computed by adding the room needed for the property names to the width of a color cell.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a bulletin board base widget. Note that it is best to avoid using this style of widget layout.

## YSIZE

The desired height of the widget, in number of visible properties. The ultimate height of the property sheet in pixels will include the heights of the column header, the possible horizontal scrollbar, and any frame. If neither YSIZE nor SCR_YSIZE is specified, the property sheet will use a default height. This default is based on the number of rows: 10, or the number of visible properties, whichever is less.

# Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL affect the behavior of property sheet widgets. In addition to those keywords that affect all widgets, the following keyword is particularly useful: REFRESH _PROPERTY.

# Keywords to WIDGET_INFO

Some keywords to WIDGET_INFO return information that applies specifically to property sheet widgets. In addition to those keywords that apply to all widgets, the following keywords are particularly useful: COMPONENT, PROPERTY_VALID, PROPERTY_VALUE.

# Widget Events Returned by Property Sheet Widgets

Several variations of the property sheet widget event structure depend upon the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER) as well as an integer TYPE field that indicates which type of structure has been returned or which type of event was generated. Programs should always check the type field before referencing fields that are not present in all property sheet event structures. The different property sheet widget event structures are described below.

## Change Event (TYPE=0)

This event is generated whenever the user enters a new value for a property. It is also used to signal that a user-defined property needs to be changed. The following statement defines the event structure returned by the WIDGET_EVENT function:

```
{WIDGET_PROPSHEET_CHANGE, ID:0L, TOP:0L, HANDLER:0L, TYPE:0L,
   COMPONENT:OBJREF, IDENTIFIER:"", PROPTYPE:0L, SET_DEFINED: OL}
```

The COMPONENT field contains an object reference to the object associated with the property sheet. When multiple objects are associated with the property sheet, this field indicates which object is to change.

The IDENTIFIER field specifies the value of the property’s identifier attribute. This identifier is unique among all of the component’s properties.

The PROPTYPE field indicates the type of the property (integer, string, etc.). The integer values for these types are:

- 0 = USERDEF
- 1 = BOOLEAN
- 2 = INTEGER
- 3 = FLOAT
- 4 = STRING
- 5 = COLOR
- 6 = LINESTYLE
- 7 = SYMBOL
- 8 = THICKNESS
- 9 = ENUMLIST

The SET_DEFINED field indicates whether or not an undefined property is having its value set. In most circumstances, along with its new value, the property should have its UNDEFINED attribute set to zero. If a property is never marked as undefined, this field can be ignored.

## Select Event (TYPE=1)

The select event is generated whenever the current row or column in the property sheet changes. Navigation between cells is performed by clicking on a cell. When the property sheet is realized, no cell is selected.

The following statement defines the event structure returned by the WIDGET_EVENT function:

```
{WIDGET_PROPSHEET_SELECT, ID:0L, TOP:0L, HANDLER:0L, TYPE:0L,
   COMPONENT:OBJREF, IDENTIFIER:""}
```

The COMPONENT field is an object reference to the object associated with the property sheet.

The IDENTIFIER field specifies the value of the property’s identifier attribute. This identifier is unique among all properties of the component.

# Example

Enter the following program in the IDL Editor:

```
; ExSinglePropSheet
;
; Creates a base with a property sheet. Only the
; default properties are visible. The property sheet's
; event handler sets values and reveals selection
; changes.

PRO PropertyEvent, event

IF (event.type EQ 0) THEN BEGIN ; Value changed.

   ; Get the value of the property identified by
   ; event.identifier.
   value = WIDGET_INFO(event.id, COMPONENT = event.component, $
      PROPERTY_VALUE = event.identifier)

   ; Set the component's property value.
   event.component -> SetPropertyByIdentifier, event.identifier, $
      value

   PRINT, 'Changed: ', event.identifier, ': ', value

ENDIF ELSE BEGIN ; Selection changed.

   PRINT, 'Selected: ' + event.identifier

ENDELSE

END

PRO ExSinglePropSheet_event, event

prop = WIDGET_INFO(event.top, $
   FIND_BY_UNAME = 'PropSheet')
WIDGET_CONTROL, prop, XSIZE = event.x, YSIZE = event.y

END

PRO CleanupEvent, baseID

WIDGET_CONTROL, baseID, GET_UVALUE = oComp
OBJ_DESTROY, oComp

END
```

```
PRO ExSinglePropSheet

; Create and initialize the component.
oComp = OBJ_NEW('IDLitVisAxis')

; Create a base and property sheet.
base = WIDGET_BASE(/TLB_SIZE_EVENT, $
   TITLE = 'Single Property Sheet Example', $
   KILL_NOTIFY = 'CleanupEvent')
prop = WIDGET_PROPERTYSHEET(base, VALUE = oComp, $
   EVENT_PRO = 'PropertyEvent', UNAME = 'PropSheet')

; Activate the widgets.
WIDGET_CONTROL, base, SET_UVALUE = oComp, /REALIZE

XMANAGER, 'ExSinglePropSheet', base, /NO_BLOCK

END
```

Save this program as `ExSinglePropSheet.pro`, then compile and run the program. A property sheet entitled Single Property Sheet Example is displayed:

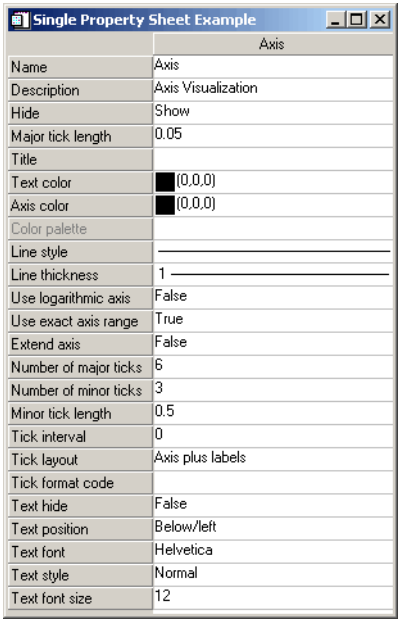



*Figure 30: Single Property Sheet Example*

For examples of the types of settings possible from the property sheet:

- Click the **Hide** setting box, click the drop-down button, and select `Hide` from the list.
- Click the **Major tick length** setting box, click the drop-down button, and move the slider to select a new value.
- Click the **Text color** setting box, click the drop-down button, and select a new color from the color selector.

## Version History

Introduced: 6.0

# WIDGET_SLIDER

The WIDGET_SLIDER function is used to create slider widgets. Slider widgets are used to indicate an integer value from a range of possible values. They consist of a rectangular region which represents the possible range of values. Inside this region is a sliding pointer that displays the current value. This pointer can be manipulated by the user via the mouse, or from within IDL via the WIDGET_CONTROL procedure.

To indicated floating-point values, see CW_FSLIDER.

## Syntax

*Result* = WIDGET_SLIDER( *Parent* [, /DRAG] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, MAXIMUM=*value*] [, MINIMUM=*value*] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, SCROLL=*units*] [, /SENSITIVE] [, /SUPPRESS_VALUE] [, /TRACKING_EVENTS] [, TITLE=*string*] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, /VERTICAL] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created slider widget.

## Arguments

### Parent

The widget ID of the parent for the new slider widget.

## Keywords

### DRAG

Set this keyword to cause events to be generated continuously while the slider is being dragged by the user. Normally, slider widgets generate position events only when the slider comes to rest at its final position and the mouse button is released.

**Note**

Under Microsoft Windows, this keyword has no effect. IDL sliders only generate events when the mouse button is released.

When a slider widget is set to return drag events, a large number of events can be generated. On slower machines, poor performance can result. Therefore, this option should only be used when detailed or truly interactive control is required.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this

technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string ( ' ' ).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## MAXIMUM

The maximum value of the range encompassed by the slider. If this keyword is not supplied, a default of 100 is used.

## MINIMUM

The minimum value of the range encompassed by the slider. If this keyword is not supplied, a default of 0 is used.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would

otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_SLIDER or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See “RESOURCE_NAME” on page 2139 for a complete discussion of this keyword.

## SCR_XSIZE

Set this keyword to the desired “screen” width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired “screen” height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SCROLL

Set the SCROLL keyword to an integer value specifying the number of integer units the scroll bar should move when the user clicks the left mouse button inside the slider area (Motif) or on the slider arrows (Windows), but not on the slider itself. The

default on both platforms is 0.1 x (MAXIMUM - MINIMUM), which is 10% of the slider range.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## SUPPRESS_VALUE

Set this keyword to inhibit the display of the current slider value.

Sliders work only with integer units. This keyword can be used to suppress the actual value of a slider so that a program can present the user with a slider that seems to work in other units (such as floating-point) or with a non-linear scale.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## TITLE

A string containing the title to be used for the slider widget.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget

hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget’s initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a widget slider is the current position of the slider.

## VERTICAL

Set this keyword to create a vertical slider. If this keyword is omitted, the slider is horizontal.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

## XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the

desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

**Note**

Setting XSIZE for a vertical slider (created with the VERTICAL keyword) does not change the visible width of the slider itself, but does change the amount of horizontal space occupied by the widget within its parent base.

### YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a "hint" to the toolkit and may be ignored in some situations.

**Note**

Setting YSIZE for a horizontal slider does not change the visible height of the slider itself, but does change the amount of vertical space occupied by the widget within its parent base.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of slider widgets. In addition to those keywords that affect all widgets, the following are particularly useful: GET_VALUE, SET_SLIDER_MAX, SET_SLIDER_MIN, SET_VALUE.

## Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO function return information that applies specifically to slider widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: SLIDER_MIN_MAX.

## Widget Events Returned by Slider Widgets

Slider widgets generate events when the mouse is used to change their value. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_SLIDER, ID:0L, TOP:0L, HANDLER:0L, VALUE:0L, DRAG:0}
```

ID is the widget ID of the button generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. VALUE returns the new value of the slider. DRAG returns integer 1 if the slider event was generated as part of a drag operation, or zero if the event was generated when the user had finished positioning the slider. Note that the slider widget only generates events during the drag operation if the DRAG keyword is set. When the DRAG keyword is set, the DRAG field can be used to avoid computationally expensive operations until the user releases the slider.

## Known Implementation Problems

Under Motif 1.0, vertical sliders with a title organized in row bases get horizontally truncated and the slider doesn’t show (the title does). Use the XSIZE keyword to work around this.

## Version History

Introduced: Pre 4.0

## See Also

CW_FSLIDER

# WIDGET_TAB

The WIDGET_TAB function is used to create a tab widget. Tab widgets present a display area on which different pages (base widgets and their children) can be displayed by selecting the appropriate tab. The titles of the tabs are supplied as the values of the TITLE keyword for each of the tag widget's child base widgets.

For a more detailed discussion of the tab widget, along with examples, see "Using Tab Widgets" in Chapter 27 of the *Building IDL Applications* manual.

## Syntax

*Result* = WIDGET_TAB( *Parent* [, /ALIGN_BOTTOM | , /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT | , /ALIGN_TOP] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, LOCATION={0 | 1 | 2 | 3}] [, MULTILINE=0 | 1 (Windows) or *num* tabs per row (Motif)] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created tab widget.

## Arguments

### Parent

The widget ID of the parent for the new tab widget.

**Note**

Only base widgets can be the parent of a tab widget.

# Keywords

## ALIGN_BOTTOM

Set this keyword to align the new widget with the bottom of its parent base. To take effect, the parent must be a ROW base.

## ALIGN_CENTER

Set this keyword to align the new widget with the center of its parent base. To take effect, the parent must be a ROW or COLUMN base. In ROW bases, the new widget will be vertically centered. In COLUMN bases, the new widget will be horizontally centered.

## ALIGN_LEFT

Set this keyword to align the new widget with the left side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_RIGHT

Set this keyword to align the new widget with the right side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_TOP

Set this keyword to align the new widget with the top of its parent base. To take effect, the parent must be a ROW base.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this

technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as group leader for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. You cannot remove a widget from an existing group.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such callback procedure. This callback procedure can be removed by setting the routine name to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

## LOCATION

Set this keyword equal to an integer that specifies which edge of the tab widget will contain the tabs. The possible values are:

| Value | Description |
|---|---|
| 0 | The tabs are placed along the top of the widget, which is the default behavior. |
| 1 | The tabs are placed along the bottom of the widget. |

*Table 105: LOCATION Keyword Values*

| Value | Description |
|---|---|
| 2 | The tabs are placed along the left edge of the widget. The text label for each tab is displayed vertically. On Windows platforms, setting the keyword to this value implies the MULTILINE keyword. |
| 3 | The tabs are placed along the right edge of the widget. The text label for each tab is displayed vertically. On Windows platforms, setting the keyword to this value implies the MULTILINE keyword. |

*Table 105: LOCATION Keyword Values (Continued)*

## MULTILINE

This keyword controls how tabs appear on the tab widget when all of the tabs do not fit on the widget in a single row. This keyword behaves differently on Windows and Motif systems.

### Windows

Set this keyword to cause tabs to be organized in a multiline display when the width of the tabs exceeds the width of the largest child base widget. If possible, IDL will create tabs that display the full tab text.

If MULTILINE = 0 and LOCATION = 0 or 1, tabs that exceed the width of the largest child base widget are shown with scroll buttons, allowing the user to scroll through the tabs while the base widget stays immobile.

If LOCATION = 1 or 2, a multiline display is always used if the tabs exceed the height of the largest child base widget.

**Note**

The width or height of the tab widget is based on the width or height of the largest base widget that is a child of the tab widget. The text of the tabs (the titles of the tab widget's child base widgets) may be truncated even if the MULTILINE keyword is set.

### Motif

Set this keyword equal to an integer that specifies the maximum number of tabs to display per row in the tab widget. If this keyword is not specified (or is explicitly set equal to zero) all tabs are placed in a single row.

**Note**

The width or height of the tab widget is based on the width or height of the largest base widget that is a child of the tab widget. The text of the tabs (the titles of the tab widget's child base widgets) is never truncated in order to make the tabs fit the space available. However, tab text may be truncated if the text of a single tab exceeds the space available. If MULTILINE is set to any value other than one, some tabs may not be displayed.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copying the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. Upon a set operation (using the UVALUE keyword to WIDGET_TAB or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. Upon a get operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string containing the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single callback procedure. This callback procedure can be removed by setting the routine name to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## SCR_XSIZE

Set this keyword to the desired screen width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired screen height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget.

**Note**

Some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string, which is used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (which is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The user value to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. You should avoid using this style of widget programming.

## XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a hint to the toolkit and may be ignored in some situations.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. You should avoid using this style of widget programming.

### YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a hint to the toolkit and may be ignored in some situations.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL affect the behavior of tab widgets. In addition to those keywords that affect all widgets, the following keywords are particularly useful: BASE_SET_TITLE, SET_TAB_CURRENT, SET_TAB_MULTILINE.

## Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO return information that applies specifically to tab widgets. In addition to those keywords that apply to all widgets, the following keywords are particularly useful: TAB_CURRENT, TAB_MULTILINE, TAB_NUMBER.

## Widget Events Returned by Tab Widgets

Tab widgets generate events when a new tab is selected. The event structure returned by the WIDGET_EVENT function is defined by the following statement:

```
{WIDGET_TAB, ID:0L, TOP:0L, HANDLER:0L, TAB:0L}
```

ID is the widget ID of the button generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. TAB returns the zero-based index of the tab selected.

## Version History

Introduced: 5.6

## See Also

"Using Tab Widgets" in Chapter 27 of the *Building IDL Applications* manual

# WIDGET_TABLE

The WIDGET_TABLE function creates table widgets. Table widgets display two-dimensional data and allow in-place data editing. They can have one or more rows and columns, and automatically create scroll bars when viewing more data than can otherwise be displayed on the screen.

For a more detailed discussion of the table widget, along with examples, see "Using Table Widgets" in Chapter 27 of the *Building IDL Applications* manual.

### Note on Table Sizing

Table widgets are sized according to the value of the following pairs of keywords to WIDGET_TABLE, in order of precedence: SCR_XSIZE/SCR_YSIZE, XSIZE/YSIZE, X_SCROLL_SIZE/Y_SCROLL_SIZE, VALUE. If either dimension remains unspecified by one of the above keywords, the default value of six (columns or rows) is used when the table is created. If the width or height specified is less than the size of the table, scroll bars are added automatically.

## Syntax

*Result* = WIDGET_TABLE( *Parent* [, ALIGNMENT={0 | 1 | 2}] [, /ALL_EVENTS] [, AM_PM=*[string, string]*] [, COLUMN_LABELS=*string_array*] [, /COLUMN_MAJOR | , /ROW_MAJOR] [, COLUMN_WIDTHS=*array*] [, DAYS_OF_WEEK=*string_array*{7 names}] [, /DISJOINT_SELECTION] [, /EDITABLE] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*] [, FORMAT=*value*] [, FRAME=*width*] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, /KBRD_FOCUS_EVENTS] [, KILL_NOTIFY=*string*] [, MONTHS=*string_array*{12 names}] [, /NO_COPY] [, /NO_HEADERS] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, /RESIZEABLE_COLUMNS] [, /RESIZEABLE_ROWS{not supported in Windows}] [, RESOURCE_NAME=*string*] [, ROW_HEIGHTS=*array*{not supported in Windows}] [, ROW_LABELS=*string_array*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SCROLL] [, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, XOFFSET=*value*] [, XSIZE=*value*] [, X_SCROLL_SIZE=*width*] [, YOFFSET=*value*] [, YSIZE=*value*] [, Y_SCROLL_SIZE=*height*] )

## Return Value

The returned value of this function is the widget ID of the newly-created table widget.

# Arguments

## Parent

The widget ID of the parent widget for the new table widget.

# Keywords

## ALIGNMENT

Set this keyword equal to a scalar or 2-D array specifying the alignment of the text within each cell. An alignment of 0 (the default) aligns the left edge of the text with the left edge of the cell. An alignment of 2 right-justifies the text, while 1 results in text centered within the cell. If ALIGNMENT is set equal to a scalar, all table cells are aligned as specified. If ALIGNMENT is set equal to a 2-D array, the alignment of each table cell is governed by the corresponding element of the array.

## ALL_EVENTS

Set this keyword to cause to the text widget to generate events whenever the user changes the contents of a table cell.

**Note**

If the EDITABLE keyword is set, an insert character event (TYPE=0) is generated when the user presses the RETURN or ENTER key in the text widget, even if the ALL_EVENTS keyword is not set. See the table below for details on the interaction between ALL_EVENTS and EDITABLE.

| Keywords | | Effects | |
|---|---|---|---|
| **ALL_EVENTS** | **EDITABLE** | **Input changes widget contents?** | **Type of events generated.** |
| Not set | Not set | No | None |
| Not set | Set | Yes | End-of-line insertion |
| Set | Not set | No | All events |
| Set | Set | Yes | All events |

*Table 106: Effects of using the ALL_EVENTS and EDITABLE keywords*

## AM_PM

Supplies a string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the FORMAT keyword.

## COLUMN_LABELS

Set this keyword equal to an array of strings used as labels for the columns of the table widget. The default labels are of the form “Column *n*”, where *n* is the column number. If this keyword is set to the empty string ( ' ' ), all column labels are set to be empty.

## COLUMN_MAJOR

This keyword is only valid if the table data is organized as a vector of structures rather than a two-dimensional array. See the VALUE keyword for details.

Set this keyword to specify that the data should be read into the table as if each element of the vector is a structure containing one column’s data. Note that the structures must all be of the same type, and must have one field for each row in the table. If this keyword is not set, the table widget behaves as if the ROW_MAJOR keyword were set.

## COLUMN_WIDTHS

Set this keyword equal to an array of widths for the columns of the table widget. The widths are given in any of the units as specified with the UNITS keyword. If no width is specified for a column, that column is set to the default size, which varies by platform. If COLUMN_WIDTHS is set to a scalar value, all columns are set to that width.

## DAYS_OF_WEEK

Supplies a string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the FORMAT keyword.

## DISJOINT_SELECTION

Set this keyword to enable the ability to select multiple rectangular regions of cells. The regions can be overlapping, touching, or entirely distinct.

Setting this keyword changes the data structures returned by the TABLE_SELECT keyword to WIDGET_INFO and the GET_VALUE keyword to WIDGET_CONTROL.

Similarly, the data structures you supply via the SET_TABLE_SELECT and SET_VALUE keywords to WIDGET_CONTROL are different in disjoint mode.

See "Selection Modes" in Chapter 27 of the *Building IDL Applications* manual for additional details.

## EDITABLE

Set this keyword to allow direct user editing of the text widget contents. Normally, the text in text widgets is read-only. See ALL_EVENTS for a description of how EDITABLE interacts with the ALL_EVENTS keyword.

**Note**

The method by which text widgets are placed into edit mode is dependent upon the windowing system. See "Edit Mode" in the *Building IDL Applications* manual

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a "device font" (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See "About Device Fonts" on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

A single font is shared by the row and column labels and by all of the cells in the widget.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts; in general, the system default font is the font appropriate for the version of Windows in question.

## FORMAT

Set this keyword equal to a single string or array of strings that specify the format of data displayed within table cells. The string(s) are of the same form as used by the FORMAT keyword to the PRINT procedure, and the default format is the same as that used by the PRINT procedure.

**Warning**

If the format specified is incompatible with the data displayed in a table cell, an error message is generated. Since the error is generated *for each cell displayed*, the number of messages printed is potentially large, and can slow execution significantly. Note also that each time a new cell is displayed (when scroll bars are repositioned, for example), a new error is generated *for each cell displayed*.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget. Note that this keyword is only a “hint” to the toolkit, and may be ignored in some instances.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KBRD_FOCUS_EVENTS

Set this keyword to make the base return keyboard focus events whenever the keyboard focus of the base changes. See “Widget Events Returned by Table Widgets” on page 2318 for more information.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## MONTHS

Supplies a string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the FORMAT keyword.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a "set" operation (using the UVALUE keyword to WIDGET_TABLE or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a "get" operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NO_HEADERS

Set this keyword to disable the display of the table widget's header area (where row and column labels are normally displayed).

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once

(because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (' '). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESIZEABLE_COLUMNS

Set this keyword to allow the user to change the size of columns using the mouse. Note that if the NO_HEADERS keyword was set, the columns cannot be resized interactively.

## RESIZEABLE_ROWS

Set this keyword to allow the user to change the size of rows using the mouse. Note that if the NO_HEADERS keyword was set, the rows cannot be resized interactively.

Under Microsoft Windows, the row size cannot be changed.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 2139 for a complete discussion of this keyword.

## ROW_HEIGHTS

Set this keyword equal to an array of heights for the rows of the table widget. The heights are given in any of the units as specified with the UNITS keyword. If no height is specified for a row, that row is set to the default size, which varies by platform. If ROW_HEIGHTS is set to a scalar value, all of the row heights are set to that value.

**Note**

This keyword is not supported under Microsoft Windows.

## ROW_LABELS

Set this keyword equal to an array of strings to be used as labels for the rows of the table. If no label is specified for a row, it receives the default label "Row *n*", where *n*

is the row number. If this keyword is set to the empty string ( ' ' ), all row labels are set to be empty.

## ROW_MAJOR

This keyword is only valid if the table data is organized as a vector of structures rather than a two-dimensional array. See the VALUE keyword for details.

Set this keyword to specify that the data should be read into the table as if each element of the vector is a structure containing one row's data. Note that the structures must all be of the same type, and must have one field for each column in the table. This is the default behavior if neither the COLUMN_MAJOR or ROW_MAJOR keyword is set.

## SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). Note that the screen width of the widget *includes* the width of scroll bars, if any are present. Setting SCR_XSIZE overrides values set for the XSIZE or X_SCROLL_SIZE keywords. See "Note on Table Sizing" on page 2307.

## SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). Note that the screen height of the widget *includes* the height of scroll bars, if any are present. Setting SCR_YSIZE overrides values set for the YSIZE or Y_SCROLL_SIZE keywords. See "Note on Table Sizing" on page 2307.

## SCROLL

Set this keyword to give the widget scroll bars that allow viewing portions of the widget contents that are not currently on the screen. See "Note on Table Sizing" on page 2307

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

**Note**

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a table widget is either a two-dimensional array or a vector of structures.

If the value is specified as a two-dimensional array, all data must be of the same data type.

If the value is specified as a vector of structures, it can be displayed either in column-major or row-major format by setting either the COLUMN_MAJOR keyword or the ROW_MAJOR keyword. All of the structures must be of the same type, and must contain one field for each row (if COLUMN_MAJOR is set) or column (if ROW_MAJOR is set) in the table. If neither keyword is set, the data is displayed in row major format.

**Note**

If the VALUE keyword is not specified, the data in the created table will be of type STRING.

If none of [XY]SIZE, SCR_[XY]SIZE, or [XY]_SCROLL_SIZE is present, the size of the table is determined by the size of the array or vector of structures specified by VALUE. See "Note on Table Sizing" on page 2307.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

## XSIZE

The width of the widget in columns. If row labels are present, one column is automatically added to this value. See "Note on Table Sizing" on page 2307.

## X_SCROLL_SIZE

The XSIZE keyword always specifies the width of a widget, in columns. When the SCROLL keyword is specified, this size is not necessarily the same as the width of the visible area. The X_SCROLL_SIZE keyword allows you to set the width of the

scrolling viewport independently of the actual width of the widget. See “Note on Table Sizing” on page 2307.

Use of the X_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when X_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify Y_SCROLL_SIZE when specifying X_SCROLL_SIZE.

### YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### YSIZE

The height of the widget in rows. If column labels are present, one row is automatically added to this value. See “Note on Table Sizing” on page 2307.

### Y_SCROLL_SIZE

The YSIZE keyword always specifies the height of a widget. in rows. When the SCROLL keyword is specified, this size is not necessarily the same as the height of the visible area. The Y_SCROLL_SIZE keyword allows you to set the height of the scrolling viewport independently of the actual width of the widget. See “Note on Table Sizing” on page 2307.

Use of the Y_SCROLL_SIZE keyword implies SCROLL. This means that scroll bars will be added in both the horizontal and vertical directions when Y_SCROLL_SIZE is specified. Because the default size of the scrolling viewport may differ between platforms, it is best to specify X_SCROLL_SIZE when specifying Y_SCROLL_SIZE.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of table widgets. In addition to those keywords that affect all widgets, the following are particularly useful: ALIGNMENT, ALL_TABLE_EVENTS, COLUMN_LABELS,

COLUMN_WIDTHS, DELETE_COLUMNS, DELETE_ROWS, EDITABLE, EDIT_CELL, FORMAT, GET_VALUE, INSERT_COLUMNS, INSERT_ROWS, KBRD_FOCUS_EVENTS, ROW_LABELS, ROW_HEIGHTS, SET_TABLE_SELECT, SET_TABLE_VIEW, SET_TEXT_SELECT, SET_VALUE, TABLE_BLANK, TABLE_DISJOINT_SELECTION, TABLE_XSIZE, TABLE_YSIZE, USE_TABLE_SELECT, USE_TEXT_SELECT.

# Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to table widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: COLUMN_WIDTHS, KBRD_FOCUS_EVENTS, ROW_HEIGHTS, TABLE_ALL_EVENTS, TABLE_DISJOINT_SELECTION, TABLE_EDITABLE, TABLE_EDIT_CELL, TABLE_SELECT, TABLE_VIEW, USE_TABLE_SELECT.

# Widget Events Returned by Table Widgets

There are several variations of the table widget event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER) as well as an integer TYPE field that indicates which type of structure has been returned. Programs should always check the field type before referencing fields that are not present in all table event structures. The different table widget event structures are described below.

## Insert Single Character (TYPE = 0)

This is the type of structure returned when a single character is typed into a cell of a table widget by a user.

```
{WIDGET_TABLE_CH, ID:0L, TOP:0L, HANDLER:0L, TYPE:0, OFFSET:0L,
   CH:0B, X:0L, Y:0L }
```

OFFSET is the (zero-based) insertion position that will result after the character is inserted. CH is the ASCII value of the character. X and Y give the zero-based address of the cell within the table.

## Insert Multiple Characters (TYPE = 1)

This is the type of structure returned when multiple characters are pasted into a cell by the window system.

```
{WIDGET_TABLE_STR, ID:0L, TOP:0L, HANDLER:0L, TYPE:1, OFFSET:0L,
   STR:'', X:0L, Y:0L}
```

OFFSET is the (zero-based) insertion position that will result after the text is inserted. STR is the string to be inserted. X and Y give the zero-based address of the cell within the table.

## Delete Text (TYPE = 2)

This is the type of structure returned when any amount of text is deleted from a cell of a table widget.

```
{WIDGET_TABLE_DEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:2, OFFSET:0L,
   LENGTH:0L, X:0L, Y:0L}
```

OFFSET is the (zero-based) character position of the first character deleted. It is also the insertion position that will result when the next character is inserted. LENGTH gives the number of characters involved. X and Y give the zero-based address of the cell within the table.

## Text Selection (TYPE = 3)

This is the type of structure returned when an area of text is selected (highlighted) by the user.

```
{WIDGET_TABLE_TEXT_SEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:3,
   OFFSET:0L, LENGTH:0L, X:0L, Y:0L}
```

The event announces a change in the insertion point. OFFSET is the (zero-based) character position of the first character to be selected. LENGTH gives the number of characters involved. A LENGTH of zero indicates that the widget has no selection, and that the insertion position is given by OFFSET. X and Y give the zero-based address of the cell within the table.

**Note**

Text insertion, text deletion, or any change in the current insertion point causes any current selection to be lost. In such cases, the loss of selection is implied by the text event reporting the insert/delete/movement and a separate zero length selection event is not sent.

## Cell Selection (TYPE = 4)

This is the type of structure returned when range of cells is selected (highlighted) or deselected by the user.

```
{WIDGET_TABLE_CELL_SEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:4,
   SEL_LEFT:0L, SEL_TOP:0L, SEL_RIGHT:0L, SEL_BOTTOM:0L}
```

The event announces a change in the currently selected cells. The range of cells selected is given by the zero-based indices into the table specified by the SEL_LEFT, SEL_TOP, SEL_RIGHT, and SEL_BOTTOM fields.

**Note**

If the table is in disjoint selection mode, selecting an additional region will result in a new WIDGET_TABLE_CELL_SEL event that reflects only the newly-selected cells. Use WIDGET_INFO, /TABLE_SELECT to obtain the entire selected region in disjoint selection mode.

When cells are deselected (either by changing the selection or by clicking in the upper left corner of the table) an event is generated in which the SEL_LEFT, SEL_TOP, SEL_RIGHT, and SEL_BOTTOM fields contain the value -1. This means that two WIDGET_TABLE_CELL_SEL events are generated when an existing selection is changed to a new selection. If your code pays attention to WIDGET_TABLE_CELL_SEL events, be sure to differentiate between select and deselect events.

**Note**

If the table is in disjoint selection mode and a new cell range is selected *starting on a previously-selected cell*, the previously selected cells are deselected but a WIDGET_TABLE_CELL_DESEL event is generated for the deselection rather than a WIDGET_TABLE_CELL_SEL event. See “Cell Deselection (Disjoint Mode) (TYPE = 9)” on page 2321 for details.

## Row Height Changed (TYPE = 6)

This is the type of structure returned when a row height is changed by the user.

```
{WIDGET_TABLE_ROW_HEIGHT, ID:0L, TOP:0L, HANDLER:0L, TYPE:6,
    ROW:0L, HEIGHT:0L}
```

The event announces that the height of the given row has been changed by the user. The ROW field contains the zero-based row number, and the HEIGHT field contains the new height.

## Column Width Changed (TYPE = 7)

This is the type of structure returned when a column width is changed by the user.

```
{WIDGET_TABLE_COL_WIDTH, ID:0L, TOP:0L, HANDLER:0L, TYPE:7,
   COL:0L, WIDTH:0L}
```

The event announces that the width of the given column has been changed by the user. The COL field contains the zero-based column number, and the WIDTH field contains the new width.

## Invalid Data (TYPE = 8)

This is the type of structure returned when the text entered by the user does not pass validation, and the user has finished editing the field (by hitting TAB or ENTER).

```
{WIDGET_TABLE_INVALID_ENTRY, ID:0L, TOP:0L, HANDLER:0L, TYPE:8,
   STR:'', X:0L, Y:0L}
```

When this event is generated, the cell's data is left unchanged. The invalid contents entered by the user is given as a text string in the STR field. The cell location is given by the X and Y fields.

## Cell Deselection (Disjoint Mode) (TYPE = 9)

This is the type of structure returned when selected cells are de-selected by the user *and the table is in disjoint selection mode*. It is identical to the (TYPE = 4) WIDGET_TABLE_CELL_SEL event structure except for the name and type value.

This event occurs when the user holds down the control key when starting a selection and the cell used to start the selection was already selected. In contrast, if the user starts a selection with the control key down but starts on a cell that was not selected, the normal WIDGET_TABLE_CELL_SEL is generated.

```
{WIDGET_TABLE_CELL_DESEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:9,
   SEL_LEFT:0L, SEL_TOP:0L, SEL_RIGHT:0L, SEL_BOTTOM:0L}
```

The range of cells selected is given by the zero-based indices into the table specified by the SEL_LEFT, SEL_TOP, SEL_RIGHT, and SEL_BOTTOM fields.

## Keyboard Focus Events

Table widgets return the following event structure when the keyboard focus changes and the base was created with the KBRD_FOCUS_EVENTS keyword set:

```
{ WIDGET_KBRD_FOCUS, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

ID is the widget ID of the table widget generating the event. TOP is the widget ID of the top level widget containing ID. HANDLER contains the widget ID of the widget associated with the handler routine. The ENTER field returns 1 (one) if the table widget is gaining the keyboard focus, or 0 (zero) if the table widget is losing the keyboard focus.

## Version History

Introduced: 5.0

DISJOINT_SELECTION keyword, Cell deselection (type 9) event added: 5.6

## See Also

WIDGET_CONTROL

# WIDGET_TEXT

The WIDGET_TEXT function creates text widgets. Text widgets display text and optionally get textual input from the user. They can have 1 or more lines, and can optionally contain scroll bars to allow viewing more text than can otherwise be displayed on the screen.

## Syntax

*Result* = WIDGET_TEXT( *Parent* [, /ALL_EVENTS] [, /CONTEXT_EVENTS]
[, /EDITABLE] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, FONT=*string*]
[, FRAME=*width*] [, FUNC_GET_VALUE=*string*]
[, GROUP_LEADER=*widget_id*] [, /KBRD_FOCUS_EVENTS]
[, KILL_NOTIFY=*string*] [, /NO_COPY] [, /NO_NEWLINE]
[, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*]
[, RESOURCE_NAME=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*]
[, /SCROLL] [, /SENSITIVE] [, /TRACKING_EVENTS] [, UNAME=*string*]
[, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*value*] [, /WRAP]
[, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created text widget.

## Arguments

### Parent

The widget ID of the parent widget for the new text widget.

## Keywords

### ALL_EVENTS

Set this keyword to cause to the text widget to generate events whenever the user changes the contents of the text area.

If the EDITABLE keyword is set, an insert character event (TYPE=0) is generated when the user presses the RETURN or ENTER key in the text widget, even if the ALL_EVENTS keyword is not set. See the table below for details on the interaction between ALL_EVENTS and EDITABLE.

| Keywords | | Effects | |
|---|---|---|---|
| **ALL_EVENTS** | **EDITABLE** | **Input changes widget contents?** | **Type of events generated.** |
| Not set | Not set | No | None |
| Not set | Set | Yes | End-of-line insertion |
| Set | Not set | No | All events |
| Set | Set | Yes | All events |

*Table 107: Effects of using the ALL_EVENTS and EDITABLE keywords*

## CONTEXT_EVENTS

Set this keyword to cause context menu events (or simply context events) to be issued when the user clicks the right mouse button over the widget. Set the keyword to 0 (zero) to disable such events. Context events are intended for use with context-sensitive menus (also known as pop-up or shortcut menus); pass the context event ID to the WIDGET_DISPLAYCONTEXTMENU procedure within your widget program's event handler to display the context menu.

For more on detecting and handling context menu events, see "Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

## EDITABLE

Set this keyword to allow direct user editing of the text widget contents. Normally, the text in text widgets is read-only. See ALL_EVENTS for a description of how EDITABLE interacts with the ALL_EVENTS keyword.

See "ALL_TEXT_EVENTS" on page 2174 for a description of how EDITABLE interacts with the ALL_TEXT_EVENTS keyword.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## FONT

The name of the font to be used by the widget. The font specified is a “device font” (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

**Note**

On Microsoft Windows platforms, if FONT is not specified, IDL uses the system default font. Different versions of Windows use different system default fonts.

## FRAME

The value of this keyword specifies the width of a frame in units specified by the UNITS keyword (pixels are the default) to be drawn around the borders of the widget.

**Note**

This keyword is only a “hint” to the toolkit, and may be ignored in some instances. Under Microsoft Windows, text widgets *always* have frames.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as “group leader” for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. It is not possible to remove a widget from an existing group.

## KBRD_FOCUS_EVENTS

Set this keyword to make the base return keyboard focus events whenever the keyboard focus of the base changes. See “Widget Events Returned by Text Widgets” on page 2330 for more information.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such “callback” procedure. It can be removed by setting the routine to the null string (`''`).

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique is fine for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copy the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. On a “set” operation (using the UVALUE keyword to WIDGET_TEXT or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. On a “get” operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NO_NEWLINE

Normally, when setting the value of a multi-line text widget, newline characters are automatically appended to the end of each line of text. Set this keyword to suppress this action.

## NOTIFY_REALIZE

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such "callback" procedure. It can be removed by setting the routine to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## RESOURCE_NAME

A string containing an X Window System resource name to be applied to the widget. See "RESOURCE_NAME" on page 2139 for a complete discussion of this keyword.

## SCR_XSIZE

Set this keyword to the desired "screen" width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired "screen" height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SCROLL

Set this keyword to give the widget scroll bars that allow viewing portions of the widget contents that are not currently on the screen.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse

cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget. Note that some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL procedure.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see “TRACKING_EVENTS” on page 2145 in the documentation for WIDGET_BASE.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO function with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (this is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

**Note**

This keyword does not affect all sizing operations. Specifically, the value of UNITS is ignored when setting the XSIZE or YSIZE keywords to WIDGET_TEXT.

## UVALUE

The “user value” to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the

convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

## VALUE

The initial value setting of the widget. The value of a text widget is the current text displayed by the widget.

VALUE can be either a string or an array of strings. Note that variables returned by the GET_VALUE keyword to WIDGET_CONTROL are always string arrays, even if a scalar string is specified in the call to WIDGET_TEXT.

## WRAP

Set this keyword to indicate that scrolling or multi-line text widgets should automatically break lines between words to keep the text from extending past the right edge of the text display area. Note that carriage returns are *not* automatically entered when lines wrap; the value of the text widget will remain a single-element array unless you explicitly enter a carriage return.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

## XSIZE

The width of the widget in characters. Note that the physical width of the text widget depends on both the value of XSIZE and on the size of the font used. The default value of XSIZE varies according to your windowing system. On Windows, the default size is roughly 20 characters. On Motif, the default size depends on the width of the text widget.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget programming.

### YSIZE

The height of the widget in text lines. Note that the physical height of the text widget depends on both the value of YSIZE and on the size of the font used. The default value of YSIZE is one line.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL procedure affect the behavior of text widgets. In addition to those keywords that affect all widgets, the following are particularly useful: ALL_TEXT_EVENTS, APPEND, CONTEXT_EVENTS, EDITABLE, GET_VALUE, KBRD_FOCUS_EVENTS, INPUT_FOCUS, NO_NEWLINE, SET_TEXT_SELECT, SET_TEXT_TOP_LINE, SET_VALUE, USE_TEXT_SELECT.

## Keywords to WIDGET_INFO

A number of keywords to the WIDGET_INFO function return information that applies specifically to text widgets. In addition to those keywords that apply to all widgets, the following are particularly useful: CONTEXT_EVENTS, KBRD_FOCUS_EVENTS, TEXT_ALL_EVENTS, TEXT_EDITABLE, TEXT_NUMBER, TEXT_OFFSET_TO_XY, TEXT_SELECT, TEXT_TOP_LINE, TEXT_XY_TO_OFFSET.

## Widget Events Returned by Text Widgets

There are several variations of the text widget event structure depending on the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER) as well as an integer TYPE field that indicates which type of structure has been returned. Programs should always check the type field before referencing fields that are not present in all text event structures. The different text widget event structures are described below.

### Insert Single Character (TYPE = 0)

This is the type of structure returned when a single character is typed or pasted into a text widget by a user.

```
{ WIDGET_TEXT_CH, ID:0L, TOP:0L, HANDLER:0L, TYPE:0, OFFSET:0L,
   CH:0B }
```

OFFSET is the (zero-based) insertion position that will result after the character is inserted. CH is the ASCII value of the character.

## Insert Multiple Characters (TYPE = 1)

This is the type of structure returned when multiple characters are pasted into a text widget by the window system.

```
{ WIDGET_TEXT_STR, ID:0L, TOP:0L, HANDLER:0L, TYPE:1, OFFSET:0L,
   STR:'' }
```

OFFSET is the (zero-based) insertion position that will result after the text is inserted. STR is the string to be inserted.

## Delete Text (TYPE = 2)

This is the type of structure returned when any amount of text is deleted from a text widget.

```
{ WIDGET_TEXT_DEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:2, OFFSET:0L,
   LENGTH:0L }
```

OFFSET is the (zero-based) character position of the first character to be deleted. It is also the insertion position that will result when the characters have been deleted. LENGTH gives the number of characters involved. A LENGTH of zero indicates that no characters were deleted.

## Selection (TYPE = 3)

This is the type of structure returned when an area of text is selected (highlighted) by the user.

```
{ WIDGET_TEXT_SEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:3, OFFSET:0L,
   LENGTH:0L }
```

The event announces a change in the insertion point. OFFSET is the (zero-based) character position of the first character to be selected. LENGTH gives the number of characters involved. A LENGTH of zero indicates that no characters are selected, and the new insertion position is given by OFFSET.

Note that text insertion, text deletion, or any change in the current insertion point causes any current selection to be lost. In such cases, the loss of selection is implied by the text event reporting the insert/delete/movement and a separate zero length selection event is *not* sent.

### Keyboard Focus Events

Text widgets return the following event structure when the keyboard focus changes and the base was created with the KBRD_FOCUS_EVENTS keyword set:

```
{ WIDGET_KBRD_FOCUS, ID:0L, TOP:0L, HANDLER:0L, ENTER:0 }
```

The first three fields are the standard fields found in every widget event. The ENTER field returns 1 (one) if the text widget is gaining the keyboard focus, or 0 (zero) if the text widget is losing the keyboard focus.

### Context Menu Events

Text widgets return the following event structure when the user clicks the right mouse button and the text widget was created with the CONTEXT_EVENTS keyword set:

```
{WIDGET_CONTEXT, ID:0L, TOP:0L, HANDLER:0L, X:0L, Y:0L}
```

The first three fields are the standard fields found in every widget event. The X and Y fields give the device coordinates at which the event occurred, measured from the upper left corner of the text widget.

## Version History

Introduced: Pre 4.0

## See Also

CW_FIELD, XDISPLAYFILE

# WIDGET_TREE

The WIDGET_TREE function is used to create and populate a tree widget. The tree widget presents a hierarchical view that can be used to organize a wide variety of data structures and information.

The WIDGET_TREE function performs two separate tasks: creating the tree widget and populating the tree widget with *nodes* (branches and leaves).

For a more detailed discussion of the tree widget, along with examples, see "Using Tree Widgets" in Chapter 27 of the *Building IDL Applications* manual.

## Syntax

*Result* = WIDGET_TREE( *Parent* [, /ALIGN_BOTTOM | , /ALIGN_CENTER | , /ALIGN_LEFT | , /ALIGN_RIGHT | , /ALIGN_TOP] [, BITMAP=*array*] [, /CONTEXT_EVENTS] [, EVENT_FUNC=*string*] [, EVENT_PRO=*string*] [, /EXPANDED] [, /FOLDER] [, FUNC_GET_VALUE=*string*] [, GROUP_LEADER=*widget_id*] [, KILL_NOTIFY=*string*] [, /MULTIPLE] [, /NO_COPY] [, NOTIFY_REALIZE=*string*] [, PRO_SET_VALUE=*string*] [, SCR_XSIZE=*width*] [, SCR_YSIZE=*height*] [, /SENSITIVE] [, /TRACKING_EVENTS] [, /TOP] [, UNAME=*string*] [, UNITS={0 | 1 | 2}] [, UVALUE=*value*] [, VALUE=*string*] [, XOFFSET=*value*] [, XSIZE=*value*] [, YOFFSET=*value*] [, YSIZE=*value*] )

## Return Value

The returned value of this function is the widget ID of the newly-created tree widget.

## Arguments

### Parent

The widget ID of the parent for the new tree widget. *Parent* can be either a base widget or a tree widget.

- If *Parent* is a base widget, WIDGET_TREE will create a tree widget that contains no other tree widgets. This type of tree widget is referred to as a *root node*.
- If *Parent* is a tree widget, WIDGET_TREE will create a new tree widget (called a *node*) in the specified tree widget.

**Note**

With the exception of the first tree widget created (the *root node*, whose *Parent* is a base widget), a tree widget (or *node*) must be created with the FOLDER keyword in order to serve as the *Parent* for other tree widgets.

# Keywords

## ALIGN_BOTTOM

Set this keyword to align the new widget with the bottom of its parent base. To take effect, the parent must be a ROW base.

## ALIGN_CENTER

Set this keyword to align the new widget with the center of its parent base. To take effect, the parent must be a ROW or COLUMN base. In ROW bases, the new widget will be vertically centered. In COLUMN bases, the new widget will be horizontally centered.

## ALIGN_LEFT

Set this keyword to align the new widget with the left side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_RIGHT

Set this keyword to align the new widget with the right side of its parent base. To take effect, the parent must be a COLUMN base.

## ALIGN_TOP

Set this keyword to align the new widget with the top of its parent base. To take effect, the parent must be a ROW base.

## BITMAP

Set this keyword equal to a 16x16x3 array representing an RGB image that will be displayed next to the node in the tree widget.

## CONTEXT_EVENTS

Set this keyword to cause context menu events (or simply context events) to be issued when the user clicks the right mouse button over the widget. Set the keyword to 0 (zero) to disable such events. Context events are intended for use with context-

sensitive menus (also known as pop-up or shortcut menus); pass the context event ID to the WIDGET_DISPLAYCONTEXTMENU within your widget program's event handler to display the context menu.

For more on detecting and handling context menu events, see "Context-Sensitive Menus" in Chapter 27 of the *Building IDL Applications* manual.

This keyword is only valid if the *Parent* of the tree widget is a base widget.

## EVENT_FUNC

A string containing the name of a function to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EVENT_PRO

A string containing the name of a procedure to be called by the WIDGET_EVENT function when an event arrives from a widget in the widget hierarchy rooted at the newly-created widget.

## EXPANDED

If the tree node being created is a *folder* (specified by the FOLDER keyword), set this keyword to cause the folder to be initially displayed expanded, showing all of its immediate child entries. By default, folders are initially displayed collapsed.

This keyword is only valid if the *Parent* of the tree widget is another tree widget.

## FOLDER

Set this keyword to cause the tree node being created to act as a *folder* (that is, as a branch of the tree rather than a leaf).

**Note**

With the exception of the root node (the tree widget whose *Parent* widget is a base widget), only tree nodes that have the FOLDER keyword set can act as the parent for other tree widgets.

This keyword is only valid if the *Parent* of the tree widget is another tree widget.

## FUNC_GET_VALUE

A string containing the name of a function to be called when the GET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this

technique allows you to change the value that should be returned for a widget. Compound widgets use this ability to define their values transparently to the user.

## GROUP_LEADER

The widget ID of an existing widget that serves as group leader for the newly-created widget. When a group leader is killed, for any reason, all widgets in the group are also destroyed.

A given widget can be in more than one group. The WIDGET_CONTROL procedure can be used to add additional group associations to a widget. You cannot remove a widget from an existing group.

## KILL_NOTIFY

Set this keyword to a string that contains the name of a procedure to be called automatically when the specified widget dies. Each widget is allowed a single such callback procedure. This callback procedure can be removed by setting the routine name to the null string (`''`). Note that the procedure specified is used only if you are not using the XMANAGER procedure to manage your widgets.

The callback routine is called with the widget identifier as its only argument. At that point, the widget identifier can only be used with the WIDGET_CONTROL procedure to get or set the user value. All other requests that require a widget ID are disallowed for the target widget. The callback is not issued until the WIDGET_EVENT function is called.

If you use the XMANAGER procedure to manage your widgets, the value of this keyword is overwritten. Use the CLEANUP keyword to XMANAGER to specify a procedure to be called when a managed widget dies.

## MULTIPLE

Set this keyword to enable multiple selection operations in the tree widget. If enabled, multiple elements in the tree widget can be selected at one time by holding down the **Control** or **Shift** key while clicking the left mouse button.

This keyword is only valid if the *Parent* of the tree widget is a base widget.

## NO_COPY

Usually, when setting or getting widget user values, either at widget creation or using the SET_UVALUE and GET_UVALUE keywords to WIDGET_CONTROL, IDL makes a second copy of the data being transferred. Although this technique works well for small data, it can have a significant memory cost when the data being copied is large.

If the NO_COPY keyword is set, IDL handles these operations differently. Rather than copying the source data, it takes the data away from the source and attaches it directly to the destination. This feature can be used by compound widgets to obtain state information from a UVALUE without all the memory copying that would otherwise occur. However, it has the side effect of causing the source variable to become undefined. Upon a set operation (using the UVALUE keyword to WIDGET_TAB or the SET_UVALUE keyword to WIDGET_CONTROL), the variable passed as value becomes undefined. Upon a get operation (GET_UVALUE keyword to WIDGET_CONTROL), the user value of the widget in question becomes undefined.

## NOTIFY_REALIZE

Set this keyword to a string containing the name of a procedure to be called automatically when the specified widget is realized. This callback occurs just once (because widgets are realized only once). Each widget is allowed a single such callback procedure. This callback procedure can be removed by setting the routine name to the null string (`''`). The callback routine is called with the widget ID as its only argument.

## PRO_SET_VALUE

A string containing the name of a procedure to be called when the SET_VALUE keyword to the WIDGET_CONTROL procedure is called for this widget. Using this technique allows you to designate a routine that sets the value for a widget. Compound widgets use this ability to define their values transparently to the user.

## SCR_XSIZE

Set this keyword to the desired screen width of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the XSIZE keyword.

## SCR_YSIZE

Set this keyword to the desired screen height of the widget, in units specified by the UNITS keyword (pixels are the default). In many cases, setting this keyword is the same as setting the YSIZE keyword.

## SENSITIVE

Set this keyword to control the initial sensitivity state of the widget.

If SENSITIVE is zero, the widget becomes insensitive. If nonzero, it becomes sensitive. When a widget is sensitive, it has normal appearance and can receive user input. For example, a sensitive button widget can be activated by moving the mouse cursor over it and pressing a mouse button. When a widget is insensitive, it indicates the fact by changing its appearance, looking disabled, and it ignores any input.

Sensitivity can be used to control when a user is allowed to manipulate the widget.

**Note**

Some widgets do not change their appearance when they are made insensitive, but they cease generating events.

After creating the widget hierarchy, you can change the sensitivity state using the SENSITIVE keyword with the WIDGET_CONTROL.

## TRACKING_EVENTS

Set this keyword to cause widget tracking events to be issued for the widget whenever the mouse pointer enters or leaves the region covered by that widget. For the structure of tracking events, see "TRACKING_EVENTS" on page 2145 in the documentation for WIDGET_BASE.

## TOP

Set this keyword to cause the tree node being created to be inserted as the parent node's top entry. By default, new nodes are inserted as the parent node's bottom entry.

This keyword is only valid if the *Parent* of the tree widget is another tree widget.

## UNAME

Set this keyword to a string that can be used to identify the widget in your code. You can associate a name with each widget in a specific hierarchy, and then use that name to query the widget hierarchy and get the correct widget ID.

To query the widget hierarchy, use the WIDGET_INFO with the FIND_BY_UNAME keyword. The UNAME should be unique to the widget hierarchy because the FIND_BY_UNAME keyword returns the ID of the first widget with the specified name.

## UNITS

Set UNITS equal to 0 (zero) to specify that all measurements are in pixels (which is the default), to 1 (one) to specify that all measurements are in inches, or to 2 (two) to specify that all measurements are in centimeters.

## UVALUE

The user value to be assigned to the widget.

Each widget can contain a user-specified value of any data type and organization. This value is not used by the widget in any way, but exists entirely for the convenience of the IDL programmer. This keyword allows you to set this value when the widget is first created.

If UVALUE is not present, the widget's initial user value is undefined.

## VALUE

Set this keyword equal to a string containing the text that will be displayed next to the tree node. If this keyword is not set, the default value `Tree` is used.

This keyword is only valid if the *Parent* of the tree widget is another tree widget.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. You should avoid using this style of widget programming.

## XSIZE

The width of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a hint to the toolkit and may be ignored in some situations.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the *upper left* corner of the parent widget.

Specifying an offset relative to a row or column major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. You should avoid using this style of widget programming.

### YSIZE

The height of the widget in units specified by the UNITS keyword (pixels are the default). Most widgets attempt to size themselves to fit the situation. However, if the desired effect is not produced, use this keyword to override it. This keyword is only a hint to the toolkit and may be ignored in some situations.

## Keywords to WIDGET_CONTROL

A number of keywords to the WIDGET_CONTROL affect the behavior of tree widgets. In addition to those keywords that affect all widgets, the following keywords are particularly useful: SET_TREE_BITMAP, SET_TREE_EXPANDED, SET_TREE_SELECT, SET_TREE_VISIBLE.

## Keywords to WIDGET_INFO

Some keywords to the WIDGET_INFO return information that applies specifically to tree widgets. In addition to those keywords that apply to all widgets, the following keywords are particularly useful: TREE_EXPANDED, TREE_SELECT, and TREE_ROOT.

## Widget Events Returned by Tree Widgets

Several variations of the tree widget event structure depend upon the specific event being reported. All of these structures contain the standard three fields (ID, TOP, and HANDLER) as well as an integer TYPE field that indicates which type of structure has been returned. Programs should always check the type field before referencing fields that are not present in all tree event structures. The different tree widget event structures are described below.

### Select (TYPE = 0)

This structure is returned when the currently selected node in the tree widget changes:

```
{WIDGET_TREE_SEL, ID:0L, TOP:0L, HANDLER:0L, TYPE:0, CLICKS:0L}
```

The CLICKS field indicates the number of mouse-button clicks that occurred when the event took place. This field contains 1 (one) when the item is selected, or 2 when the user double-clicks on the item.

### Expand (TYPE = 1)

This structure is returned when a folder in the tree widget expands or collapses:

```
{WIDGET_TREE_EXPAND, ID:0L, TOP:0L, HANDLER:0L, TYPE:1, EXPAND:0L}
```

The EXPAND field contains 1 (one) if the folder expanded or 0 (zero) if the folder collapsed.

### Context Menu Events

Tree widgets return the following event structure when the user clicks the right mouse button and the tree widget was created with the CONTEXT_EVENTS keyword set:

```
{WIDGET_CONTEXT, ID:0L, TOP:0L, HANDLER:0L, X:0L, Y:0L}
```

The first three fields are the standard fields found in every widget event. The X and Y fields give the device coordinates at which the event occurred, and are measured from the upper left corner of the tree widget.

## Version History

Introduced: 5.6

## See Also

"Using Tree Widgets" in Chapter 27 of the *Building IDL Applications* manual

# WINDOW

The WINDOW procedure creates a window for the display of graphics or text. It is only necessary to use WINDOW if more than one simultaneous window or a special size window is desired because a window is created automatically the first time any display procedure attempts to access the window system. The newly-created window becomes the current window, and the system variable !D.WINDOW is set to that window's window index. (See the description of the WSET procedure for a discussion of the current IDL window.)

The behavior of WINDOW varies slightly depending on the window system in effect. See the discussion of IDL graphics devices in Appendix A, "IDL Graphics Devices" for additional details.

## Syntax

WINDOW [, *Window_Index*] [, COLORS=*value*] [, /FREE] [, /PIXMAP] [, RETAIN={0 | 1 | 2}] [, TITLE=*string*] [, XPOS=*value*] [, YPOS=*value*] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

## Arguments

### Window_Index

The window index for the newly-created window. A window index is an integer value between 0 and 31 that is used to refer to the window. If this parameter is omitted, window index 0 is used. If the value of *Window_Index* specifies an existing window, the existing window is deleted and a new one is created. If you need to create more than 32 windows, use the FREE keyword described below.

## Keywords

### COLORS

**Note**

This keyword is ignored under Microsoft Windows.

The maximum number of color table indices to be used when drawing. This keyword has an effect only if supplied when the first window is created. If COLORS is not present when the first window is created, all or most of the available color indices are allocated depending upon the window system in use.

To use monochrome windows on a color display in X Windows, use COLORS = 2 when creating the first window. One color table is maintained for all windows. A negative value for COLORS specifies that all but the given number of colors from the shared color table should be allocated.

Although this keyword is ignored under Microsoft Windows, we could use the following code to use a monochrome window on all platforms:

```
WINDOW, COLORS=2 ; ignored on Windows
white=!D.N_COLORS-1
PLOT, FINDGEN(20), COLOR=white
```

## FREE

Set this keyword to create a window using the smallest unused window index above 32. If this keyword is present, the *Window_Index* argument can be omitted. The default position of the new window is opposite that of the current window. Using the FREE keyword allows the creation of a large number of windows. The system variable !D.WINDOW is set to the index of the newly-created window.

## PIXMAP

Set the PIXMAP keyword to specify that the window being created is actually an invisible portion of the display memory called a pixmap.

## RETAIN

Set this keyword to 0, 1, or 2 to specify how backing store should be handled for the window:

- 0 = no backing store
- 1 = requests that the server or window system provide backing store
- 2 = specifies that IDL provide backing store directly

See “Backing Store” on page 3824 for details.

## TITLE

A scalar string that contains the window’s label. If not specified, the window is given a label of the form “IDL *n*”, where *n* is the index number of the window. For example, to create a window with the label “IDL Graphics”, enter:

```
WINDOW, TITLE='IDL Graphics'
```

## XPOS

The X position of the window, specified in device coordinates. On Motif platforms, XPOS specifies the X position of the *lower* left corner and is measured from the lower left corner of the screen. On Windows platforms, XPOS specifies the X position of the *upper* left corner and is measured from the upper left corner of the screen. That is, specifying

```
WINDOW, XPOS = 0, YPOS = 0
```

will create a window in the lower left corner on Motif machines and in the upper left corner on Windows machines.

If no position is specified, the position of the window is determined from the value of Window Index using the following rules:

- Window 0 is placed in the upper right hand corner.
- Even numbered windows are placed on the top half of the screen and odd numbered windows are placed on the bottom half.
- Windows 0,1,4,5,8, and 9 are placed on the right side of the screen and windows 2,3,6, and 7 are placed on the left.

**Note**

The order of precedence (highest to lowest) for positioning windows is: XPOS/YPOS keywords to WINDOW, Tile/Cascade IDE graphics (user system) preferences, optional index argument to WINDOW. Also realize that setting LOCATION is only a request to the Window manager and may not always be honored due to system peculiarities.

## YPOS

The Y position of the window, specified in device coordinates. See the description of XPOS for details.

## XSIZE

The width of the window in pixels.

## YSIZE

The height of the window in pixels.

## Examples

Create graphics window number 0 with a size of 400 by 400 pixels and a title that reads “Square Window” by entering:

```
WINDOW, 0, XSIZE=400, YSIZE=400, TITLE='Square Window'
```

## Version History

Introduced: Original

## See Also

WDELETE, WSET, WSHOW

# WRITE_BMP

The WRITE_BMP procedure writes an image and its color table vectors to a Microsoft Windows Version 3 device independent bitmap file (.BMP).

WRITE_BMP does not handle 1-bit-deep images or compressed images, and is not fast for 4-bit images. The algorithm works best on images where the number of bytes in each scan-line is evenly divisible by 4.

This routine is written in the IDL language. Its source code can be found in the file `write_bmp.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

WRITE_BMP, *Filename*, *Image*[, *R*, *G*, *B*] [, /FOUR_BIT] [, IHDR=*structure*] [, HEADER_DEFINE=*h*{define *h* before call}] [, /RGB]

## Arguments

### Filename

A scalar string containing the full pathname of the bitmap file to write.

### Image

The array to write into the new bitmap file. The array should be scaled into a range of bytes for 8- and 24-bit deep images. Scale to 0-15 for 4-bit deep images. If the image has 3 dimensions and the first dimension is 3, a 24-bit deep bitmap file is created.

**Note**

For 24-bit images, color interleaving is blue, green, red: *Image*[0, *i*, *j*] = blue, *Image*[1, *i*, *j*] = green, *Image*[2, *i*, *j*] = red.

### R, G, B

Color tables. If omitted, the colors loaded in the COLORS common block are used.

# Keywords

## FOUR_BIT

Set this keyword to write as a 4-bit device independent bitmap. If omitted or zero, an 8-bit deep bitmap is written.

## IHDR

Set this keyword to a BITMAPINFOHEADER structure containing the file header fields that are not obtained from the image itself. The fields in this structure that can be set are: `bi{XY}PelsPerMeter`, `biClrUsed`, and `biClrImportant`.

## HEADER_DEFINE

If this keyword is set, WRITE_BMP returns an empty BITMAPINFOHEADER structure, containing zeros. No other actions are performed. This structure may be then modified with the pertinent fields and passed in via the IHDR keyword parameter. See the Microsoft Windows Programmers Reference Guide for a description of each field in the structure.

Note: this parameter must be defined *before* the call. For example:

```
H = 0
WRITE_BMP, HEADER_DEFINE = H
```

## RGB

Set this keyword to reverse the color interleaving for 24-bit images to red, green, blue: *Image*[0, *i*, *j*] = red, *Image*[1, *i*, *j*] = green, *Image*[2, *i*, *j*] = blue. By default, 24-bit images are written with color interleaving of blue, green, red.

# Examples

The following command captures the contents of the current IDL graphics window and saves it to a Microsoft Windows Bitmap file with the name `test.bmp`. Note that this works only on a PseudoColor (8-bit) display:

```
WRITE_BMP, 'test.bmp', TVRD()
```

The following commands scale an image to 0-15, and then write a 4-bit BMP file, using a grayscale color table:

```
; Create a ramp from 0 to 255:
r = BYTSCL(INDGEN(16))

WRITE_BMP, 'test.bmp', BYTSCL(Image, MAX=15), r, r, r, /FOUR
```

## Version History

Introduced: Pre 4.0

## See Also

READ_BMP, QUERY_* Routines

# WRITE_IMAGE

The WRITE_IMAGE procedure writes an image and its color table vectors, if any, to a file of a specified type. WRITE_IMAGE can write most types of image files supported by IDL.

## Syntax

WRITE_IMAGE, *Filename*, *Format*, *Data* [, *Red*, *Green*, *Blue*] [, /APPEND]

## Arguments

### Filename

A scalar string containing the name of the file to write.

### Format

A scalar string containing the name of the file format to write. The following are the supported formats:

- BMP
- JPEG
- PNG
- PPM
- SRF
- TIFF

### Data

An IDL variable containing the image data to write to the file.

### Red

An optional vector containing the red channel of the color table if a colortable exists.

### Green

An optional vector containing the green channel of the color table if a colortable exists.

### Blue

An optional vector containing the blue channel of the color table if a colortable exists.

## Keywords

### APPEND

Set this keyword to force the image to be appended to the file instead of overwriting the file. APPEND may be used with image formats that supports multiple images per file and is ignored for formats that support only a single image per file.

## Version History

Introduced: 5.3

# WRITE_JPEG

The WRITE_JPEG procedure writes compressed images to files. JPEG (Joint Photographic Experts Group) is a standardized compression method for full-color and gray-scale images. This procedure is based in part on the work of the Independent JPEG Group.

As the Independent JPEG Group states, JPEG is intended for real-world scenes (such as digitized photographs). Line art, such as drawings or IDL plots, and other unrealistic images are not its strong suit. Note also that JPEG is a lossy compression scheme. That is, the output image is *not* identical to the input image. Hence you cannot use JPEG if you must have identical output bits. On typical images of real-world scenes, however, very good compression levels can be obtained with no visible change, and amazingly high compression levels are possible if you can tolerate a low-quality image. You can trade off output image quality against compressed file size by adjusting a compression parameter. Files are encoded in JFIF, the JPEG File Interchange Format; however, such files are usually simply called JPEG files.

If you need to store images in a format that uses lossless compression, consider using the WRITE_PNG procedure. This procedure writes a Portable Network Graphics (PNG) file using lossless compression with either 8 or 16 data bits per channel. To store 8-bit or 24-bit images without compression, consider using WRITE_BMP (for Microsoft Bitmap format files) or WRITE_TIFF (to write Tagged Image Format Files).

For a short technical introduction to the JPEG compression algorithm, see: Wallace, Gregory K. “The JPEG Still Picture Compression Standard”, *Communications of the ACM*, April 1991 (vol. 34, no. 4), pp. 30-44.

**Note**

All JPEG files consist of byte data. Input data is converted to bytes before being written to a JPEG file.

## Syntax

WRITE_JPEG [, *Filename* | , UNIT=*lun*] , *Image* [, /ORDER] [, /PROGRESSIVE] [, QUALITY=*value*{0 to 100}] [, TRUE={1 | 2 | 3}]

# Arguments

## Filename

A string containing the name of file to be written in JFIF (JPEG) format. If this parameter is not present, the UNIT keyword must be specified.

## Image

A byte array of either two or three dimensions, containing the image to be written. Grayscale images must have two dimensions. TrueColor images must have three dimensions with the index of the dimension that contains the color specified with the TRUE keyword.

# Keywords

## ORDER

JPEG/JFIF images are normally written in top-to-bottom order. If the image array is in the standard IDL order (i.e., from bottom-to-top) set ORDER to 0, its default value. If the image array is in top-to-bottom order, ORDER must be set to 1.

## PROGRESSIVE

Set this keyword to write the image as a series of scans of increasing quality. When used with a slow communications link, a decoder can generate a low-quality image very quickly, and then improve its quality as more scans are received.

**Warning**

Not all JPEG applications can handle progressive JPEG files, and it is up the JPEG reader to progressively display the JPEG image. For example, IDL's READ_JPEG routine ignores the progressive readout request and reads the entire image in at the first reading.

## QUALITY

This keyword specifies the quality index, in the range of 0 (terrible) to 100 (excellent) for the JPEG file. The default value is 75, which corresponds to very good quality. Lower values of QUALITY produce higher compression ratios and smaller files.

### TRUE

This keyword specifies the index, starting at 1, of the dimension over which the color is interleaved. For example, for an image that is pixel interleaved and has dimensions of (3, *m*, *n*), set TRUE to 1. Specify 2 for row-interleaved images (*m*, 3, *n*); and 3 for band-interleaved images (*m*, *n*, 3). If TRUE is not set, the image is assumed to have no interleaving (it is not a TrueColor image).

### UNIT

This keyword designates the logical unit number of an already open file to receive the output, allowing multiple JFIF images per file or the embedding of JFIF images in other data files. If this keyword is used, *Filename* should not be specified.

**Note**

When opening a file intended for use with the UNIT keyword, if the filename does not end in `.jpg`, or `.jpeg`, you must specify the STDIO keyword to OPEN in order for the file to be compatible with WRITE_JPEG.

## Examples

Write the image contained in the array A, using JPEG compression with a quality index of 25. The image is stored in bottom-to-top order:

```
image = DIST(100)
WRITE_JPEG, 'test1.jpg', image, QUALITY=25
```

Write a TrueColor image to a JPEG file. The image is contained in the band-interleaved array A with dimensions (*m*, *n*, 3). Assume it is stored in top-to-bottom order:

```
WRITE_JPEG, 'test2.jpg', image, TRUE=3, /ORDER
```

## Version History

Introduced: Pre 4.0

## See Also

READ_JPEG, QUERY_* Routines

# WRITE_NRIF

The WRITE_NRIF procedure writes an image and its color table vectors to an NCAR Raster Interchange Format (NRIF) rasterfile.

WRITE_NRIF only writes 8- or 24-bit deep rasterfiles of types “Indexed Color” (8-bit) and “Direct Color integrated” (24-bit). The color map is included only for 8-bit files.

See the document “NCAR Raster Interchange Format and TAGS Raster Reference Manual,” available from the Scientific Computing Division, National Center for Atmospheric Research, Boulder, CO, 80307-3000, for information on the structure of NRIF files.

This routine is written in the IDL language. Its source code can be found in the file `write_nrif.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

WRITE_NRIF, *File*, *Image* [, *R*, *G*, *B*]

## Arguments

### File

A scalar string containing the full path name of the NRIF file to write.

### Image

The byte array to be written to the NRIF file. If *Image* has the dimensions (*n*,*m*), an 8-bit NRIF file with color tables is created. If *Image* has the dimensions (3,*n*,*m*), a 24-bit NRIF file is created, where each byte triple represents the red, green, and blue intensities at (*n*,*m*) on a scale from 0 to 255. The NRIF image will be rendered from bottom to top, in accordance with IDL standards.

### R, G, B

The Red, Green, and Blue color vectors to be used as a color table with 8-bit images. If color vectors are supplied, they are included in the output (8-bit images only). If *R*, *G*, *B* values are not provided, the last color table established using LOADCT is included. If no color table has been established, WRITE_NRIF calls LOADCT to load the grayscale entry (table 0).

**Note**

WRITE_NRIF does not recognize color vectors loaded directly using TVLCT, so if a custom color table is desired and it is not convenient to use XPALETTE, include the R, G, and B vectors that were used to create the color table.

## Version History

Introduced: Pre 4.0

# WRITE_PICT

The WRITE_PICT procedure writes an image and its color table vectors to a PICT (version 2) format image file. The PICT format is used by Apple Macintosh computers.

Note: WRITE_PICT only works with 8-bit displays

This routine is written in the IDL language. Its source code can be found in the file `write_pict.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

WRITE_PICT, *Filename* [, *Image*, *R*, *G*, *B*]

## Arguments

### Filename

A scalar string containing the full pathname of the PICT file to write.

### Image

The byte array to be written to the PICT file. If *Image* is omitted, the entire current graphics window is read into an array and written to the PICT file.

### R, G, B

The Red, Green, and Blue color vectors to be written to the PICT file. If *R*, *G*, *B* values are not provided, the last color table established using LOADCT is included. If no color table has been established, WRITE_PICT calls LOADCT to load the grayscale entry (table 0).

## Examples

Create a pseudo screen dump from the current window. Note that this works only on a PseudoColor (8-bit) display:

```
WRITE_PICT, 'test.pict', TVRD()
```

## Version History

Introduced: Pre 4.0

## See Also

READ_PICT, QUERY_* Routines

# WRITE_PNG

The WRITE_PNG procedure writes a 2-D or 3-D IDL variable into a Portable Network Graphics (PNG) file. The data in the file is stored using lossless compression with either 8 or 16 data bits per channel, based on the input IDL variable type. 3-D IDL variables must have the number of channels as their leading dimension (pixel interleaved). For BYTE format 2-D IDL variables, an optional palette may be stored in the image file along with a list of pixel values which are to be considered transparent by a reading program.

**Note**

IDL supports version 1.0.5 of the PNG Library.

## Syntax

WRITE_PNG, *Filename*, *Image*[, *R*, *G*, *B*] [, /ORDER] [, /VERBOSE] [, TRANSPARENT=*array*]

## Arguments

### Filename

A scalar string containing the full pathname of the PNG file to write.

### Image

The array to write into the new PNG file. If *Image* is one of the integer data types, it is converted to type unsigned integer (UINT) and written out at 16 data bits per channel. All other data types are converted to bytes and written out at 8-bits per channel.

**Note**

If *Image* is two-dimensional (single-channel) and *R*, *G*, and *B* are provided, all input data types (including integer) are converted to bytes and written out as 8-bit data.

### R, G, B

For single-channel images, *R*, *G*, and *B* should contain the red, green, and blue color vectors, respectively. For multi-channel images, these arguments are ignored.

# Keywords

## ORDER

Set this keyword to indicate that the rows of the image should be written from bottom to top. The rows are written from top to bottom by default. ORDER provides compatibility with PNG files written using versions of IDL prior to IDL 5.4, which wrote PNG files from bottom to top.

## VERBOSE

Produces additional diagnostic output during the write.

## TRANSPARENT

Set this keyword to an array of pixel index values which are to be treated as "transparent" for the purposes of image display. This keyword is valid only if *Image* is a single-channel (color indexed) image and the R, G, B palette is provided.

# Examples

Create an RGBA (16-bits/channel) and a Color Indexed (8-bits/channel) image with a palette.

```
rgbdata = UINDGEN(4,320,240)
cidata = BYTSCL(DIST(256))
red = INDGEN(256)
green = INDGEN(256)
blue = INDGEN(256)
WRITE_PNG,'rgb_image.png',rgbdata
WRITE_PNG,'ci_image.png',cidata,red,green,blue

; Query and Read the data:
names = ['rgb_image.png','ci_image.png','unknown.png']
FOR i=0,N_ELEMENTS(names)-1 DO BEGIN
   ok = QUERY_PNG(names[i],s)
   IF (ok) THEN BEGIN
      HELP,s,/STRUCTURE
      IF (s.HAS_PALETTE) THEN BEGIN
         img = READ_PNG(names[i],rpal,gpal,bpal)
         HELP,img,rpal,gpal,bpal
      ENDIF ELSE BEGIN
         img = READ_PNG(names[i])
         HELP,img
      ENDELSE
   ENDIF ELSE BEGIN
```

```
      PRINT,names[i],' is not a PNG file'
    ENDELSE
  ENDFOR
```

## Version History

Introduced: 5.2

## See Also

READ_PNG, QUERY_* Routines

# WRITE_PPM

The WRITE_PPM procedure writes an image to a PPM (TrueColor) or PGM (gray scale) file. This routine is written in the IDL language. Its source code can be found in the file `write_ppm.pro` in the `lib` subdirectory of the IDL distribution.

**Note**

WRITE_PPM only writes 8-bit deep PGM/PPM files of the standard type. Images should be ordered so that the first row is the top row.

PPM/PGM format is supported by the PBMPLUS toolkit for converting various image formats to and from portable formats, and by the Netpbm package.

## Syntax

WRITE_PPM, *Filename*, *Image* [, /ASCII]

## Arguments

### Filename

A scalar string specifying the full pathname of the PPM or PGM file to write.

### Image

The 2D (gray scale) or 3D (TrueColor) array to be written to a file.

## Keywords

### ASCII

Set this keyword to force WRITE_PPM to use formatted ASCII input/output to write the image data. The default is to use the far more efficient binary input/output (RAWBITS) format.

## Examples

```
image = DIST(100)
WRITE_PPM, 'file.ppm', image
```

## Version History

Introduced: 4.0

## See Also

READ_PPM, QUERY_* Routines

# WRITE_SPR

The WRITE_SPR procedure writes a row-indexed sparse array structure to a specified file. Row-indexed sparse arrays are created using the SPRSIN function.

## Syntax

WRITE_SPR, *AS, Filename*

## Arguments

### AS

A row-indexed sparse array created by SPRSIN.

### Filename

The name of the file that will contain AS.

## Keywords

None.

## Examples

```
; Create an array:
A = [[3.,0., 1., 0., 0.],$
     [0.,4., 0., 0., 0.],$
     [0.,7., 5., 9., 0.],$
     [0.,0., 0., 0., 2.],$
     [0.,0., 0., 6., 5.]]

; Convert it to sparse storage format:
A = SPRSIN(A)

; Store it in the file sprs.as:
WRITE_SPR, A, 'sprs.as'
```

## Version History

Introduced: Pre 4.0

## See Also

FULSTR, LINBCG, SPRSAB, SPRSAX, SPRSIN, READ_SPR

# WRITE_SRF

The WRITE_SRF procedure writes an image and its color table vectors to a Sun Raster File (SRF).

WRITE_SRF only writes 32-, 24-, and 8-bit-deep rasterfiles of type RT_STANDARD. Use the UNIX command `rasfilter8to1` to convert these files to 1-bit deep files. See the file `/usr/include/rasterfile.h` for the structure of Sun rasterfiles.

This routine is written in the IDL language. Its source code can be found in the file `write_srf.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

WRITE_SRF, *Filename* [, *Image*, *R*, *G*, *B*] [, /ORDER] [, /WRITE_32]

## Arguments

### Filename

A scalar string containing the full pathname of the SRF to write.

### Image

The array to be written to the SRF. If *Image* has dimensions (3,*n*,*m*), a 24-bit SRF is written. If *Image* is omitted, the entire current graphics window is read into an array and written to the SRF file. *Image* should be of byte type, and in top to bottom scan line order.

### R, G, B

The Red, Green, and Blue color vectors to be written to the file. If *R*, *G*, *B* values are not provided, the last color table established using LOADCT is included. If no color table has been established, WRITE_SRF calls LOADCT to load the grayscale entry (table 0).

## Keywords

### ORDER

Set this keyword to write the image from the top down instead of from the bottom up. This setting is only necessary when writing a file from the current IDL graphics window; it is ignored when writing a file from a data array passed as a parameter.

### WRITE_32

Set this keyword to write a 32-bit file. If the input image is a TrueColor image, dimensioned (3, *n*, *m*), it is normally written as a 24-bit raster file.

## Examples

Create a pseudo screen dump from the current window:

```
WRITE_SRF, 'test.srf', TVRD()
```

## Version History

Introduced: Original

## See Also

READ_SRF, QUERY_* Routines

# WRITE_SYLK

The WRITE_SYLK function writes the contents of an IDL variable to a SYLK (Symbolic Link) format spreadsheet data file.

**Note**

This routine writes only numeric and string SYLK data. It cannot handle spreadsheet and cell formatting information (cell width, text justification, font type, date, time, monetary notations, etc.). A given SYLK data file cannot be appended with data blocks through subsequent calls.

This routine is written in the IDL language. Its source code can be found in the file `write_sylk.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = WRITE_SYLK( *File*, *Data* [, STARTCOL=*column*] [, STARTROW=*row*] )

## Return Value

The function returns TRUE if the write operation was successful.

## Arguments

### File

A scalar string specifying the full path name of the SYLK file to write.

### Data

A scalar, vector, or 2D array to be written to *File*.

## Keywords

### STARTCOL

Set this keyword to the first column of spreadsheet cells to write. If not specified, the write operation begins with the first column found in the file (column 0).

### STARTROW

Set this keyword to the first row of spreadsheet cells to write. If not specified, the write operation begins with the first row of cells found in the file (row 0).

## Examples

Suppose you wish to write the contents of a 2 by 2 floating-point array, `data`, to a SYLK data file called “bar.slk” such that the matrix would appear with it’s upper left data at the cell in the 10th row and the 20th column. Use the following command:

```
status = WRITE_SYLK('bar.slk', data, STARTROW = 9, STARTCOL = 19)
```

The IDL variable `status` will contain the value 1 if the operation was successful.

## Version History

Introduced: 4.0

## See Also

READ_SYLK

# WRITE_TIFF

The WRITE_TIFF procedure can write TIFF files with one or more channels, where each channel can contain 1, 4, 8, 16, or 32-bit integer pixels, or floating-point values.

## Syntax

WRITE_TIFF, *Filename [, Image]* [, /APPEND]
[, BITS_PER_SAMPLE={1 | 4 | 8}] [, RED=*value*] [, GREEN=*value*]
[, BLUE=*value*] [, COMPRESSION={0 | 2 | 3}] [, GEOTIFF=*structure*]
[, /LONG | , /SHORT | , /FLOAT] [, ORIENTATION=*value*]
[, PLANARCONFIG={1 | 2}] [, UNITS={1 | 2 | 3}] [, /VERBOSE]
[, XRESOL=*pixels/inch*] [, YRESOL=*pixels/inch*]

## Arguments

### Filename

A scalar string containing the full pathname of the TIFF to write.

### Image

The array to be written to the TIFF. If *Image* has dimensions (k,n,m), a k-channel TIFF is written. Image should be in top to bottom scan line order. By default, this array is converted to byte format before being written (see the LONG, SHORT and FLOAT keywords below). Note that many TIFF readers can read only one- or three-channel images.

**Note**

The Image argument is optional if PLANARCONFIG is set to 2 and the RED, GREEN, and BLUE keywords have been set to 2D arrays.

**Note**

Grayscale TIFF images are written out with the PhotometricInterpretation tag set to BlackIsZero, implying that values of 0 should correspond to black. If you want values of 0 to correspond to white, you should invert your pixel values before calling WRITE_TIFF.

### Order

*This argument is obsolete. The Order argument has been replaced by the ORIENTATION keyword. Code that uses the Order argument will continue to work as before, but new code should use the ORIENTATION keyword instead.*

## Keywords

### APPEND

Set this keyword to specify that the image should be added to the existing file, creating a multi-image TIFF file.

### BITS_PER_SAMPLE

Set this keyword to either 1, 4, or 8 to create a grayscale image file with the specified number of bits per pixel. For 1-bit (bi-level) images, an output pixel is assigned the value 1 (one) if the corresponding input pixel is nonzero. For 4-bit grayscale images, the input pixel values *must* be in the range 0 through 15, or the image will be garbled. The default is BITS_PER_SAMPLE=8. This keyword is ignored if an RGB image or color palette is present, or if one of the FLOAT, LONG, or SHORT keywords is set.

### COMPRESSION

Set this keyword to select the type of compression to be used:

- 0 = none (default)
- 2 = PackBits
- 3 = JPEG (ITIFF files)

**Note**

For COMPRESSION=3 (JPEG), all images are assumed to be in top-to-bottom order, and the ORIENTATION keyword should not be specified. If your input image is not in top-to-bottom order, you should use REVERSE(*image*, 2) to flip the order before calling WRITE_TIFF.

### FLOAT

Set this keyword to write the pixel components as floating-point entities (the default is 8-bit).

## GEOTIFF

Set this keyword to an anonymous structure containing one field for each of the GeoTIFF tags and keys to be written into the file. The GeoTIFF structure is formed using fields named from the following table.

| Anonymous Structure Field Name | IDLDatatype |
|---|---|
| **TAGS:** | |
| "MODELPIXELSCALETAG" | DOUBLE[3] |
| "MODELTRANSFORMATIONTAG" | DOUBLE[4,4] |
| "MODELTIEPOINTTAG" | DOUBLE[6,*] |
| **KEYS:** | |
| "GTMODELTYPEGEOKEY" | INT |
| "GTRASTERTYPEGEOKEY" | INT |
| "GTCITATIONGEOKEY" | STRING |
| "GEOGRAPHICTYPEGEOKEY" | INT |
| "GEOGCITATIONGEOKEY" | STRING |
| "GEOGGEODETICDATUMGEOKEY" | INT |
| "GEOGPRIMEMERIDIANGEOKEY" | INT |
| "GEOGLINEARUNITSGEOKEY" | INT |
| "GEOGLINEARUNITSIZEGEOKEY" | DOUBLE |
| "GEOGANGULARUNITSGEOKEY" | INT |
| "GEOGANGULARUNITSIZEGEOKEY" | DOUBLE |
| "GEOGELLIPSOIDGEOKEY" | INT |
| "GEOGSEMIMAJORAXISGEOKEY" | DOUBLE |
| "GEOGSEMIMINORAXISGEOKEY" | DOUBLE |
| "GEOGINVFLATTENINGGEOKEY" | DOUBLE |
| "GEOGAZIMUTHUNITSGEOKEY" | INT |

*Table 108: GEOTIFF Structures*

| Anonymous Structure Field Name | IDLDatatype |
|---|---|
| "GEOGPRIMEMERIDIANLONGGEOKEY" | DOUBLE |
| "PROJECTEDCSTYPEGEOKEY" | INT |
| "PCSCITATIONGEOKEY" | STRING |
| "PROJECTIONGEOKEY" | INT |
| "PROJCOORDTRANSGEOKEY" | INT |
| "PROJLINEARUNITSGEOKEY" | INT |
| "PROJLINEARUNITSIZEGEOKEY" | DOUBLE |
| "PROJSTDPARALLEL1GEOKEY" | DOUBLE |
| "PROJSTDPARALLEL2GEOKEY" | DOUBLE |
| "PROJNATORIGINLONGGEOKEY" | DOUBLE |
| "PROJNATORIGINLATGEOKEY" | DOUBLE |
| "PROJFALSEEASTINGGEOKEY" | DOUBLE |
| "PROJFALSENORTHINGGEOKEY" | DOUBLE |
| "PROJFALSEORIGINLONGGEOKEY" | DOUBLE |
| "PROJFALSEORIGINLATGEOKEY" | DOUBLE |
| "PROJFALSEORIGINEASTINGGEOKEY" | DOUBLE |
| "PROJFALSEORIGINNORTHINGGEOKEY" | DOUBLE |
| "PROJCENTERLONGGEOKEY" | DOUBLE |
| "PROJCENTERLATGEOKEY" | DOUBLE |
| "PROJCENTEREASTINGGEOKEY" | DOUBLE |
| "PROJCENTERNORTHINGGEOKEY" | DOUBLE |
| "PROJSCALEATNATORIGINGEOKEY" | DOUBLE |
| "PROJSCALEATCENTERGEOKEY" | DOUBLE |
| "PROJAZIMUTHANGLEGEOKEY" | DOUBLE |

*Table 108: GEOTIFF Structures (Continued)*

| Anonymous Structure Field Name | IDLDatatype |
|---|---|
| "PROJSTRAIGHTVERTPOLELONGGEOKEY" | DOUBLE |
| "VERTICALCSTYPEGEOKEY" | INT |
| "VERTICALCITATIONGEOKEY" | STRING |
| "VERTICALDATUMGEOKEY" | INT |
| "VERTICALUNITSGEOKEY" | INT |

*Table 108: GEOTIFF Structures (Continued)*

**Note**

If a GeoTIFF key appears multiple times in a file, only the value for the first instance of the key is returned.

## LONG

Set this keyword to write the pixel components as unsigned 32-bit entities (the default is 8-bit).

## ORIENTATION

Set this keyword to an integer value to specify the orientation of the TIFF image. The default is ORIENTATION=1.

**Note**

For COMPRESSION=3 (JPEG), all images are assumed to be in top-to-bottom order, and this keyword should not be specified.

Possible values are:

| Value | Description |
|---|---|
| 0 | Column 0 represents the left-hand side, and row 0 represents the bottom (same as 4) |
| 1 | Column 0 represents the left-hand side, and row 0 represents the top. |

*Table 109: ORIENTATION Keyword Values*

| Value | Description |
|---|---|
| 2 | Column 0 represents the right-hand side, and row 0 represents the top. |
| 3 | Column 0 represents the right-hand side, and row 0 represents the bottom. |
| 4 | Column 0 represents the left-hand side, and row 0 represents the bottom (same as 0) |
| 5 | Column 0 represents the top, and row 0 represents the left-hand side. |
| 6 | Column 0 represents the top, and row 0 represents the right-hand side. |
| 7 | Column 0 represents the bottom, and row 0 represents the right-hand side. |
| 8 | Column 0 represents the bottom, and row 0 represents the left-hand side. |

*Table 109: ORIENTATION Keyword Values (Continued)*

**Warning**

Not all TIFF readers honor the value of the ORIENTATION field. IDL writes the value into the file, but some readers are known to ignore this value. In such cases, we recommend that you convert the image to top-to-bottom order with the REVERSE function and then set ORIENTATION to 1.

## PLANARCONFIG

This keyword determines the order in which a multi-channel image is stored and written. It has no effect with a single-channel image. Set this keyword to 2 to if the Image parameter is interleaved by “plane”, or band, and its dimensions are (*Columns*, *Rows*, *Channels*). The default value is 1, indicating that multi-channel images are interleaved by color, also called channel, and its dimensions are (*Channels*, *Columns*, *Rows*).

As a special case, this keyword may be set to 2 to write an RGB image that is contained in three separate arrays (color planes), stored in the variables specified by the RED, GREEN, and BLUE keywords. Otherwise, omit this parameter (or set it to 1).

**Note**

Many TIFF readers can read only one- or three-channel images.

## RED, GREEN, BLUE

If you are writing a Palette color image, set these keywords equal to the color table vectors, scaled from 0 to 255.

If you are writing an RGB interleaved image (i.e., if the PLANARCONFIG keyword is set to 2), set these keywords to the names of the variables containing the three image components.

## SHORT

Set this keyword to write the pixel components as unsigned 16-bit entities (the default is 8-bit).

## UNITS

Set this keyword to one of the following values to specify the units used for the values specified by the XRESOL and YRESOL keywords:

| Value | Description |
|---|---|
| 1 | No units |
| 2 | Inches (the default) |
| 3 | Centimeters |

*Table 110: UNITS Keyword Values*

## VERBOSE

Set this keyword to produce additional diagnostic output during the write.

## XRESOL

Set this keyword to the horizontal resolution, in pixels per unit, where the unit is specified by the value of the UNITS keyword (inches, by default). The default value of XRESOL is 100. Note that while this value is stored in the TIFF file, it may be interpreted by the TIFF reader in a variety of ways, or ignored.

### YRESOL

Set this keyword to the vertical resolution, in pixels per unit, where the unit is specified by the value of the UNITS keyword (inches, by default). The default value of YRESOL is 100. Note that while this value is stored in the TIFF file, it may be interpreted by the TIFF reader in a variety of ways, or ignored.

## Examples

### Example 1

Create a pseudo screen dump from the current window. Note that this works only on a PseudoColor (8-bit) display:

```
WRITE_TIFF, 'test.tiff', TVRD()
```

### Example 2

Write a three-channel image from three one-channel (two-dimensional) arrays, contained in the variables Red, Green, and Blue:

```
WRITE_TIFF, 'test.tif', Red, Green, Blue, PLANARCONFIG=2
```

### Example 3

Write and read a multi-image TIFF file. The first image is a 16-bit single channel image stored using compression. The second image is an RGB image stored using 32-bits/channel uncompressed.

```
; Write the image data:
data = FIX(DIST(256))
rgbdata = LONARR(3,320,240)
WRITE_TIFF,'multi.tif',data,COMPRESSION=1,/SHORT
WRITE_TIFF,'multi.tif',rgbdata,/LONG,/APPEND
; Read the image data back
ok = QUERY_TIFF('multi.tif',s)
IF (ok) THEN BEGIN
   FOR i=0,s.NUM_IMAGES-1 DO BEGIN
      imp = QUERY_TIFF('multi.tif',t,IMAGE_INDEX=i)
      img = READ_TIFF('multi.tif',IMAGE_INDEX=i)
      HELP,t,/STRUCTURE
      HELP,img
   ENDFOR
ENDIF
```

## Version History

Introduced: 5.0

ITIFF support added: 5.6

## See Also

READ_TIFF, QUERY_* Routines

# WRITE_WAV

The WRITE_WAV procedure writes the audio stream to the named .WAV file.

## Syntax

WRITE_WAV, *Filename*, *Data*, *Rate*

## Arguments

### Filename

A scalar string containing the full pathname of the .WAV file to write.

### Data

The array to write into the new .WAV file. The array can be a one- or two-dimensional array. A two-dimensional array is written as a multi-channel audio stream where the leading dimension of the IDL array is the number of channels. If the input array is in BYTE format, the data is written as 8-bit samples, otherwise, the data is written as signed 16-bit samples.

### Rate

The sampling rate for the data array in samples per second.

## Keywords

None.

## Version History

Introduced: 5.3

# WRITE_WAVE

The WRITE_WAVE procedure writes a three dimensional IDL array to a `.wave` or `.bwave` file for use with the Wavefront Advanced Data Visualizer. Note that this routine only writes one scalar field for each Wavefront file that it creates.

This routine is written in the IDL language. Its source code can be found in the file `write_wave.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

WRITE_WAVE, *File*, *Array* [, /BIN] [, DATANAME=*string*] [, MESHNAME=*string*] [, /NOMESHDEF] [, /VECTOR]

## Arguments

### File

A scalar string containing the full path name of the Wavefront file to write.

### Array

A 3D array to be written to the file.

## Keywords

### BIN

Set this keyword to create a binary file. By default, text files are created.

### DATANAME

Set this keyword to the name of the data inside of the Wavefront file. If not specified, the name used is “idldata”.

### MESHNAME

Set this keyword to the name of the mesh used in the Wavefront file. If not specified, the name used is “idlmesh”.

### NOMESHDEF

Set this keyword to *omit* the mesh definition from the Wavefront file.

### VECTOR

Set this keyword to write the variable as a vector. The data is written as an array of 3-space vectors. The array may contain any number of dimensions but must have a leading dimension of 3. If the leading array dimension is not 3, this keyword is ignored.

## Version History

Introduced: Pre 4.0

## See Also

READ_WAVE

# WRITEU

The WRITEU procedure writes unformatted binary data from an expression into a file. This procedure performs a direct transfer with no processing of any kind being done to the data.

## Syntax

WRITEU, *Unit*, $Expr_1$ ..., $Expr_n$ [, TRANSFER_COUNT=*variable*]

## Arguments

### Unit

The IDL file unit to which the output is sent.

### $Expr_i$

The expressions to be output. For non-string variables, the number of bytes implied by the data type is output. When WRITEU is used with a variable of type string, IDL outputs exactly the number of bytes contained in the existing string.

## Keywords

### TRANSFER_COUNT

Set this keyword to a named variable in which to return the number of elements transferred by the output operation. Note that the number of elements is not the same as the number of bytes (except in the case where the data type being transferred is bytes). For example, transferring 256 floating-point numbers yields a transfer count of 256, not 1024 (the number of bytes transferred).

This keyword is useful with files opened with the RAWIO keyword to the OPEN routines. Normally, writing more data than an output device will accept causes an error. Files opened with the RAWIO keyword will not generate such an error. Instead, the programmer must keep track of the transfer count to judge the success or failure of a WRITEU operation.

### Obsolete Keywords

The following keywords are obsolete:

- REWRITE

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Examples

```
; Create some data to store in a file:
D = BYTSCL(DIST(200))
; Open a new file for writing as IDL file unit number 1:
OPENW, 1, 'newfile'
; Write the data in D to the file:
WRITEU, 1, D
; Close file unit 1:
CLOSE, 1
```

## Version History

Introduced: Original

## See Also

OPEN, READU, Chapter 10, “Files and Input/Output” in the *Building IDL Applications* manual, and “Unformatted Input/Output with Structures” in Chapter 7 of the *Building IDL Applications* manual.

# WSET

The WSET procedure selects the current window. Most IDL graphics routines do not explicitly require the IDL window to be specified. Instead, they use the window known as the current window. The window index number of the current window is contained in the read-only system variable !D.WINDOW. WSET only works with devices that have windowing systems.

## Syntax

WSET [, *Window_Index*]

## Arguments

### Window_Index

This argument specifies the window index of the window to be made current. If this argument is not specified, a default of 0 is used.

If you set *Window_Index* equal to -1, IDL will try to locate an existing window to make current, ignoring any managed draw widgets that may exist. If there is no window to make current, WSET changes the value of the WINDOW field of the !D system variable to -1, indicating that there are no current windows.

If there are no existing IDL windows, and you call WSET without the *Window_Index* argument or with a *Window_Index* of 0, a new window with the index 0 is opened. Calling WSET with a *Window_Index* for a window that does not exist, except for window 0, results in a “Window is closed and unavailable” error message.

## Keywords

None.

## Examples

Create IDL windows 1 and 2 by entering:

```
WINDOW, 1 & WINDOW, 2
```

Set the current window to window 1 and display an image by entering:

```
WSET, 1 & TVSCL, DIST(100)
```

Set the current window to window 2 and display an image by entering:

```
WSET, 2 & TVSCL, DIST(100)
```

## Version History

Introduced: Original

## See Also

WDELETE, WINDOW, WSHOW

# WSHOW

The WSHOW procedure exposes or hides the designated window.

## Syntax

WSHOW [, *Window_Index* [, *Show*]] [, /ICONIC]

## Arguments

### Window_Index

The window index of the window to be hidden or exposed. If this argument is not specified, the current window is assumed. If this index is the window ID of a draw widget, the widget base associated with that drawable is brought to the front of the screen.

### Show

Set *Show* to 0 to hide the window. Omit this argument or set it to 1 to expose the window.

## Keywords

### ICONIC

Set this keyword to iconify the window. Set ICONIC to 0 to de-iconify the window.

Under windowing systems, iconification is the task of the window manager, and client applications such as IDL have no direct control over it. The ICONIC keyword serves as a hint to the window manager, which is free to iconify the window or ignore the request as it sees fit.

## Examples

To bring IDL window number 0 to the front, enter:

```
WSHOW, 0
```

## Version History

Introduced: Original

## See Also

WDELETE, WINDOW, WSET

# WTN

The WTN function returns a multi-dimensional discrete wavelet transform of the input array A. The transform is based on a Daubechies wavelet filter.

WTN is based on the routine `wtn` described in section 13.10 of *Numerical Recipes in C: The Art of Scientific Computing* (Second Edition), published by Cambridge University Press, and is used by permission.

## Syntax

*Result* = WTN( *A*, *Coef* [, /COLUMN] [, /DOUBLE] [, /INVERSE] [, /OVERWRITE] )

Return Value

## Arguments

### A

The input vector or array. The dimensions of *A* must all be powers of 2.

### Coef

An integer that specifies the number of wavelet filter coefficients. The allowed values are 4, 12, or 20. When *Coef* is 4, the `daub4()` function (see *Numerical Recipes*, section 13.10) is used. When *Coef* is 12 or 20, `pwt()` is called, preceded by `pwtset()` (see *Numerical Recipes*, section 13.10).

## Keywords

### COLUMN

Set this keyword if the input array *A* is in column-major format (composed of column vectors) rather than in row-major format (composed of row vectors).

### DOUBLE

Set this keyword to force the computation to be done in double-precision arithmetic.

### INVERSE

If the INVERSE keyword is set, the inverse transform is computed. By default, WTN performs the forward wavelet transform.

### OVERWRITE

Set the OVERWRITE keyword to perform the transform “in place.” The result overwrites the original contents of the array.

## Examples

This example demonstrates the use of IDL’s discrete wavelet transform and sparse array storage format to compress and store an 8-bit gray-scale digital image. First, an image selected from the `people.dat` data file is transformed into its wavelet representation and written to a separate data file using the WRITEU procedure.

Next, the transformed image is converted, using the SPRSIN function, to row-indexed sparse storage format retaining only elements with an absolute magnitude greater than or equal to a specified threshold. The sparse image is written to a data file using the WRITE_SPR procedure.

Finally, the transformed image is reconstructed from the storage file and displayed alongside the original.

```
; Begin by choosing the number of wavelet coefficients to use and a
; threshold value:
coeffs = 12 & thres = 10.0

; Open the people.dat data file, read an image using associated
; variables, and close the file:
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])
images = assoc(1, bytarr(192, 192))
image_1 = images[0]
close, 1

; Expand the image to the nearest power of two using cubic
; convolution, and transform the image into its wavelet
; representation using the WTN function:
pwr = 256
image_1 = CONGRID(image_1, pwr, pwr, /CUBIC)
wtn_image = WTN(image_1, coeffs)

; Write the image to a file using the WRITEU procedure and check
; the size of the file (in bytes) using the FSTAT function:
OPENW, 1, 'original.dat'
WRITEU, 1, wtn_image
```

```
status = FSTAT(1)
CLOSE, 1
PRINT, 'Size of the file is ', status.size, ' bytes.'

; Now, we convert the wavelet representation of the image to a
; row-indexed sparse storage format using the SPRSIN function,
; write the data to a file using the WRITE_SPR procedure, and check
; the size of the "compressed" file:
sprs_image = SPRSIN(wtn_image, THRES = thres)
WRITE_SPR, sprs_image, 'sparse.dat'
OPENR, 1, 'sparse.dat'
status = FSTAT(1)
CLOSE, 1
PRINT, 'Size of the compressed file is ', status.size, ' bytes.'

; Determine the number of elements (as a percentage of total
; elements) whose absolute magnitude is less than the specified
; threshold. These elements are not retained in the row-indexed
; sparse storage format:
PRINT, 'Percentage of elements under threshold: ',$
   100.*N_ELEMENTS(WHERE(ABS(wtn_image) LT thres, $
   count)) / N_ELEMENTS(image_1)

; Next, read the row-indexed sparse data back from the file
; sparse.dat using the READ_SPR function and reconstruct the
; image from the non-zero data using the FULSTR function:
sprs_image = READ_SPR('sparse.dat')
wtn_image = FULSTR(sprs_image)

; Apply the inverse wavelet transform to the image:
image_2 = WTN(wtn_image, COEFFS, /INVERSE)

; Calculate and print the amount of data used in reconstruction of
; the image:
PRINT, 'The image on the right is reconstructed from:', $
   100.0 - (100.* count/N_ELEMENTS(image_1)),$
   '% of original image data.'

; Finally, display the original and reconstructed images side by
; side:
WINDOW, 1, XSIZE = pwr*2, YSIZE = pwr, $
   TITLE = 'Wavelet Image Compression and File I/O'
TV, image_1, 0, 0
TV, image_2, pwr - 1, 0
```

### IDL Output

```
Size of the file is   262144 bytes.
Size of the compressed file is   69600 bytes.
```

```
Percentage of elements under threshold:   87.0331
The image on the right is reconstructed from: 12.9669% of original
image data.
```

The sparse array contains only 13% of the elements contained in the original array. The following figure is created from this example. The image on the left is the original 256 by 256 image. The image on the right was compressed by the above process and was reconstructed from 13% of the original data. The size of the compressed image's data file is 26.6% of the size of the original image's data file. Note that due to limitations in the printing process, differences between the images may not be as evident as they would be on a high-resolution printer or monitor.

*Figure 31: Original image (left) and image reconstructed from 13% of the data (right).*

## Version History

Introduced: 4.0

## See Also

FFT

# WV_* Routines

For information, see the *Chapter 1, "Introduction to the IDL Wavelet Toolkit"* in the *IDL Wavelet Toolkit* manual.

# XBM_EDIT

The XBM_EDIT procedure is a utility for creating and editing icons for use with IDL widgets as bitmap labels for widget buttons.

The icons created with XBM_EDIT can be saved in two different file formats. IDL "array definition files" are text files that can be inserted into IDL programs. "Bitmap array files" are data files that can be read into IDL programs. Bitmap array files should be used temporarily until the final icon design is determined and then they can be saved as IDL array definitions for inclusion in the final widget code. This routine does not check the file types of the files being read and assumes that they are of the correct size and type for reading. XBM_EDIT maintains its state in a common block so it is restricted to one working copy at a time.

This routine is written in the IDL language. Its source code can be found in the file `xbm_edit.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XBM_EDIT [, /BLOCK] [, FILENAME=*string*] [, GROUP=*widget_id*] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

## Arguments

None.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XBM_EDIT block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

### FILENAME

Set this keyword to a scalar string that contains the filename to be used for the new icon. If this argument is not specified, the name “idl.bm” is used. The filename can be changed in XBM_EDIT by editing the “Filename” field before selecting a file option.

### GROUP

The widget ID of the widget that calls XBM_EDIT. When this ID is specified, the death of the caller results in the death of XBM_EDIT.

### XSIZE

The number of pixels across the bitmap is in the horizontal direction. The default value is 16 pixels.

### YSIZE

The number of pixels across the bitmap is in the vertical direction. The default value is 16 pixels.

## Version History

Introduced: Pre 4.0

## See Also

WIDGET_BUTTON

# XDISPLAYFILE

The XDISPLAYFILE procedure is a utility for displaying ASCII text files using a widget interface.

This routine is written in the IDL language. Its source code can be found in the file `xdisplayfile.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XDISPLAYFILE, *Filename* [, /BLOCK] [, DONE_BUTTON=*string*]
[, /EDITABLE] [, FONT=*string*] [, GROUP=*widget_id*] [, HEIGHT=*lines*]
[, /MODAL] [, TEXT=*string or string array*] [, TITLE=*string*]
[, WIDTH=*characters*] [, WTEXT=*variable*]

## Arguments

### Filename

A scalar string that contains the filename of the file to display. *Filename* can include a path to that file.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XDISPLAYFILE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## DONE_BUTTON

Set this keyword to a string containing the text to use for the Done button label. If omitted, the text “Done with <filename>” is used.

## EDITABLE

Set this keyword to allow modifications to the text displayed in XDISPLAYFILE. Setting this keyword also adds a “Save” button in addition to the Done button.

## FONT

A string containing the name of the font to use. The font specified is a device font (an X Windows font on Motif systems; a TrueType or PostScript font on Windows systems). See “About Device Fonts” on page 3962 for details on specifying names for device fonts. If this keyword is omitted, the default font is used.

## GROUP

The widget ID of the widget that calls XDISPLAYFILE. If this keyword is specified, the death of the group leader results in the death of XDISPLAYFILE.

## HEIGHT

The number of text lines that the widget should display at one time. If this keyword is not specified, 24 lines is the default.

## MODAL

Set this keyword to create the XDISPLAYFILE dialog as a modal dialog. Setting the MODAL keyword allows you to call XDISPLAYFILE from another modal dialog.

## TEXT

A string or string array to be displayed in the widget instead of the contents of a file. If this keyword is present, the *Filename* input argument is ignored (but is still required). String arrays are displayed one element per line.

## TITLE

A string to use as the widget title rather than the file name or “XDisplayFile”.

## WIDTH

The width of the widget display in characters. If this keyword is not specified, 80 characters is the default.

### WTEXT

Set this keyword to a named variable that will contain the widget ID of the text widget. This allows setting text selections and cursor positions programmatically. For example, the following code opens the XDISPLAYFILE widget and selects the first 10 characters of the file displayed in the text widget:

```
XDISPLAYFILE, 'myfile.txt', /EDITABLE, WTEXT=w
WIDGET_CONTROL, w, SET_TEXT_SELECT=[0, 10]
```

## Version History

Introduced: Pre 4.0

## See Also

PRINT/PRINTF, XYOUTS

# XDXF

The XDXF procedure is a utility for displaying and interactively manipulating DXF objects.

## Using XDXF

XDXF displays a resizeable top-level base with a menu and draw widget used to display and manipulate the orientation of a DXF object.

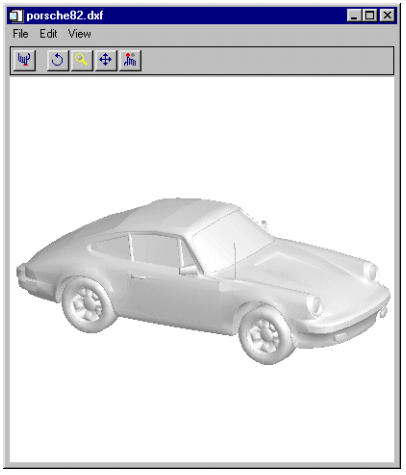



*Figure 32: The XDXF Utility*

XDXF also displays a dialog that contains block and layer information and allows the user to turn on and off the display of individual layers.

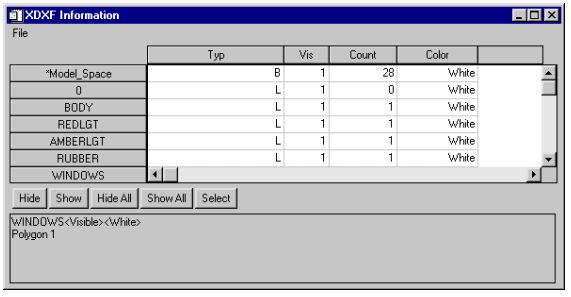



*Figure 33: The XDXF Information Dialog*

### The XDXF Toolbar

The XDXF toolbar contains the following buttons:

**Reset:** Resets rotation, scaling, and panning.

**Rotate:** Click the left mouse button on the object and drag to rotate.

**Pan:** Click the left mouse button on the object and drag to pan.

**Zoom:** Click the left mouse button on the object and drag to zoom in or out.

**Select:** Click on the object. The name of the selected object is displayed, if the object has a name, otherwise its class is displayed.

### The XDXF Information Dialog

The XDXF Information dialog displays information about the blocks and layers contained in the currently displayed object, and allows you to turn on and off the display of each layer.

To show or hide layers in the DXF object, select the layer from the list of layers on the left of the dialog, and click the **Show** or **Hide** button. Alternatively, you can click in the “Vis” field for the desired layer. To show or hide all layers, click the **Show All** or **Hide All** buttons.

If the **View Block Outlines** checkbox is selected, a green box will be displayed around the currently selected block, if any.

## Syntax

XDXF [, *Filename*] [, /BLOCK] [, GROUP=*widget_id*] [, SCALE=*value*] [, /TEST] [*keywords to XOBJVIEW*]

## Arguments

### Filename

A string specifying the name of the DXF file to display. If this argument is not specified, a file selection dialog is opened.

# Keywords

XDXF accepts the keywords to XOBJVIEW. (Note, however, that specifying the XOBJVIEW keyword MODAL is interpreted by XDXF as a call to the BLOCK keyword.) In addition, XDXF supports the following keywords:

## BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XDXF block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## GROUP

The widget ID of the widget that calls XDXF. When this ID is specified, the death of the caller results in the death of XDXF.

## SCALE

Set this keyword to the zoom factor for the initial view. The default is 1/SQRT(3). This default value provides the largest possible view of the object, while ensuring that no portion of the object will be clipped by the XDXF window, regardless of the object's orientation.

## TEST

If this keyword is set, the file `heart.dxf` in the IDL distribution is automatically opened in XDXF.

# Examples

Display the file `heart.dxf`, contained in the IDL distribution:

```
XDXF, FILEPATH('heart.dxf', $
   SUBDIR=['examples', 'data'])
```

## Version History

Introduced: 5.4

## See Also

IDLffDXF

# XFONT

The XFONT function is a utility that creates a modal widget for selecting and viewing an X Windows font.

Calling XFONT resets the current X Windows font.

**Note**

This routine is only available on UNIX platforms.

This routine is written in the IDL language. Its source code can be found in the file `xfont.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

*Result* = XFONT( [, GROUP=*widget_id*] [, /PRESERVE_FONT_INFO] )

## Return Value

The function returns a string containing the name of the last selected font. If no font is selected, or the “Cancel” button is clicked, a null string is returned.

## Arguments

None.

## Keywords

### GROUP

The widget ID of the widget that calls XFONT. When this ID is specified, the death of the caller results in the death of XFONT.

### PRESERVE_FONT_INFO

Set this keyword to make XFONT save the server font directory in common blocks so that subsequent calls to XFONT start-up much faster. If this keyword is not set, the common block is cleaned.

## Version History

Introduced: Pre 4.0

## See Also

EFONT, SHOWFONT

# XINTERANIMATE

The XINTERANIMATE procedure is a utility for displaying an animated sequence of images using off-screen pixmaps or memory buffers. The speed and direction of the display can be adjusted using the widget interface.

MPEG animation files can be created either programmatically using keywords to open and save a file, or interactively using the widget interface. Note that the MPEG standard does not allow movies with odd numbers of pixels to be created.

**Note**

MPEG support in IDL requires a special license. For more information, contact your RSI sales representative or technical support.

**Note**

Only a single copy of XINTERANIMATE can run at a time. If you need to run multiple instances of the animation widget concurrently, use the CW_ANIMATE compound widget.

This routine is written in the IDL language. Its source code can be found in the file `xinteranimate.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Using XINTERANIMATE

Displaying an animated series of images using XINTERANIMATE requires at least three calls to the routine: one to initialize the animation widget, one to load images, and one to display the images. When initialized using the SET keyword, XINTERANIMATE creates an approximately square pixmap or memory buffer, large enough to contain the requested number of frames of the requested size. Images are loaded using the IMAGE and FRAME keywords. Finally, images are displayed by copying them from the pixmap or memory buffer to the visible draw widget.

See CW_ANIMATE for a description of the widget interface controls used by XINTERANIMATE.

# Syntax

XINTERANIMATE [, *Rate*]

**Keywords for initialization:** [, SET=*[sizex, sizey, nframes]*] [, /BLOCK] [, /CYCLE] [, GROUP=*widget_id*] [, /MODAL] [, MPEG_BITRATE=*value*] [, MPEG_IFRAME_GAP=*integer value*] [, MPEG_MOTION_VEC_LENGTH={1 | 2 | 3}] [, /MPEG_OPEN, MPEG_FILENAME=*string*] [ MPEG_QUALITY=*value*{0 to 100}] [, /SHOWLOAD] [, /TRACK] [, TITLE=*string*]

**Keywords for loading images:** [, FRAME=*value*{0 to (*nframes*-1)}[, IMAGE=*value*]] [, /ORDER] [, WINDOW=*[window_num* [, *x0*, *y0*, *sx*, *sy*]*]*]

**Keywords for running animations:** [, /CLOSE] [, /KEEP_PIXMAPS] [, /MPEG_CLOSE] [, XOFFSET=*pixels*] [, YOFFSET=*pixels*]

# Arguments

## Rate

A value between 0 and 100 that represents the speed of the animation as a percentage of the maximum display rate. The fastest animation is with a value of 100 and the slowest is with a value of 0. The default animation rate is 100. The animation must be initialized using the SET keyword before calling XINTERANIMATE with a rate value.

# Keywords: Initialization

The following keywords are used to initialize the animation display. The SET keyword *must* be provided. Other keywords described in this section are optional; note that they work only when SET is specified.

## SET

Set this keyword to a three-element vector [*Sizex*, *Sizey*, *Nframes*] to initialize XINTERANIMATE. *Sizex* and *Sizey* represent the width and height of the images to be displayed, in pixels. *Nframes* is the number of frames in the animation sequence. Note that *Nframes* must be at least 2 frames.

## BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active

command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XINTERANIMATE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## CYCLE

Normally, frames are displayed going either forward or backwards. If the CYCLE keyword is set, the animation reverses direction after the last frame in either direction is displayed.

## GROUP

Set this keyword to the widget ID of the widget that calls XINTERANIMATE. When GROUP is specified, the death of the calling widget results in the death of XINTERANIMATE.

## MODAL

Set this keyword to block processing of events from other widgets until the user quits XINTERANIMATE. A group leader must be specified (via the GROUP keyword) for the MODAL keyword to have any effect. By default, XINTERANIMATE does not block event processing.

## MPEG_BITRATE

Set this keyword to a double-precision value to specify the MPEG movie bit rate. Higher bit rates will create higher quality MPEGs but will increase file size. The following table describes the valid values:

| MPEG Version | Range |
|---|---|
| MPEG 1 | 0.1 to 104857200.0 |
| MPEG 2 | 0.1 to 429496729200.0 |

*Table 111: BITRATE Value Range*

If you do not set this keyword, IDL computes the MPEG_BITRATE value based upon the value you have specified for the MPEG_QUALITY keyword.

**Note**

Only use the MPEG_BITRATE keyword if changing the MPEG_QUALITY keyword value does not produce the desired results. It is highly recommended to set the MPEG_BITRATE to at least several times the frame rate to avoid unusable MPEG files or file generation errors.

## MPEG_FILENAME

Set this keyword equal to a string specifying the name of the MPEG file. If no file name is specified, the default value (`idl.mpg`) is used.

## MPEG_IFRAME_GAP

Set this keyword to a positive integer value that specifies the number of frames between I frames to be created in the MPEG file. I frames are full-quality image frames that may have a number of predicted or interpolated frames between them.

If you do not specify this keyword, IDL computes the MPEG_IFRAME_GAP value based upon the value you have specified for the MPEG_QUALITY keyword.

**Note**

Only use the MPEG_IFRAME_GAP keyword if changing the MPEG_QUALITY keyword value does not produce the desired results.

## MPEG_MOTION_VEC_LENGTH

Set this keyword to an integer value specifying the length of the motion vectors to be used to generate predictive frames. Valid values include:

- 1 = Small motion vectors.
- 2 = Medium motion vectors.
- 3 = Large motion vectors.

If you do not set this keyword, IDL computes the MPEG_MOTION_VEC_LENGTH value based upon the value you have specified for the MPEG_QUALITY keyword.

**Note**

Only use the MPEG_MOTION_VEC_LENGTH keyword if changing the MPEG_QUALITY value does not produce the desired results.

### MPEG_OPEN

Set this keyword to open an MPEG file.

### MPEG_QUALITY

Set this keyword to an integer value between 0 (low quality) and 100 (high quality) inclusive to specify the quality at which the MPEG stream is to be stored. Higher quality values result in lower rates of time compression and less motion prediction which provide higher quality MPEGs but with substantially larger file size. Lower quality factors may result in longer MPEG generation times. The default is 50.

**Note**

Since MPEG uses JPEG (lossy) compression, the original picture quality can't be reproduced even when setting QUALITY to its highest setting.

### SHOWLOAD

Set this keyword to display each frame and update the frame slider as frames are loaded.

### TRACK

Set this keyword to cause the frame slider to track the current frame when the animation is in progress. The default is not to track.

### TITLE

Use this keyword to specify a string to be used as the title of the animation widget. If TITLE is not specified, the title is set to "XInterAnimate."

## Keywords: Loading Images

The following keywords are used to load images into the animation display. They have no effect when initializing or running animations.

### FRAME

Use this keyword to specify the frame number when loading frames. FRAME must be set to a number in the range 0 to *Nframes*-1.

### IMAGE

Use this keyword to specify a single image to be loaded at the animation position specified by the FRAME keyword. (FRAME *must* also be specified.)

### ORDER

Set this keyword to display images from the top down instead of the default bottom up.

### WINDOW

When this keyword is specified, an image is copied from an existing window to the animation pixmap or memory buffer. (When using some windowing systems, using this keyword is much faster than reading from the display and then calling XINTERANIMATE with a 2-D array.)

The value of this parameter is either an IDL window number (in which case the entire window is copied), or a vector containing the window index and the rectangular bounds of the area to be copied. For example:

```
WINDOW = [Window_Number, X0, Y0, Sx, Sy]
```

## Keywords: Running Animations

The following keywords are used when running the animation. They have no effect when initializing the animation or loading images.

### CLOSE

Set this keyword to delete the offscreen pixmaps or buffers and the animation widget itself. This also takes place automatically when the user presses the “Done With Animation” button or closes the window with the window manager.

### KEEP_PIXMAPS

If this keyword is set, XINTERANIMATE will not destroy the animation pixmaps or buffers when it is killed. Calling XINTERANIMATE again without going through the SET and LOAD steps will play the same animation without the overhead of creating the pixmaps.

### MPEG_CLOSE

Set this keyword to close and save the MPEG file. This keyword has no effect if MPEG_OPEN was not used during initialization.

### XOFFSET

Use this keyword to specify the horizontal offset, in pixels from the left of the frame, of the image in the destination window.

### YOFFSET

Use this keyword to specify the vertical offset, in pixels from the bottom of the frame, of the image in the destination window.

## Examples

Enter the following commands to open the file `ABNORM.DAT` (a series of images of a human heart) and animate the images it contains using XINTERANIMATE.

```
OPENR, unit, FILEPATH('abnorm.dat', SUBDIR=['examples','data']), $
   /GET_LUN
H = BYTARR(64, 64, 16)
READU, unit, H
CLOSE, unit

; Read the images into variable H:
H = REBIN(H, 128, 128, 16)

; Initialize XINTERANIMATE:
XINTERANIMATE, SET=[128, 128, 16], /SHOWLOAD

; Load the images into XINTERANIMATE:
FOR I=0,15 DO XINTERANIMATE, FRAME = I, IMAGE = H[*,*,I]

; Play the animation:
XINTERANIMATE, /KEEP_PIXMAPS
```

**Note**

Since the KEEP_PIXMAPS keyword was supplied, the same animation can be replayed (after the animation widget has been destroyed) with the single command `XINTERANIMATE`.

## Version History

Introduced: Pre 4.0

## See Also

CW_ANIMATE

# XLOADCT

The XLOADCT procedure is a utility that provides a graphical widget interface to the LOADCT procedure. XLOADCT displays the current colortable and shows a list of available predefined color tables. Clicking on the name of a color table causes that color table to be loaded in true color decomposed visual. Many other options, such as Gamma correction, stretching, and transfer functions can also be applied to the colortable.

This routine is written in the IDL language. Its source code can be found in the file `xloadct.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XLOADCT [, /BLOCK] [, BOTTOM=*value*] [, FILE=*string*] [, GROUP=*widget_id*] [, /MODAL] [, NCOLORS=*value*] [, /SILENT]
[, UPDATECALLBACK=‘*procedure_name*’ [, UPDATECBDATA=*value*]]
[, /USE_CURENT]

## Arguments

None.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XLOADCT block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## BOTTOM

The first color index to use. XLOADCT will use color indices from BOTTOM to BOTTOM+NCOLORS-1. The default is BOTTOM=0.

## FILE

Set this keyword to a string representing the name of the file to be used instead of the file `colors1.tbl` in the IDL directory.

## GROUP

The widget ID of the widget that calls XLOADCT. When this ID is specified, a death of the caller results in a death of XLOADCT.

## MODAL

Set this keyword to block processing of events from other widgets until the user quits XLOADCT. A group leader must be specified (via the GROUP keyword) for the MODAL keyword to have any effect. By default, XLOADCT does not block event processing.

## NCOLORS

The number of colors to use. Use color indices from 0 to the smaller of !D.TABLE_SIZE-1 and NCOLORS-1. The default is all available colors (!D.TABLE_SIZE).

## SILENT

Normally, no informational message is printed when a color map is loaded. If this keyword is set to zero, the message is printed.

## UPDATECALLBACK

Set this keyword to a string containing the name of a user-supplied procedure that will be called when the color table is updated by XLOADCT. The procedure may optionally accept a keyword called DATA, which will be automatically set to the value specified by the optional UPDATECBDATA keyword.

## UPDATECBDATA

Set this keyword to a value of any type. It will be passed via the DATA keyword to the user-supplied procedure specified via the UPDATECALLBACK keyword, if any. If

the UPDATECBDATA keyword is not set the value accepted by the DATA keyword to the procedure specified by UPDATECALLBACK will be undefined.

### USE_CURRENT

Set this keyword to use the current color tables, regardless of the contents of the COLORS common block.

## Version History

Introduced: Pre 4.0

## See Also

LOADCT, XPALETTE, TVLCT

# XMANAGER

The XMANAGER procedure provides the main event loop and management for widgets created using IDL. Calling XMANAGER "registers" a widget program with the XMANAGER event handler. XMANAGER takes control of event processing until all widgets have been destroyed.

Beginning with IDL version 5.0, IDL supports an *active command line* that allows the IDL command input line to continue accepting input while properly configured widget applications are running. See "A Note About Blocking in XMANAGER" on page 2417 for a more detailed explanation of the active command line.

This routine is written in the IDL language. Its source code can be found in the file `xmanager.pro` in the `lib` subdirectory of the IDL distribution.

**Warning**

Although this routine is written in the IDL language, it may change in the future in its internal implementation. For future upgradability, it is best not to modify or even worry about what this routine does internally.

## Syntax

XMANAGER [, *Name*, *ID*] [, /CATCH] [, CLEANUP=*string*]
[, EVENT_HANDLER='*procedure_name*'] [, GROUP_LEADER=*widget_id*]
[, /JUST_REG] [, /NO_BLOCK]

## Arguments

### Name

A string that contains the name of the routine that creates the widget (i.e., the name of the widget creation routine that is calling XMANAGER).

**Note**

The *Name* argument is stored in a COMMON block for use by the XREGISTERED routine. The stored name is case-sensitive.

### ID

The widget ID of the top-level base that is the root of the widget hierarchy being to be managed.

# Keywords

## BACKGROUND

*This keyword is obsolete and is included in XMANAGER for compatibility with existing code only. Its functionality has been replaced by the TIMER keyword to the WIDGET_CONTROL procedure.*

## CATCH

Set this keyword to cause XMANAGER to catch any errors, using the CATCH procedure, when dispatching widget events. If the CATCH keyword is set equal to zero, execution halts and IDL provides traceback information when an error is detected. This keyword is set by default (errors are caught and processing continues).

Do not specify either the *Name* or *ID* argument to XMANAGER when specifying the CATCH keyword (they are ignored). CATCH turns error catching on and off for *all* applications managed by XMANAGER. When CATCH is specified, XMANAGER changes its error-catching behavior and returns immediately, without taking any other action.

**Note**

Beginning with IDL version 5.0, the default behavior of XMANAGER is to catch errors and continue processing events. In versions of IDL prior to version 5.0, XMANAGER halted when an error was detected. This change in default behavior was necessary in order to allow multiple widget applications (all being managed by XMANAGER) to coexist peacefully. When CATCH is set equal to zero, (the old behavior), any error halts XMANAGER, and thus halts event processing for all running widget applications.

Note also that CATCH is only effective if XMANAGER is blocking to dispatch errors. If event dispatching for an active IDL command line is in use, the CATCH keyword has no effect.

The CATCH=0 setting (errors are not caught and processing halts in XMANAGER when an error is detected) is intended as a debugging aid. Finished programs should not set CATCH=0.

## CLEANUP

Set this keyword to a string that contains the name of the routine to be called when the widget program dies. If this keyword is not specified, the routine (if any) specified

for the program's top-level base by the KILL_NOTIFY keyword to WIDGET_BASE or WIDGET_CONTROL is used.

The routine specified by CLEANUP becomes the KILL_NOTIFY routine for the widget application, overriding any cleanup routines that have been set previously via the KILL_NOTIFY keyword to WIDGET_BASE or WIDGET_CONTROL.

**Note**

Specifying a routine for the widget application's top-level base via the KILL_NOTIFY keyword to WIDGET_CONTROL *after* the call to XMANAGER will override the value of the CLEANUP keyword.

The cleanup routine is called with the widget identifier as its only argument.

## EVENT_HANDLER

Set this keyword to a string that contains the name of a routine to be called when a widget event occurs in the widget program being registered. If this keyword is not supplied, XMANAGER will construct a default name by adding the "_event" suffix to the *Name* argument. See the example below for a more detailed explanation.

## GROUP_LEADER

The widget ID of the group leader for the widget being processed. When the leader dies either by the users actions or some other routine, all widgets that have that leader will also die.

For example, a widget that views a help file for a demo widget would have that demo widget as its leader. When the help widget is registered, it sets the keyword GROUP_LEADER to the widget ID of the demo widget. If the demo widget were destroyed, the help widget led by it would be killed by the XMANAGER.

## JUST_REG

Set this keyword to indicate that XMANAGER should just register the widget and return immediately. This keyword is useful if you want to register a group of related top-level widgets before beginning event processing and one or more of the registered widgets requests that XMANAGER block event processing. (Note that in this case a later call to XMANAGER without the JUST_REG keyword is necessary to begin blocking.)

(See "A Note About Blocking in XMANAGER" on page 2417 for further discussion of the active command line.)

**Warning**

JUST_REG is not the same as NO_BLOCK. See "JUST_REG vs. NO_BLOCK" on page 2417 for additional details.

## NO_BLOCK

Set this keyword to tell XMANAGER that the registering client does not require XMANAGER to block if active command line event processing is available. If active command line event processing is available *and* every current XMANAGER client specifies NO_BLOCK, then XMANAGER will not block and the user will have access to the command line while widget applications are running.

**Note**

NO_BLOCK is ignored by IDL Runtime. If a main procedure uses XMANAGER with the NO_BLOCK keyword set, IDL Runtime defers subsequent processing of the commands following the XMANAGER call until the widget associated with the call to XMANAGER is destroyed.

It is important to understand the result of making nested calls to XMANAGER. XMANAGER can only block event processing for one client at a time. In applications involving multiple calls to XMANAGER (either directly or via calls to other routines that call XMANAGER, such as XLOADCT), blocking occurs only for the outermost call to XMANAGER, unless XMANAGER is told not to block in that call. If an application contains two calls to XMANAGER, the second call cannot block unless the first call sets the NO_BLOCK keyword. If an application contains a call to XMANAGER, followed by a call to XLOADCT, XLOADCT will not block unless the NO_BLOCK keyword was set in the call to XMANAGER (and the BLOCK keyword to XLOADCT is set). Consider the following example:

```
PRO blocking_example_event, event
   ; The following call blocks only if the NO_BLOCK keyword to
   ; XMANAGER is set:
   XLOADCT, /BLOCK
END

PRO blocking_example
   base=WIDGET_BASE(/COLUMN)
   button1=WIDGET_BUTTON(base,VALUE='Run XLOADCT')
   WIDGET_CONTROL,base, /REALIZE
   XMANAGER,'blocking_example', base, /NO_BLOCK
END
```

If the NO_BLOCK keyword to XMANAGER was not set in the above example, XLOADCT would not block, even though the BLOCK keyword was set. Setting the

NO_BLOCK keyword to XMANAGER prevents XMANAGER from blocking, thereby allowing the subsequent call to XMANAGER (via XLOADCT) to block.

**Warning**

NO_BLOCK is not the same as JUST_REG. See "JUST_REG vs. NO_BLOCK" on page 2417 for additional details.

# A Note About Blocking in XMANAGER

By default, IDL widget application blocking is *enabled*. Unless you take the appropriate steps, widget applications will block all other processing from occurring in IDL. Keeping the following issues in mind when writing widget applications will give you the best chance to create applications that coexist with other applications and the IDL command line.

## Active Command Line

Beginning with IDL version 5.0, most versions of IDL's command-processing front-end are able to support an *active command line* while running properly constructed widget applications. What this means is that—provided the widget application is properly configured—the IDL command input line is available for input while a widget application is running and widget events are being processed.

There are currently 3 separate IDL command-processing front-end implementations:

- Microsoft Windows IDLDE
- Motif IDLDE (UNIX)
- UNIX plain tty

Note that widget applications must be well-behaved with respect to blocking widget event processing. Since in most cases XMANAGER is used to handle widget event processing, this means that in order for the command line to remain active, all widget applications must be run with the NO_BLOCK keyword to XMANAGER set. (Note that since NO_BLOCK is *not* the default, it is quite likely that some application will block.) If a single application runs in blocking mode, the command line will be inaccessible until the blocking application exits. When a blocking application exits, the IDL command line will once again become active.

## JUST_REG vs. NO_BLOCK

Although their names imply a similar function, the JUST_REG and NO_BLOCK keywords perform very different services. It is important to understand what they do and how they differ.

The JUST_REG keyword tells XMANAGER that it should simply register a client and then return immediately. The result is that the client becomes known to XMANAGER, and that future calls to XMANAGER will take this client into account. Therefore, JUST_REG only controls how the registering call to XMANAGER should behave. The client can still be registered as requiring XMANAGER to block by setting NO_BLOCK=0. In this case, *future* calls to XMANAGER will block.

**Note**

JUST_REG is useful in situations where you suspect blocking might occur—if the active command line is not supported and you wish to keep it active before beginning event processing, if no command line is available (as with IDL Runtime applications), or if blocking will be requested at a later time. If no blocking will occur or if the blocking behavior is useful, it is not necessary to use JUST_REG.

The NO_BLOCK keyword tells XMANAGER that the registered client does not require XMANAGER to block if the command-processing front-end is able to support active command line event processing. XMANAGER remembers this attribute of the client until the client exits, even after the call to XMANAGER that registered the client returns. NO_BLOCK is just a “vote” on how XMANAGER should behave—the final decision is made by XMANAGER by considering the NO_BLOCK attributes of *all* of its current clients as well as the ability of the command-processing front-end in use to support the active command line.

## Blocking vs. Non-blocking Applications

The issue of blocking in XMANAGER requires some explanation. IDL widget events are not processed until the WIDGET_EVENT function is called to handle them. Otherwise, they are queued by IDL indefinitely. Knowing how and when to call WIDGET_EVENT is the primary service provided by XMANAGER.

There are two ways blocking is typically handled:

1. The first call to XMANAGER processes events by calling WIDGET_EVENT as necessary until no managed widgets remain on the screen. This is referred to as “blocking” because XMANAGER does not return to the caller until it is done, and the IDL command line is not available.
2. XMANAGER does not block, and instead, the part of IDL that reads command input also watches for widget events and calls WIDGET_EVENT as necessary while also reading command input. This is referred to as “non-blocking” or “active command line” mode.

XMANAGER will block unless the following conditions are met:

- All registered widget applications have the NO_BLOCK keyword to XMANAGER set.
- No modal dialogs are displayed. (Modal dialogs always block until dismissed.)

In general, we suggest that new widget applications be written with XMANAGER blocking disabled (that is, with the NO_BLOCK keyword set), unless the widget application will be run on IDL Runtime.

**Note**

NO_BLOCK is ignored by IDL Runtime. If a main procedure uses XMANAGER with the NO_BLOCK keyword set, IDL Runtime defers subsequent processing of the commands following the XMANAGER call until the widget associated with the call to XMANAGER is destroyed.

Since a widget application that does block event processing for itself will block event processing for all other widget applications (and the IDL command line) as well, we suggest that older widget applications be upgraded to take advantage of the new, non-blocking behavior by adding the NO_BLOCK keyword to most calls to XMANAGER.

## Examples

The following code creates a widget named EXAMPLE that is just a base widget with a “Done” button and registers it with the XMANAGER. Widgets being registered with the XMANAGER must provide at least two routines. The first routine creates the widget and registers it with the manager and the second routine processes the events that occur within that widget. An example widget is supplied below that uses only two routines. A number of other “Simple Widget Examples”, can be viewed by entering WEXMASTER at the IDL prompt. These simple programs demonstrate many aspects of widget programming.

The following lines of code would be saved in a single file, named `example.pro`:

```
; Begin the event handler routine for the EXAMPLE widget:
PRO example_event, ev

; The uservalue is retrieved from a widget when an event occurs:
WIDGET_CONTROL, ev.id, GET_UVALUE = uv

; If the event occurred in the Done button, kill the widget
; example:
if (uv eq 'DONE') THEN WIDGET_CONTROL, ev.top, /DESTROY
```

```
; End of the event handler part:
END

; This is the routine that creates the widget and registers it with
; the XMANAGER:
PRO example

; Create the top-level base for the widget:
base = WIDGET_BASE(TITLE='Example')

; Create the Done button and set its uservalue to "DONE":
done = WIDGET_BUTTON(base, VALUE = 'Done', UVALUE = 'DONE')
; Realize the widget (i.e., display it on screen):
WIDGET_CONTROL, base, /REALIZE

; Register the widget with the XMANAGER, leaving the IDL command
; line active:
XMANAGER, 'example', base, /NO_BLOCK

; End of the widget creation part:
END
```

First the event handler routine is listed. The handler routine has the same name as the main routine with the characters "_event" added. If you would like to use another event handler name, you would need to pass its name to XMANAGER using the EVENT_HANDLER keyword.

Notice that the event routine is listed before the main routine. If you include both the event routine and the main routine in a single `.pro` file with the name of the main routine (a common practice), this is necessary to ensure that the event routine is compiled. If the event routine were placed after the main routine in the file, IDL would compile and execute the main routine — and the compiler would exit — before the event routine was compiled. Alternatively, you can save your event routine in its own file with its own name (which in the above example would be `example_event.pro`), and IDL will compile the routine when it is required.

Notice also the NO_BLOCK keyword to XMANAGER has been included. This allows IDL to continue processing events and accepting input at the command prompt while the `example` widget application is running.

## Version History

Introduced: Pre 4.0

## See Also

XMTOOL, XREGISTERED, Chapter 26, “Creating Widget Applications” in the *Building IDL Applications* manual.

# XMNG_TMPL

The XMNG_TMPL procedure is a template for widgets that use the XMANAGER. Use this template instead of writing your widget applications from “scratch”. This template can be found in the file `xmng_tmpl.pro` in the `lib` subdirectory of the IDL distribution.

The documentation header should be altered to reflect the actual implementation of the XMNG_TMPL widget. Use a global search and replace to replace the word `XMNG_TMPL` with the name of the routine you would like to use. All the comments with a “`***`” in front of them should be read, decided upon and removed from the final copy of your new widget routine.

## Syntax

XMNG_TMPL [, /BLOCK] [, GROUP=*widget_id*]

## Arguments

None.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XMNG_TMPL block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

### GROUP

The widget ID of the widget that calls XMNG_TMPL. When this ID is specified, the death of the caller results in the death of XMNG_TMPL.

## Version History

Introduced: Pre 4.0

## See Also

CW_TMPL

# XMTOOL

The XMTOOL procedure displays a tool for viewing widgets currently being managed by the XMANAGER. Only one instance of the XMTOOL can run at one time.

This routine is written in the IDL language. Its source code can be found in the file `xmtool.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XMTOOL [, /BLOCK] [, GROUP=*widget_id*]

## Arguments

None.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XMTOOL block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

### GROUP

The widget ID of the widget that calls XMTOOL. If the calling widget is destroyed, the XMTOOL is also destroyed.

## Version History

Introduced: Pre 4.0

## See Also

XMANAGER

# XOBJVIEW

The XOBJVIEW procedure is a utility used to quickly and easily view and manipulate IDL Object Graphics on screen. It displays given objects in an IDL widget with toolbar buttons and menus providing functionality for manipulating, printing, and exporting the resulting graphic. The mouse can be used to rotate, scale, or translate the overall model shown in a view, or to select graphic objects in a view.

This routine is written in the IDL language. Its source code can be found in the file `xobjview.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Using XOBJVIEW

XOBJVIEW displays a resizeable top-level base with a menu, toolbar and draw widget, as shown in the following figure:

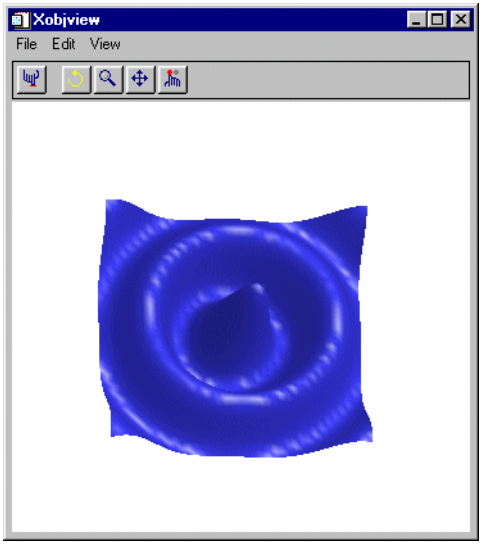



*Figure 34: The XOBJVIEW widget*

## The XOBJVIEW Toolbar

The XOBJVIEW toolbar contains the following buttons:

**Reset:** Resets rotation, scaling, and panning.

**Rotate:** Click the left mouse button on the object and drag to rotate.

**Pan:** Click the left mouse button on the object and drag to pan.

**Zoom:** Click the left mouse button on the object and drag to zoom in or out.

**Select:** Click on the object. The name of the selected object is displayed, if the object has a name, otherwise its class is displayed.

# Syntax

XOBJVIEW, *Obj* [, BACKGROUND=*[r, g, b]*] [, /BLOCK] [, /DOUBLE_VIEW ] [, GROUP=*widget_id*] [, /JUST_REG] [, /MODAL] [, REFRESH=*widget_id*] [, RENDERER={0 | 1}] [, SCALE=*value*] [, STATIONARY=*objref(s)*] [, /TEST] [, TITLE=*string*] [, TLB=*variable*] [, XOFFSET=*value*] [, XSIZE=*pixels*] [, YOFFSET=*value*] [, YSIZE=*pixels*]

# Arguments

## Obj

A reference to an atomic graphics object, an IDLgrModel, or an array of such references. If *Obj* is an array, the array can contain a mixture of such references. Also, if *Obj* is an array, all object references in the array must be unique (i.e. no two references in the array can refer to the same object).

*Obj* is not destroyed when XOBJVIEW is quit or killed.

# Keywords

## BACKGROUND

Set this keyword to a three-element [r, g, b] color vector specifying the background color of the XOBJVIEW window.

## BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes

all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XOBJVIEW block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## DOUBLE_VIEW

Set this keyword to cause XOBJVIEW to set the DOUBLE property on the IDLgrView that it uses to display graphical data.

## GROUP

The widget ID of the widget that calls XOBJVIEW. When this ID is specified, the death of the caller results in the death of XOBJVIEW.

## JUST_REG

Set this keyword to indicate that the XOBJVIEW utility should just be registered and return immediately. This is useful if you want to register XOBJVIEW before beginning event processing and one or more widgets requests that XMANAGER block event processing.

**Note**

If your application will be distributed for use with an IDL Runtime license, and it allows users to control the contents of an XOBJVIEW window via a separate interface registered with XMANAGER, you must set the JUST_REG keyword. See "JUST_REG vs. NO_BLOCK" on page 2417 for additional details.

## MODAL

Set this keyword to block processing of events from other widgets until the user quits XOBJVIEW. The MODAL keyword does not require a group leader to be specified. If no group leader is specified, and the MODAL keyword is set, XOBJVIEW fabricates an invisible group leader for you.

**Note**

To be modal, XOBJVIEW does not require that its caller specify a group leader. This is unlike other IDL widget procedures such as XLOADCT, which, to be modal, do require that their caller specify a group leader. These other procedures

were implemented this way to encourage the caller to create a modal widget that will be well-behaved with respect to layering and iconizing. (See “Iconizing, Layering, and Destroying Groups of Top-Level Bases” on page 2128 for more information.)

To provide a simple means of invoking XOBJVIEW as a modal widget in applications that contain no other widgets, XOBJVIEW can be invoked as MODAL without specifying a group leader, in which case XOBJVIEW fabricates an invisible group leader for you. For applications that contain multiple widgets, however, it is good programming practice to supply an appropriate group leader when invoking XOBJVIEW, /MODAL. As with other IDL widget procedures with names prefixed with “X”, specify the group leader via the GROUP keyword.

## REFRESH

Set this keyword to the widget ID of the XOBJVIEW instance to be refreshed. To retrieve the widget ID of an instance of XOBJVIEW, first call XOBJVIEW with the TLB keyword. To refresh that instance of XOBJVIEW, call XOBVIEW again and set REFRESH to the value retrieved by the TLB keyword in the earlier call to XOBJVIEW. For example, in the initial call to XOBJVIEW, use the TLB keyword as follows:

```
XOBJVIEW, myobj, TLB=tlb
```

If the properties of `myobj` are changed in your application or at the IDL command line, refresh the view in XOBJVIEW by calling XOBJVIEW again with the REFRESH keyword:

```
XOBJVIEW, REFRESH=tlb
```

For an example application demonstrating the use of the REFRESH keyword, see “Example 3” on page 2433.

**Note**

Currently, the REFRESH keyword can only be used to refresh the object itself. All other keywords and arguments to XOBJVIEW are ignored when REFRESH is specified, therefore, properties such as the background color and scale are not affected.

## RENDERER

Set this keyword to an integer value indicating which graphics renderer to use when drawing objects in the XOBJVIEW draw window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation

By default, your platform's native OpenGL implementation is used. If your platform does not have a native OpenGL implementation, IDL's software implementation is used regardless of the value of this property. See "Hardware vs. Software Rendering" in Chapter 34 of the *Using IDL* manual for details. Your choice of renderer may also affect the maximum size of the XOBJVIEW draw window. See "IDLgrWindow" on page 3705 for details.

## SCALE

Set this keyword to the zoom factor for the initial view. The default is 1/SQRT(3). This default value provides the largest possible view of the object, while ensuring that no portion of the object will be clipped by the XOBJVIEW window, regardless of the object's orientation.

## STATIONARY

Set this keyword to a reference to an atomic graphics object, an IDLgrModel, or an array of such references. If this keyword is an array, the array can contain a mixture of such references. Also, if this keyword is an array, all object references in the array must be unique (i.e., no two references in the array can refer to the same object). Objects passed to XOBJVIEW via this keyword will not scale, rotate, or translate in response to mouse events. Default stationary objects are two lights. These two lights are replaced if one or more lights are supplied via this keyword. Objects specified via this keyword are not destroyed by XOBJVIEW when XOBJVIEW is quit or killed.

For example, to change the default lights used by XOBJVIEW, you could specify your own lights using the STATIONARY keyword as follows:

```
mylight1 = OBJ_NEW('IDLgrLight', TYPE=0, $
   COLOR=[255,0,0]) ; Ambient red
mylight2 = OBJ_NEW('IDLgrLight', TYPE=2, $
   COLOR=[255,0,0], LOCATION=[2,2,5]) ; Directional red

mymodel = OBJ_NEW('IDLgrModel')
mymodel -> Add, mylight1
mymodel -> Add, mylight2

XOBJVIEW, /TEST, STATIONARY=mymodel
```

## TLB

Set this keyword to a named variable that upon return will contain the widget ID of the top level base.

## TEST

If set, the *Obj* argument is not required (and is ignored if provided). A blue sinusoidal surface is displayed. This allows you to test code that uses XOBJVIEW without having to create an object to display.

## TITLE

Set this keyword to the string that appears in the XOBJVIEW title bar.

## XOFFSET

The horizontal offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent.

Specifying an offset relative to a row-major or column-major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## XSIZE

Set this keyword to the width of the drawable area in pixels. The default is 400.

## YOFFSET

The vertical offset of the widget in units specified by the UNITS keyword (pixels are the default) relative to its parent. This offset is specified relative to the upper left corner of the parent widget.

Specifying an offset relative to a row-major or column-major base widget does not work because those widgets enforce their own layout policies. This keyword is primarily of use relative to a plain base widget. Note that it is best to avoid using this style of widget layout.

## YSIZE

Set this keyword to the height of the drawable area in pixels. The default is 400.

# Examples

## Example 1

This example displays a simple IDLgrSurface object using XOBJVIEW:

```
oSurf = OBJ_NEW('IDLgrSURFACE', DIST(20))
XOBJVIEW, oSurf
```

## Example 2

This example displays an IDLgrModel object consisting of two separate objects:

```
; Create contour object:
oCont = OBJ_NEW('IDLgrContour', DIST(20), N_LEVELS=10)

; Create surface object:
oSurf = OBJ_NEW('IDLgrSurface', $
   DIST(20),INDGEN(20)+20, INDGEN(20)+20)

; Create model object:
oModel = OBJ_NEW('IDLgrModel')

; Add contour and surface objects to model:
oModel->Add, oCont
oModel->Add, oSurf

; View model:
XOBJVIEW, oModel
```

This code results in the following view in the XOBJVIEW widget:

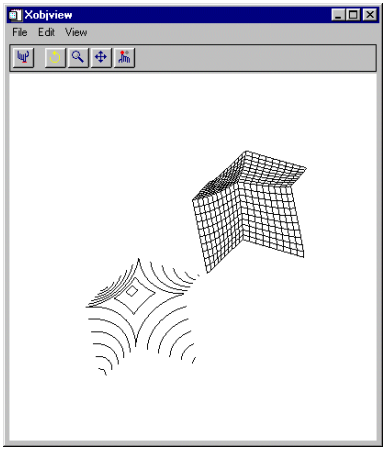



*Figure 35: Using XOBJVIEW to view a model consisting of two objects*

Note that when you click the Select button, and then click on an object, the class of that object appears next to the Select button. If the selected object has a non-null NAME property associated with it, that string value will be displayed, otherwise the name of the selected object's class will be displayed.

If you want the class of the model to appear when you click over any object in the model, you can set the SELECT_TARGET property of the model as follows:

```
oModel->SetProperty, /SELECT_TARGET
```

Also note that it is not necessary to create a model to view more than one object using XOBJVIEW. We could view the oCont and oSurf objects created in the above example by placing them in an array as follows:

```
XOBJVIEW, [oCont, oSurf]
```

## Example 3

This example demonstrates how the REFRESH keyword can be used to refresh the object displayed in an instance of XOBJVIEW.

```
PRO xobjview_refresh_event, event
   WIDGET_CONTROL, event.id, GET_UVALUE=uval
   WIDGET_CONTROL, event.top, GET_UVALUE=state
```

```
   CASE uval OF
      'red': BEGIN
          WIDGET_CONTROL, event.id, GET_VALUE=val
          state.myobj -> GetProperty, COLOR=c
          state.myobj -> SetProperty, COLOR=[val,c[1],c[2]]
          XOBJVIEW, REFRESH=state.tlb
          END
      'green':  BEGIN
          WIDGET_CONTROL, event.id, GET_VALUE=val
          state.myobj -> GetProperty, COLOR=c
          state.myobj -> SetProperty, COLOR=[c[0],val,c[2]]
          XOBJVIEW, REFRESH=state.tlb
          END
      'blue': BEGIN
          WIDGET_CONTROL, event.id, GET_VALUE=val
          state.myobj -> GetProperty, COLOR=c
          state.myobj -> SetProperty, COLOR=[c[0],c[1],val]
          XOBJVIEW, REFRESH=state.tlb
          END
   ENDCASE
END

PRO xobjview_refresh_cleanup, wID
   WIDGET_CONTROL, wID, GET_UVALUE=state
   OBJ_DESTROY, state.myobj
END

PRO xobjview_refresh
   base = WIDGET_BASE(/COLUMN, TITLE='Adjust Object Color', $
      XOFFSET=420, XSIZE=200)

   myobj = OBJ_NEW('IDLgrSurface', $
      BESELJ(SHIFT(DIST(40), 20, 20) / 2,0) * 20, $
      COLOR=[255, 60, 60], STYLE=2, SHADING=1)
   XOBJVIEW, myobj, TLB=tlb, GROUP=base, BACKGROUND=[0,0,0]

   red = WIDGET_SLIDER(base, /DRAG, MIN=0, MAX=255, TITLE='Red', $
      UVALUE='red', VALUE=255)
   green = WIDGET_SLIDER(base, /DRAG, MIN=0, MAX=255, $
      TITLE='Green', UVALUE='green', VALUE=60)
   blue = WIDGET_SLIDER(base, /DRAG, MIN=0, MAX=255, $
      TITLE='Blue', UVALUE='blue', VALUE=60)

   WIDGET_CONTROL, base, /REALIZE

   state = {myobj:myobj, tlb:tlb}
   WIDGET_CONTROL, base, SET_UVALUE=state
```

```
      XMANAGER, 'xobjview_refresh', base, /NO_BLOCK, $
         CLEANUP='xobjview_refresh_cleanup'
END
```

## Version History

Introduced: 5.3

## See Also

XOBJVIEW_ROTATE, XOBJVIEW_WRITE_IMAGE

# XOBJVIEW_ROTATE

The XOBJVIEW_ROTATE procedure is used to programmatically rotate the object currently displayed in XOBJVIEW. XOBJVIEW must be called prior to calling XOBJVIEW_ROTATE. This procedure can be used to create animations of object displays.

This routine is written in the IDL language. Its source code can be found in the file `xobjview_rotate.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XOBJVIEW_ROTATE, *Axis*, *Angle* [, /PREMULTIPLY]

## Arguments

### Axis

A 3-element vector of the form [*x*, *y*, *z*] describing the axis about which the model is to be rotated.

### Angle

The amount of rotation, measured in degrees.

## Keywords

### PREMULTIPLY

Set this keyword to cause the rotation matrix specified by *Axis* and *Angle* to be pre-multiplied to the model's transformation matrix. By default, the rotation matrix is post-multiplied.

## Examples

The following example creates an animation of the test object (a surface) currently displayed in XOBJVIEW. It does this by rotating the surface through 360 degrees in increments of 10 degrees using XOBJVIEW_ROTATE, and writing the display image to a BMP file for each increment using XOBJVIEW_WRITE_IMAGE.

```
PRO RotateAndWriteObject

XOBJVIEW, /TEST
FOR i = 0, 359 DO BEGIN
   XOBJVIEW_ROTATE, [0, 1, 0], 1, /PREMULTIPLY;
   XOBJVIEW_WRITE_IMAGE, 'img' + $
   STRCOMPRESS(i, /REMOVE_ALL) + '.bmp', 'bmp'
ENDFOR

END
```

## Version History

Introduced: 5.5

## See Also

XOBJVIEW, XOBJVIEW_WRITE_IMAGE

# XOBJVIEW_WRITE_IMAGE

The XOBJVIEW_WRITE_IMAGE procedure is used to write the object currently displayed in XOBJVIEW to an image file with the specified name and file format. XOBJVIEW must be called prior to calling XOBJVIEW_WRITE_IMAGE.

This routine is written in the IDL language. Its source code can be found in the file `xobjview_write_image.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XOBJVIEW_WRITE_IMAGE, *Filename*, *Format* [, DIMENSIONS=*[x, y]* ]

## Arguments

### Filename

A scalar string containing the name of the file to write.

### Format

A scalar string containing the name of the file format to write. See WRITE_IMAGE for a list of supported formats.

## Keywords

### DIMENSIONS

Set this keyword to a 2-element vector of the form [*x*, *y*] specifying the size of the output image, in pixels. If this keyword is not specified, the image will be written using the dimensions of the current XOBJVIEW draw widget.

## Examples

See XOBJVIEW_ROTATE.

## Version History

Introduced: 5.5

## See Also

XOBJVIEW, XOBJVIEW_ROTATE

# XPALETTE

The XPALETTE procedure is a utility that displays a widget interface that allows interactive creation and modification of colortables using the RGB, CMY, HSV, or HLS color systems. Single colors can be defined or multiple color indices between two endpoints can be interpolated.

This routine is written in the IDL language. Its source code can be found in the file `xpalette.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Using the XPALETTE Interface

Calling XPALETTE causes a graphical interface to appear. The elements of this interface are described below.

### Plots on Left Side of Interface

Three plots show the current red, green, and blue vectors.

### Status Region

The center of the XPALETTE widget is a status region containing:

- The total number of colors.
- The current color index. XPALETTE allows changing one color at a time. This color is known as the “current color” and is indicated in the color spectrum display with a special marker.
- The current mark index. The mark is used to remember a color index. Click the “Set Mark Button” to make the current color index the mark index.
- A sample of the current color. The special marker used in the color spectrum display prevents the user from seeing the color of the current index, but it is visible here.

### Control Panel

A panel of 8 buttons control common XPALETTE functions:

- **Done:** Click this button to exit XPALETTE. The new color tables are saved in the COLORS common block and loaded to the display.
- **Predefined:** Click this button to start XLOADCT, allowing selection of one of the predefined color tables. Note that when you change the color map via XLOADCT, XPALETTE is not always able to keep its display accurate. This problem can be overcome by pressing the XPALETTE “Redraw” button after changing the colortable via XLOADCT.

- **Help:** Click this button to display help information.
- **Redraw:** Click this button to redraws the display using the current state of the color map.
- **Set Mark:** Click this button to set the value of the mark index to the current color index.
- **Switch Mark:** Click this button to exchange the mark and the current index.
- **Copy Current:** Click this button to make every color lying between the current index and the mark index (inclusive) the same color as the current color.
- **Interpolate:** Click this button to smoothly interpolate colors between the current index and the mark index.

### Color System Control

This section of the interface allows you to select the color system used to modify individual colors. The “Select Color System” pulldown menu lets you select from four different systems—RGB, CMY, HSV, and HLS. Depending upon the current system, 3 sliders below the pulldown menu allow you to alter the current color.

### Right Side Color Spectrum Display

A display on the right side of the XPALETTE interface shows the current color map as a series of squares. Color index 0 is at the upper left. The color index increases monotonically by rows going left to right and top to bottom. The current color index is indicated by a special marker symbol. There are 4 ways to change the current color:

- Click on any square in the color map display.
- Use the “By Index” slider to move to the desired color index.
- Use the “Row” Slider to move the marker vertically.
- Use the “Column” Slider to move the marker horizontally.

## A Note about the Colors Used in the Interface

XPALETTE uses two colors from the current color table as drawing foreground and background colors. These are used for the RGB plots on the left, and the current index marker on the right. This means that if the user set these two colors to the same value, the XPALETTE display could become unreadable (like writing on black paper with black ink). XPALETTE minimizes this possibility by noting changes to the color map and always using the brightest available color for the foreground color and the darkest for the background. Thus, the only way to make XPALETTE’s display

unreadable is to set the entire color map to a single color, which is highly unlikely. The only side effect of this policy is that you may notice XPALETTE redrawing the entire display after you've modified the current color. This simply means that the change has made XPALETTE pick new drawing colors.

# Syntax

XPALETTE [, /BLOCK] [, GROUP=*widget_id*]
[, UPDATECALLBACK='*procedure_name*' [, UPDATECBDATA=*value*]]

# Arguments

None.

# Keywords

## BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XPALETTE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## GROUP

The widget ID of the widget that calls XPALETTE. When this ID is specified, a death of the caller results in a death of XPALETTE.

## UPDATECALLBACK

Set this keyword to a string containing the name of a user-supplied procedure that will be called when the color table is updated by XLOADCT. The procedure may optionally accept a keyword called DATA, which will be automatically set to the value specified by the optional UPDATECBDATA keyword.

### UPDATECBDATA

Set this keyword to a value of any type. It will be passed via the DATA keyword to the user-supplied procedure specified via the UPDATECALLBACK keyword, if any. If the UPDATECBDATA keyword is not set the value accepted by the DATA keyword to the procedure specified by UPDATECALLBACK will be undefined.

## Version History

Introduced: Pre 4.0

## See Also

LOADCT, MODIFYCT, XLOADCT, TVLCT

# XPCOLOR

The XPCOLOR procedure is a utility that allows you to adjust the value of the current plotting color (foreground) using sliders, and store the desired color in the global system variable, !P.COLOR.

When XPCOLOR is called from the IDL input command line, the **Set Plot Color** dialog box appears. The dialog has two buttons (**Done** and **Help**) a single color swatch window, three sliders, and a pulldown menu with the four color systems: red, green, blue (RGB); cyan, magenta, yellow (CMY); hue, saturation, value (HSV); and hue, lightness, and saturation (HLS).

When you have chosen the color system and adjusted the sliders to your liking, click **Done** to store the color selected in the !P.COLOR system variable. Any plots generated in IDL afterwards use the color selected as the plotting (foreground) color until !P.COLOR is changed again.

**Note**

For a more flexible color editor, use the XPALETTE User Library routine.

This routine is written in the IDL language. Its source code can be found in the file `xpcolor.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XPCOLOR [, GROUP=*widget_id* ]

## Arguments

None.

## Keywords

### GROUP

Set this keyword to the group leader widget ID as passed to XMANAGER.

## Version History

Introduced: 4.0

# XPLOT3D

The XPLOT3D procedure is a utility for creating and interactively manipulating 3-D plots.

This routine is written in the IDL language. Its source code can be found in the file `xplot3d.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Using XPLOT3D

XPLOT3D displays a resizeable top-level base with a menu, toolbar and draw widget, as shown in the following figure:

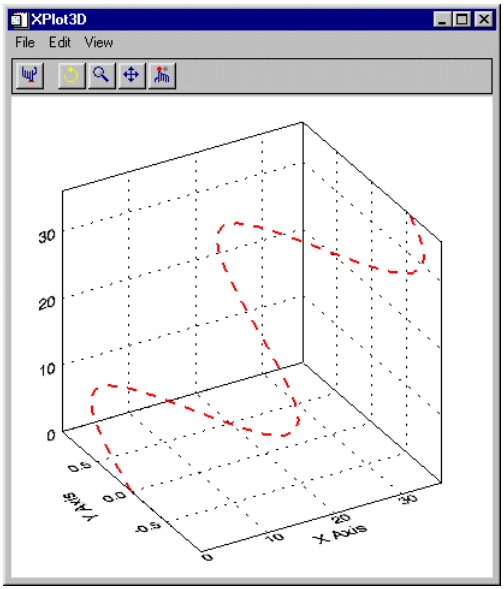



*Figure 36: The XPLOT3D Utility*

### The XPLOT3D Toolbar

The XPLOT3D toolbar contains the following buttons:

**Reset:** Resets rotation, scaling, and panning.

**Rotate:** Click the left mouse button on the plot and drag to rotate.

**Zoom:** Click the left mouse button on the plot and drag to zoom in or out.

**Pan:** Click the left mouse button on the plot and drag to pan.

**Select:** Click on a curve to display the curve name (if defined with the NAME keyword) on the XPLOT3D toolbar. If no name was defined for the curve, “IDLGRPOLYLINE” is displayed.

### Projecting Data onto Plot “Walls”

To turn on or off the projection of data onto the walls of the box enclosing the 3-D plot, select **All On**, **All Off**, **XY**, **YZ**, or **XZ** from the **View** → **2D Projection** menu.

### Changing the Axis Type

The **View** → **Axes** menu allows you to select one of the following types of axes:

- Simple Axes — displays the X, Y, and Z axes as lines.
- Box Axes — displays the X, Y, and Z axes as planes.
- No Axes — turns off the display of axes.

## Syntax

XPLOT3D, *X*, *Y*, *Z* [, /BLOCK] [, COLOR=*[r,g,b]*] [, /DOUBLE_VIEW]
[, GROUP=*widget_id*] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5 | 6}] [, /MODAL]
[, NAME=*string*] [, /OVERPLOT] [, SYMBOL=*objref(s)*] [, /TEST]
[, THICK=*points*{1.0 to 10.0}] [, TITLE=*string*] [, XRANGE=*[min, max]*]
[, YRANGE=*[min, max]*] [, ZRANGE=*[min, max]*] [, XTITLE=*string*]
[, YTITLE=*string*] [, ZTITLE=*string*]

## Arguments

### X

A vector of X data values.

### Y

A vector of Y data values.

### Z

A vector of Z data values.

# Keywords

## BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XPLOT3D block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## COLOR

Set this keyword to an [*r*, *g*, *b*] triplet specifying the color of the curve.

## DOUBLE_VIEW

Set this keyword to cause XPLOT3D to set the DOUBLE property on the IDLgrView that it uses to display the plot.

## GROUP

Set this keyword to the widget ID of the widget that calls XPLOT3D. When this keyword is specified, the death of the caller results in the death of XPLOT3D.

## LINESTYLE

Set this keyword to a value indicating the line style that should be used to draw the curve. The value can be either an integer value specifying a pre-defined line style, or a 2-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE keyword to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot

- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where repeat indicates the number of times consecutive runs of 1s or 0s in the bitmask should be repeated. (That is, if three consecutive 0s appear in the bitmask and the value of repeat is 2, then the line that is drawn will have six consecutive bits turned off.) The value of repeat must be in the range $1 \leq \text{repeat} \leq 255$.

The bitmask indicates which pixels are drawn and which are not along the length of the line. The bitmask is most conveniently specified as a 16-bit hexadecimal value.

For example, LINESTYLE = [2, 'F0F0'X] describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

## MODAL

Set this keyword to block processing of events from other widgets until the user quits XPLOT3D. The MODAL keyword does not require a group leader to be specified. If no group leader is specified, and the MODAL keyword is set, XPLOT3D fabricates an invisible group leader for you.

**Note**

To be modal, XPLOT3D does not require that its caller specify a group leader. This is unlike other IDL widget procedures such as XLOADCT, which, to be modal, do require that their caller specify a group leader. These other procedures were implemented this way to encourage the caller to create a modal widget that will be well-behaved with respect to layering and iconizing. (See “Iconizing, Layering, and Destroying Groups of Top-Level Bases” on page 2128 for more information.)

To provide a simple means of invoking XPLOT3D as a modal widget in applications that contain no other widgets, XPLOT3D can be invoked as MODAL without specifying a group leader, in which case XPLOT3D fabricates an invisible group leader for you. For applications that contain multiple widgets, however, it is good programming practice to supply an appropriate group leader when invoking XPLOT3D, /MODAL. As with other IDL widget procedures with names prefixed with “X”, specify the group leader via the GROUP keyword.

## NAME

Set this keyword to a string specifying the name for the data curve being plotted. The name is displayed on the XPLOT3D toolbar when the curve is selected with the

mouse. (To select the curve with the mouse, XPLOT3D must be in select mode. You can put XPLOT3D in select mode by clicking on the rightmost button on the XPLOT3D toolbar.)

## OVERPLOT

Set this keyword to draw the curve in the most recently created view. The TITLE, [XYZ]TITLE, [XYZ]RANGE, and MODAL keywords are ignored if this keyword is set.

## SYMBOL

Set this keyword to a vector containing one or more instances of the IDLgrSymbol object class to indicate the plotting symbols to be used at each vertex of the polyline. If there are more vertices than elements in SYMBOL, the elements of the SYMBOL vector are cyclically repeated. By default, no symbols are drawn. To remove symbols from a polyline, set SYMBOL to a scalar.

## TEST

If set, the *X*, *Y*, and *Z* arguments are not required (and are ignored if provided). A sinusoidal curve is displayed instead. This allows you to test code that uses XPLOT3D without having to specify plot data.

## THICK

Set this keyword to a value between 1.0 and 10.0, specifying the line thickness to be used to draw the polyline, in points. The default is 1.0 points.

## TITLE

Set this keyword to a string to appear in the XPLOT3D title bar.

## XRANGE

Set this keyword to a 2-element array of the form [*min*, *max*] specifying the X-axis range.

## YRANGE

Set this keyword to a 2-element array of the form [*min*, *max*] specifying the Y-axis range.

### ZRANGE

Set this keyword to a 2-element array of the form [*min*, *max*] specifying the Z-axis range.

### XTITLE

Set this keyword to a string specifying the title for the X axis of the plot.

### YTITLE

Set this keyword to a string specifying the title for the Y axis of the plot.

### ZTITLE

Set this keyword to a string specifying the title for the Z axis of the plot.

## Examples

The following example displays two curves in XPLOT3D, using a custom plotting symbol for one of the curves:

```
;Define plot data:
X = INDGEN(20)
Y1 = SIN(X/3.)
Y2 = COS(X/3.)
Z = X

;Display curve 1 in XPLOT3D:
XPLOT3D, X, Y1, Z, NAME='Curve1', THICK=2

;Define custom plotting symbols:
oOrb = OBJ_NEW('orb', COLOR=[0, 0, 255])
oOrb->Scale, .75, .1, .5
oSymbol = OBJ_NEW('IDLgrSymbol', oOrb)

;Overplot curve 2 in XPLOT3D:
XPLOT3D, X, Y2, Z, COLOR=[0,255,0], NAME='Curve2', $
   SYMBOL=oSymbol, THICK=2, /OVERPLOT
```

This code results in the following:

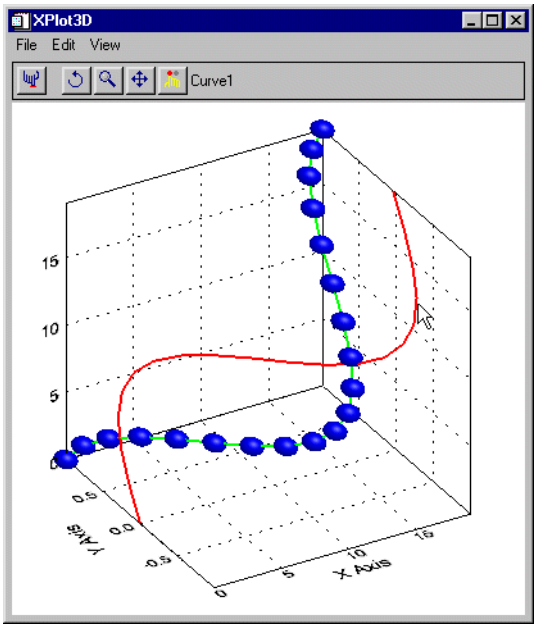



*Figure 37: Two curves displayed in XPLOT3D*

## Version History

Introduced: 5.4

## See Also

IPLOT

# XREGISTERED

The XREGISTERED function returns the number of instances of the widget named as its argument that are currently registered with the XMANAGER. The registered widget is brought to the front of the desktop unless the NOSHOW keyword is set.

If the specified widget is not currently registered with XMANAGER, XREGISTERED returns zero.

This routine is written in the IDL language. Its source code can be found in the file `xregistered.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = XREGISTERED(*Name* [, /NOSHOW] )

## Arguments

### Name

A string containing the name of the widget in question.

**Note**

XREGISTERED checks for *Name* in a COMMON block created by XMANAGER. The stored name is case-sensitive.

## Keywords

### NOSHOW

If the widget in question is registered, it is brought to the front of all the other windows by default. Set this keyword to keep the widget from being brought to the front.

## Examples

Suppose that you have a widget program that registers itself with the XMANAGER with the command:

```
XMANAGER, 'mywidget', base
```

You could limit this widget to one instantiation by adding the following line as the first line (after the procedure definition statement) of the widget creation routine:

```
IF ( XREGISTERED('mywidget') NE 0 ) THEN RETURN
```

## Version History

Introduced: Pre 4.0

## See Also

XMANAGER

# XROI

The XROI procedure is a utility for interactively defining regions of interest (ROIs), and obtaining geometry and statistical data about these ROIs.

This routine is written in the IDL language. Its source code can be found in the file `xroi.pro` in the `lib/utilities` subdirectory of the IDL distribution.

**Note**

See "Using XROI" on page 2460, for detailed information describing importing images, modifying image and ROI colors, retrieving ROI information and growing regions.

## Syntax

XROI [, *ImageData*] [, *R*] [, *G*] [, *B*] [, /BLOCK]
[[, /FLOATING] , GROUP=*widget_ID*] [, /MODAL] [, REGIONS_IN=*value*]
[, REGIONS_OUT=*value*] [, REJECTED=*variable*] [, RENDERER={0 | 1}]
[, ROI_COLOR=*[r, g, b] or variable*] [, ROI_GEOMETRY=*variable*]
[, ROI_SELECT_COLOR=*[r, g, b] or variable*] [, STATISTICS=*variable*]
[, TITLE=*string*] [, TOOLS=*string/string array* {valid values are 'Translate-Scale', 'Rectangle', 'Ellipse', 'Freehand Draw', 'Polygon Draw', and 'Selection'}]
[, X_SCROLL_SIZE=*value*] [, Y_SCROLL_SIZE=*value*]

## Arguments

### ImageData

*ImageData* is both an input and output argument. It is an array representing an 8-bit or 24-bit image to be displayed. *ImageData* can be any of the following:

- [*m*, *n*] — 8-bit image
- [3, *m*, *n*] — 24-bit image
- [*m*, 3, *n*] — 24-bit image
- [*m*, *n*, 3] — 24-bit image

If *ImageData* is not supplied, the user will be prompted for a file via DIALOG_PICKFILE. On output, *ImageData* will be set to the current image data. (The current image data can be different than the input image data if the user imported an image via the **File** → **Import Image** menu item.)

### R, G, B

*R*, *G*, and *B* are arrays of bytes representing red, green, or blue color table values, respectively. *R*, *G*, and *B* are both input and output arguments. On input, these values are applied to the image if the image is 8-bit. To get the red, green, or blue color table values for the image on output from XROI, specify a named variable for the appropriate argument. (If the image is 24-bit, this argument will output a 256-element byte array containing the values given at input, or BINDGEN(256) if the argument was undefined on input.)

## Keywords

### BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XROI block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

### FLOATING

Set this keyword, along with the GROUP keyword, to create a floating top-level base widget. If the windowing system provides Z-order control, floating base widgets appear above the base specified as their group leader. If the windowing system does not provide Z-order control, the FLOATING keyword has no effect.

**Note**

Floating widgets must have a group leader. Setting this keyword without also setting the GROUP keyword causes an error.

### GROUP

Set this keyword to the widget ID of the widget that calls XROI. When this keyword is specified, the death of the caller results in the death of XROI.

## MODAL

Set this keyword to block other IDL widgets from receiving events while XROI is active.

## REGIONS_IN

Set this keyword to an array of IDLgrROI references. This allows you to open XROI with previously defined regions of interest (see Example 3). This is also useful when using a loop to open multiple images in XROI. By using the same named variable for both the REGIONS_IN and REGIONS_OUT keywords, you can reuse the same ROIs in multiple images (see Example 2). This keyword also accepts –1, or OBJ_NEW() (Null object) to indicate that there are no ROIs to read in. This allows you to assign the result of a previous REGIONS_OUT to REGIONS_IN without worrying about the case where the previous REGIONS_OUT is undefined.

## REGIONS_OUT

Set this keyword to a named variable that will contain an array of IDLgrROI references. This keyword is assigned the null object reference if there are no ROIs defined. By using the same named variable for both the REGIONS_IN and REGIONS_OUT keywords, you can reuse the same ROIs in multiple images (see Example 2).

**Note**

This keyword must be used in conjunction with the BLOCK keyword.

## REJECTED

Set this keyword to a named variable that will contain those REGIONS_IN that are not in REGIONS_OUT. The objects defined in the variable specified for REJECTED can be destroyed with a call to OBJ_DESTROY, allowing you to perform cleanup on objects that are not required (see Example 2). This keyword is assigned the null object reference if no REGIONS_IN are rejected by the user.

**Note**

This keyword must be used in conjunction with the BLOCK keyword.

## RENDERER

Set this keyword to an integer value to indicate which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation (the default)

## ROI_COLOR

This keyword is both an input and an output parameter. Set this keyword to a 3-element byte array, [*r*, *g*, *b*], indicating the color of ROI outlines when they are not selected. This color will be used by XROI unless and until the color is changed by the user via the "Unselected Outline Color" portion of the "ROI Outline Colors" dialog (which is accessed by selecting **Edit → ROI Outline Colors**). If this keyword is assigned a named variable, that variable will be set to the current [*r*, *g*, *b*] value at the time that XROI returns.

## ROI_GEOMETRY

Set this keyword to a named variable that will contain an array of anonymous structures, one for each ROI that is valid when this routine returns. The structures will contain the following fields:

| Field | Description |
|---|---|
| area | The area of the region of interest, in square pixels. |
| centroid | The coordinates (*x*, *y*, *z*) of the centroid of the region of interest, in pixels. |
| perimeter | The perimeter of the region of interest, in pixels. |

*Table 112: Fields of the structure returned by ROI_GEOMETRY*

If there are no valid regions of interest when this routine returns, ROI_GEOMETRY will be undefined.

**Note**

If there are no REGIONS_IN, XROI must either be modal or must block control flow in order for ROI_GEOMETRY to be defined upon exit from XROI. Otherwise, XROI will return before an ROI can be defined, and ROI_GEOMETRY will therefore be undefined.

**Note**

This keyword must be used in conjunction with the BLOCK keyword.

## ROI_SELECT_COLOR

This keyword is both an input and an output parameter. Set this keyword to a 3-element byte array, [*r*, *g*, *b*], indicating the color of ROI outlines when they are selected. This color will be used by XROI unless and until the color is changed by the user via the “Selected Outline Color” portion of the “ROI Outline Colors” dialog (which is accessed by selecting **Edit → ROI Outline Colors**). If this keyword is assigned a named variable, that variable will be set to the current [*r*, *g*, *b*] value at the time that XROI returns.

## STATISTICS

Set this keyword to a named variable to receive an array of anonymous structures, one for each ROI that is valid when this routine returns. The structures will contain the following fields:

| Field | Description |
|---|---|
| count | Number of pixels in region. |
| minimum | Minimum pixel value. |
| maximum | Maximum pixel value. |
| mean | Mean pixel value. |
| stddev | Standard deviation of pixel values. |

*Table 113: Fields of the structure returned by STATISTICS*

If *ImageData* is 24-bit, or if there are no valid regions of interest when the routine exits, STATISTICS will be undefined.

**Note**

If there are no REGIONS_IN, XROI must either be modal or must block control flow in order for STATISTICS to be defined upon exit from XROI. Otherwise, XROI will return before an ROI can be defined, and STATISTICS will therefore be undefined.

## TITLE

Set this keyword to a string to appear in the XROI title bar.

## TOOLS

Set this keyword a string or vector of strings from the following list to indicate which ROI manipulation tools should be supported when XROI is run:

- 'Translate-Scale' — Translation and scaling of ROIs. Mouse down inside the bounding box selects a region, mouse motion translates (repositions) the region. Mouse down on a scale handle of the bounding box enables scaling (stretching, enlarging and shrinking) of the region according to mouse motion. Mouse up finishes the translation or scaling.
- 'Rectangle' — Rectangular ROI drawing. Mouse down positions one corner of the rectangle, mouse motions creates the rectangle, positioning the rectangle's opposite corner, mouse up finishes the rectangular region.
- 'Ellipse' — Elliptical ROI drawing. Mouse down positions the center of the ellipse, mouse motion positions the corner of the ellipse's imaginary bounding box, mouse up finishes the elliptical region.
- 'Freehand Draw' — Freehand ROI drawing. Mouse down begins a region, mouse motion adds vertices to the region (following the path of the mouse), mouse up finishes the region.
- 'Polygon Draw' — Polygon ROI drawing. Mouse down begins a region, subsequent mouse clicks add vertices, double-click finishes the region.
- 'Selection' — ROI selection. Mouse down/up selects the nearest region. The nearest vertex in that region is identified with a crosshair symbol.

If more than one string is specified, a series of bitmap buttons will appear at the top of the XROI widget in the order specified (to the right of the fixed set of bitmap buttons used for saving regions, displaying region information, copying to clipboard, and flipping the image). If only one string is specified, no additional bitmap buttons will appear, and the manipulation mode is implied by the given string. If this keyword is not specified, bitmap buttons for all three manipulation tools are included on the XROI toolbar.

## X_SCROLL_SIZE

Set this keyword to the width of the scroll window. If this keyword is larger than the image width then it will be set to the image width. The default is to use the image width or the screen width, whichever is smaller.

### Y_SCROLL_SIZE

Set this keyword to the height of the scroll window. If this keyword is larger than the image height then it will be set to the image height. The default is to use the image height or the screen height, whichever is smaller.

## Using XROI

XROI displays a top-level base with a menu, toolbar and draw widget. After defining an ROI, the **ROI Information** window appears, as shown in the following figure:

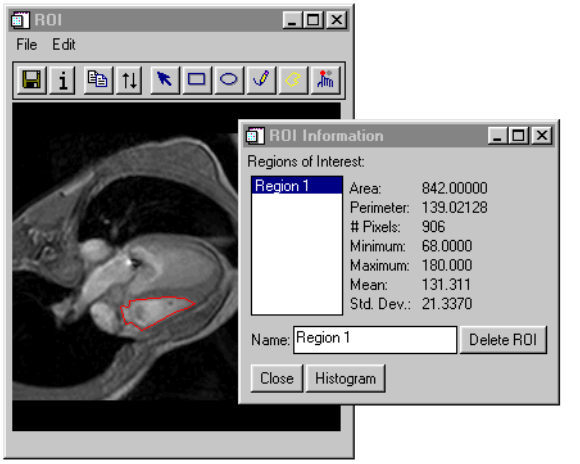



*Figure 38: The XROI Utility*

As you move the mouse over an image, the x and y pixel locations are shown in the status line on the bottom of the XROI window. For 8-bit images, the data value (z) is also shown. If an ROI is defined, the status line also indicates the mouse position relative to the ROI using the text “Inside”, “Outside”, “On Edge,” or “On Vertex.”

### The XROI Toolbar

The XROI toolbar contains the following buttons:

**Save:** Opens a file selection dialog for saving the currently defined ROIs to a save file.

**Info:** Opens the **ROI Information** window.

**Copy:** Copies the contents of the display area to the clipboard.

**Flip:** Flips image vertically. Note that only the image is flipped; any ROIs that have been defined do not move.

Depending on the value of the TOOLS keyword, the XROI toolbar may also contain the following buttons:

**Translate/ Scale:** Click this button to translate or scale ROIs. Mouse down inside the bounding box selects a region, mouse motion translates (repositions) the region. Mouse down on a scale handle of the bounding box enables scaling (stretching, enlarging and shrinking) of the region according to mouse motion. Mouse up finishes the translation or scaling.

**Draw Rectangle:** Click this button to draw rectangular ROIs. Mouse down positions one corner of the rectangle, mouse motions creates the rectangle, positioning the rectangle's opposite corner, mouse up finishes the rectangular region.

**Draw Ellipse:** Click this button to draw elliptical ROIs. Mouse down positions the center of the ellipse, mouse motion positions the corner of the ellipse's imaginary bounding box, mouse up finishes the elliptical region.

**Draw Freehand:** Click this button to draw freehand ROIs. Mouse down begins a region, mouse motion adds vertices to the region (following the path of the mouse), mouse up finishes the region.

**Draw Polygon:** Click this button to draw polygon ROIs. Mouse down begins a region, subsequent mouse clicks add vertices, double-click finishes the region.

**Select:** Click this button to select an ROI region. Clicking the image causes a cross hairs symbol to be drawn at the nearest vertex of the selected ROI.

## Importing an Image into XROI

To import an image into XROI, select **File → Import Image**. This opens a DIALOG_READ_IMAGE dialog, which can be used to preview and select an image.

## Changing the Image Color Table

To change the color table properties for the current image, select **Edit → Image Color Table**. This opens the CW_PALETTE_EDITOR dialog, which is a compound widget used to edit color palettes. See CW_PALETTE_EDITOR for more information. This menu item is grayed out if the image does not have a color palette.

## Changing the ROI Outline Colors

To change the outline colors for selected and unselected ROIs, select **Edit → ROI Outline Colors**. This opens the **ROI Outline Colors** dialog, which consists of two CW_RGBSLIDER widgets for interactively adjusting the ROI outline colors. The left widget is used to define the color for the selected ROI, and the right widget is used to define the color of unselected ROIs. You can select the RGB, CMY, HSV, or HLS color system from the **Color System** drop-down list.

## Viewing ROI Information

To view geometry and statistical data about the currently selected ROI, click the **Info** button or select **Edit → ROI Information**. This opens the **ROI Information** dialog, which displays area, perimeter, number of pixels, minimum and maximum pixel values, mean, and standard deviation. Values for statistical information (minimum, maximum, mean, and standard deviation) appear as “N/A” for 24-bit images.

## Viewing a Histogram Plot for an ROI

To view a histogram for an ROI, use either the shortcut menu or the ROI Information dialog.

To view an ROI’s histogram plot using the shortcut menu:

1. Position the cursor on the line defining the boundary of an ROI in the drawing window and click the right mouse button. This selects the region and brings up its shortcut menu.
2. Select the **Plot Histogram** menu option from the shortcut menu.

To view an ROI’s histogram plot using the ROI Information dialog:

1. Open the ROI Information dialog by clicking the **Info** button or selecting **Edit → ROI Information**.

2. Select a region from the list and click the **Histogram** button on the ROI Information dialog.

Either of the previous methods opens a LIVE_PLOT dialog showing the ROI's histogram that can be used to interactively control the plot properties.

**Note**

XROI's histogram plot feature now supports RGB images.

## Growing an ROI

Once a region has been created, it may be used as a source ROI for region growing. Region growing is a process of generating one or more new ROIs based upon the image pixel values that fall within the source ROI and the values of the neighboring pixels. New pixels are added to the new grown region if those image pixel values fall within a specified threshold.

**Note**

This option is an interactive implementation of the REGION_GROW function.

To create a new, grown region, do the following:

1. Within the draw area, click the right mouse button on the ROI that is to be grown. This will select the region and bring up its shortcut menu.
2. Select **Grow Region → By threshold** or select **Grow Region → By std. dev. multiple** from the shortcut menu to control how the region is grown.

   The **By threshold** option grows the region to include all neighboring pixels that fall within a specified threshold range. By default, the range is defined by the minimum and maximum pixel values occurring within the original region. To specify a different threshold range, see Using the Region Grow Properties Dialog in the following section.

   The **By std. dev. multiple** option grows a region to include all neighboring pixels that fall within the range of:

   ```
   Mean +/- StdDevMultiplier * StdDev
   ```

   where `Mean` is the mean value of the pixel values within the source ROI, `StdDevMultiplier` is a multiplier that is set using the Region Grow Properties dialog (described below), and `StdDev` is the sample standard deviation of the pixel values within the original region.

## Using the Region Grow Properties Dialog

The Region Grow Properties dialog allows you to view and edit the properties associated with a region growing process. To bring up the Region Grow Properties dialog, do one of the following:

- Click the right mouse button on an ROI in the drawing window and select **Grow Region → Properties...** shortcut menu option.
- Select **Edit → Region Grow Properties**... from the XROI menu bar.

This brings up the Region Grow Properties dialog, shown in the following figure.

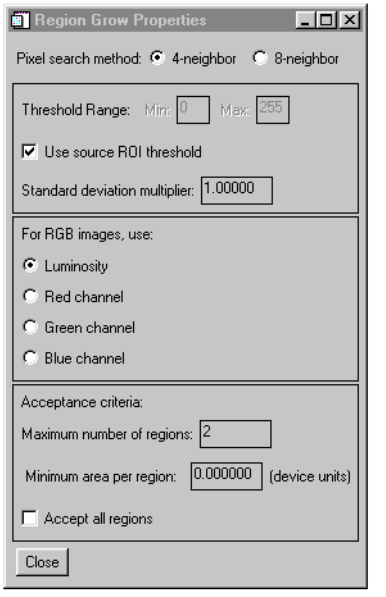



*Figure 39: XROI's Region Grow Properties Dialog*

The Region Grow Properties dialog offers the following options:

| Option | Description |
|---|---|
| Pixel search method: | Describes which pixels are searched when growing the original ROI. The option are:<br>• **4-neighbor** — Searches only the four neighboring pixels that share a common edge with the current pixel. This is the default.<br>• **8-neighbor** — Searches all eight neighboring pixels, including those that are located diagonally relative to the original pixel and share a common corner. |
| Threshold range: | Represents the minimum and maximum image pixel values that are to be included in the grown region when using the **Grow Region → By threshold** option (described in "Growing an ROI" on page 2463). By default, the range of pixel values used are those occurring in the ROI to be grown.<br>To change the threshold values, uncheck **Use source ROI threshold** and enter the minimum and maximum threshold values in the **Min:** and **Max:** fields provided. |
| Standard deviation multiplier: | Represents the factor by which the sample standard deviation of the original ROI's pixel values is multiplied. This factor only applies when the **Grow Region → By std. dev. multiple** option (described in "Growing an ROI" on page 2463) is used.<br>Change the multiplier value by typing the value into the **Standard deviation multiplier** field provided. |

*Table 114: Options of the Region Grow Properties Dialog*

| Option | Description |
|---|---|
| For RGB image, use: | Determines the basis of region growing for an RGB (rather than indexed) image. The image data values used when growing a RGB region can be one of the following:<br>• **Luminosity** — Uses the luminosity values associated with an RGB image. This is the default method. Luminosity is computed as:<br>Luminosity = (0.3 * Red) + (0.59 * Green) + (0.11 * Blue)<br>• **Red Channel**, **Green Channel** or **Blue Channel** — Uses the ROI's red, green or blue channel as a basis for region growing. Click the channel's associated button to specify the channel to be used.<br>**Note -** For indexed images, the image data itself is always used for region growing. |
| Acceptance criteria: | Determines which contours of the grown region are accepted as new regions, (which will also be displayed in the draw area and in the ROI Information dialog list of regions). The region growing process can result in a large number of contours, some of which may be considered insignificant. By default, no more than two regions (those with the greatest geometrical area) are accepted. Modify the acceptance criteria by altering the following values:<br>• **Maximum number of regions:** — Specifies the upper limit of the number of regions to create when growing an ROI.<br>• **Minimum area per region:** — Specifies that only contours having a geometric area (computed in device coordinates) of at least the value stated are accepted and displayed.<br>• **Accept all regions:** — Select this option to accept all generated contours, regardless of count or area. |

*Table 114: Options of the Region Grow Properties Dialog (Continued)*

### Deleting an ROI

An ROI can be deleted using either the shortcut menu or using the ROI Information dialog.

To delete an ROI using the shortcut menu:

1. Click the right mouse button on the line defining the boundary of the ROI in the drawing area that you wish to delete. This selects the region and bring up the shortcut menu.
2. Select the **Delete** menu option from the shortcut menu.

To delete an ROI using the ROI Information dialog:

1. Click the **Info** button or select **Edit → ROI Information**. This opens the **ROI Information** dialog.
2. In the **ROI Information** dialog, select the ROI you wish to delete from the list of ROIs. You can also select an ROI by clicking the **Select** button on the XROI toolbar, then clicking on an ROI on the image.
3. Click the **Delete ROI** button.

## Examples

### Example 1

This example opens a single image in XROI:

```
image = READ_PNG(FILEPATH('mineral.png', $
   SUBDIR=['examples', 'data']))
XROI, image
```

### Example 2

This example reads 3 images from the file `mr_abdomen.dcm`, and calls XROI for each image. A single list of regions is maintained, saving the user from having to redefine regions on each image:

```
;Read 3 images from mr_abdomen.dcm and open each one in XROI:
FOR i=0,2 DO BEGIN
   image = READ_DICOM(FILEPATH('mr_abdomen.dcm',$
      SUBDIR=['examples', 'data']), IMAGE_INDEX=i)
   XROI, image, r, g, b, REGIONS_IN = regions, $
      REGIONS_OUT = regions, $
      ROI_SELECT_COLOR = roi_select_color, $
      ROI_COLOR = roi_color, REJECTED = rejected, /BLOCK
```

```
   OBJ_DESTROY, rejected
ENDFOR

OBJ_DESTROY, regions
```

Perform the following steps:

1. Draw an ROI on the first image, then close that XROI window. Note that the next image contains the ROI defined in the first image. This is accomplished by setting REGIONS_IN and REGIONS_OUT to the same named variable in the FOR loop of the above code.
2. Draw another ROI on the second image.
3. Click the **Select** button and select the first ROI. Then click the **Info** button to open the **ROI Information** window, and click the **Delete ROI** button.
4. Close the second XROI window. Note that the third image contains the ROI defined in the second image, but not the ROI deleted on the second image. This example sets the REJECTED keyword to a named variable, and calls OBJ_DESTROY on that variable. Use of the REJECTED keyword is not necessary to prevent deleted ROIs from appearing on subsequent images, but allows you perform cleanup on objects that are no longer required.

## Example 3

XROI's **File** → **Save ROIs** option allows you to save selected regions of interest. This example shows how to restore such a save file. Suppose you have a file named `mineralRoi.sav` that contains regions of interest selected in the `mineral.png` image file. You would need to complete the following steps to restore the file:

1. First, restore the file, `mineralRoi.sav`. Provide a value for the RESTORE procedure's RESTORED_OBJECTS keyword. Using the scenario stated above, you could enter the following:

```
RESTORE, 'mineralRoi.sav', RESTORED_OBJECTS = myRoi
```

2. Pass the restored object data containing your regions of interest into XROI by specifying `myRoi` as the value for REGIONS_IN as follows:

```
XROI, READ_PNG(FILEPATH('mineral.png', SUBDIRECTORY = $
    ['examples', 'data'])), REGIONS_IN = myRoi
```

   This opens the previously selected regions of interest in the XROI utility.

## Version History

Introduced: 5.4

X_SCROLL_SIZE and Y_SCROLL_SIZE keywords added: 5.6

## See Also

IIMAGE

# XSQ_TEST

The XSQ_TEST function computes the Chi-square goodness-of-fit test between observed frequencies and the expected frequencies of a theoretical distribution.

Expected frequencies of magnitude less than 5 are combined with adjacent elements resulting in a reduction of cells used to formulate the chi-squared test statistic. If the observed frequencies differ significantly from the expected frequencies, the Chi-square test statistic will be large and the fit is poor. This situation requires the rejection of the hypothesis that the given observed frequencies are an accurate approximation to the expected frequency distribution.

This routine is written in the IDL language. Its source code can be found in the file `xsq_test.pro` in the `lib` subdirectory of the IDL distribution.

## Syntax

*Result* = XSQ_TEST( *Obfreq*, *Exfreq* [, EXCELL=*variable*] [, OBCELL=*variable*] [, RESIDUAL=*variable*] )

## Return Value

The result is a two-element vector containing the Chi-square test statistic X2 and the one-tailed probability of obtaining a value of X2 or greater.

## Arguments

### Obfreq

An *n*-element integer, single-, or double-precision floating-point vector containing observed frequencies.

### Exfreq

An *n*-element integer, single-, or double-precision floating-point vector containing expected frequencies.

# Keywords

## EXCELL

Set this keyword to a named variable that will contain a vector of expected frequencies used to formulate the Chi-square test statistic. If each of the expected frequencies contained in *Exfreq*, has a magnitude of 5 or greater, then this vector is identical to *Exfreq*. If *Exfreq* contains elements of magnitude less than 5, adjacent expected frequencies are combined. The identical combinations are performed on the corresponding elements of *Obfreq*.

## OBCELL

Set this keyword to a named variable that will contain a vector of observed frequencies used to formulate the Chi-square test statistic. The elements of this vector are often referred to as the “cells” of the observed frequencies. The length of this vector is determined by the length of EXCELL described below.

## RESIDUAL

Set this keyword to a named variable that will contain a vector of signed differences between corresponding cells of observed frequencies and expected frequencies.

```
RESIDUAL[i] = OBCELL[i] - EXCELL[i].
```

The length of this vector is determined by the length of EXCELL described above.

# Examples

```
; Define the vectors of observed and expected frequencies:
obfreq = [2, 1, 4, 15, 10, 5, 3]
exfreq = [0.5, 2.1, 5.9, 10.3, 10.7, 7.0, 3.5]

; Test the hypothesis that the given observed frequencies are an
; accurate approximation to the expected frequency distribution:
result = XSQ_TEST(obfreq, exfreq)
PRINT, result
```

### IDL Output

```
3.05040       0.383920
```

Since the vector of expected frequencies contains elements of magnitude less than 5, adjacent expected frequencies are combined resulting in fewer cells. The identical combinations are performed on the corresponding elements of observed frequencies.

The computed value of 0.383920 indicates that there is no reason to reject the proposed hypothesis at the 0.05 significance level.

## Version History

Introduced: 4.0

## See Also

CTI_TEST

# XSURFACE

The XSURFACE procedure is a utility that provides a graphical interface to the SURFACE and SHADE_SURF commands. Different controls are provided to change the viewing angle and other plot parameters. The command used to generate the resulting surface plot is shown in a text window. Note that this procedure does not accept SURFACE or SHADE_SURF keywords.

This routine is written in the IDL language. Its source code can be found in the file `xsurface.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XSURFACE, *Data* [, /BLOCK] [, GROUP=*widget_id*]

## Arguments

### Data

The two-dimensional array to display as a wire-mesh or shaded surface.

## Keywords

### BLOCK

Set this keyword to have XMANAGER *block* when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting BLOCK=1 will cause *all* widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XSURFACE block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

### GROUP

Set this keyword to the widget ID of the widget that calls XSURFACE. When GROUP is specified, the death of the calling widget results in the death of XSURFACE.

## Examples

```
; Make a 2-D array:
z = DIST(30)

; Call XSURFACE. The XSURFACE widget appears:
XSURFACE, z
```

## Version History

Introduced: Pre 4.0

## See Also

ISURFACE, SHADE_SURF, SURFACE

# XVAREDIT

The XVAREDIT procedure is a utility that provides a widget-based editor for any IDL variable. Use the input fields to change desired values of the variable or array. Click “Accept” to write the new values into the variable. Click “Cancel” to exit XVAREDIT without saving changes.

This routine is written in the IDL language. Its source code can be found in the file `xvaredit.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XVAREDIT, *Var* [, NAME='*variable_name*'{ignored if variable is a structure}] [, GROUP=*widget_id*] [, X_SCROLL_SIZE=*columns*] [, Y_SCROLL_SIZE=*rows*]

## Arguments

### Var

The variable to be edited. On output, this variable contains the edited value if the user selects the “Accept” button, or the original value if the user selects the “Cancel” button.

## Keywords

### NAME

The NAME of the variable. This keyword is overwritten with the structure name if the variable is a structure.

### GROUP

The widget ID of the widget that calls XVAREDIT. When this ID is specified, a death of the caller results in a death of XVAREDIT.

### X_SCROLL_SIZE

Set this keyword to the column width of the scrolling viewport. The default is 4.

### Y_SCROLL_SIZE

Set this keyword to the row width of the scrolling viewport. The default is 4.

## Version History

Introduced: Pre 4.0

# XVOLUME

The XVOLUME procedure is a utility for viewing and interactively manipulating volumes and isosurfaces.

This routine is written in the IDL language. Its source code can be found in the file `xvolume.pro` in the `lib/utilities` subdirectory of the IDL distribution.

**Tip**

The XVOLUME_ROTATE and XVOLUME_WRITE_IMAGE procedures, which can be called only after a call to XVOLUME, can be used to easily create animations of volumes and isosurfaces displayed in XVOLUME. See XVOLUME_ROTATE for an example.

## Using XVOLUME

XVOLUME displays a resizeable top-level base with a toolbar, a menu, a graphical interface for controlling volume and isosurface properties, and a draw widget for displaying and manipulating the volume, as shown in the following figure:

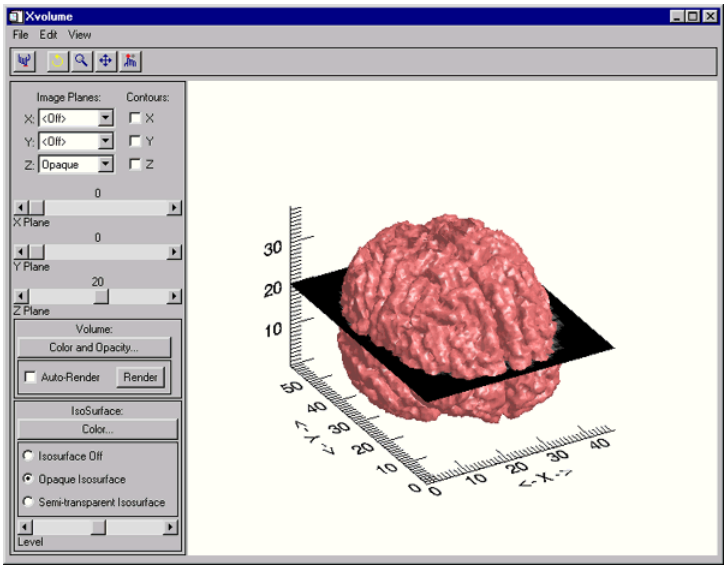



*Figure 40: The XVOLUME Utility*

## The XVOLUME Toolbar

The XVOLUME toolbar contains the following buttons.

**Note**

If you have the **Auto-Render** option selected, the Rotate, Zoom, and Pan features may be more difficult to use. For the best performance while manipulating the orientation of a volume using these features, uncheck the **Auto-Render** option.

**Reset:** Resets rotation, scaling, and panning.

**Rotate:** Click the left mouse button on the volume and drag to rotate.

**Zoom:** Click the left mouse button on the volume and drag to zoom in or out.

**Pan:** Click the left mouse button on the volume and drag to pan.

**Select:** Click in the draw widget to identify the selected item. A name identifying the selected item is displayed next to the Select button.

## The XVOLUME Interface

The XVOLUME interface provides the following elements for controlling the display of image planes and contours, volumes, and isosurfaces:

### Image Planes and Contours

Image planes and contours allow you to visualize the values associated with the volume or isosurface at a specified X, Y, or Z plane.

- **Image Planes** — Select one of the following options from the drop-down list for each dimension to control the display of image planes:
  - **Off**: Turns off the image plane display.
  - **Opaque**: Displays an opaque image plane at the location specified by the corresponding plane slider.
  - **Transparent**: Displays a transparent image plane at the location specified by the corresponding plane slider. The transparency value of the plane is taken from the volume at the current location of the image plane.

- **Contours** — Check this option to display contours on the specified plane at the location specified by corresponding the plane slider.
- **Plane Sliders** — Move these sliders to change the position of the plane in each dimension.

### Volume

- **Color and Opacity**: Click this button to change the color and/or opacity of the current volume. This opens a CW_PALETTE_EDITOR dialog, which is a compound widget used to edit color palettes. See CW_PALETTE_EDITOR for more information.
- **Auto-Render**: Select this option to have rendering executed automatically after each change you make to the volume. If **Auto-Render** is unchecked, you must manually click the **Render** button to see changes you have made to the volume. If **Auto-Render** is checked, the **Render** button will be grayed out.
- **Render**: Click on this button to execute rendering computations and display the current volume. If **Auto-Render** is checked, this button will be grayed out.

### Isosurface

An isosurface is a 3-D surface on which the data values are constant along the entire surface. Use the following elements to control the appearance of the isosurface:

- **Color**: Click this button to change the color system and/or values for the current isosurface. This opens a CW_RGBSLIDER dialog, which is a compound widget that provides a drop-down list for selecting the RGB, CMY, HSV, or HLS color system, and three sliders for adjusting the values associated with each color system.
- **Isosurface Off**: Select this option to turn off the isosurface display.
- **Opaque Isosurface**: Select this option to display an opaque isosurface.
- **Semi-transparent Isosurface**: Select this option to display a semi-transparent isosurface.
- **Level**: Use this slider to adjust the threshold value of the isosurface.

## Syntax

XVOLUME, *Vol*, [, /BLOCK] [, GROUP=*widget_id*] [, /INTERPOLATE] [, /MODAL] [, RENDERER={0 | 1}] [, /REPLACE] [, SCALE=*value*] [, /TEST] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

# Arguments

## Vol

A 3-dimensional array of the form [*x*, *y*, *z*] that specifies a data volume.

# Keywords

## BLOCK

Set this keyword to have XMANAGER block when this application is registered. By default, BLOCK is set equal to zero, providing access to the command line if active command line processing is available. Note that setting the BLOCK keyword causes all widget applications to block, not just this application. For more information, see the documentation for the NO_BLOCK keyword to XMANAGER.

**Note**

Only the outermost call to XMANAGER can block. Therefore, to have XVOLUME block, any earlier calls to XMANAGER must have been called with the NO_BLOCK keyword. See the documentation for the NO_BLOCK keyword to XMANAGER for an example.

## GROUP

Set this keyword to the widget ID of the widget that calls XVOLUME. When this keyword is specified, the death of the caller results in the death of XVOLUME.

## INTERPOLATE

Set this keyword to indicate that trilinear interpolation is to be used when rendering the volume and the image planes. Setting this keyword improves the quality of images produced, at the cost of more computing time, especially when the volume has low resolution with respect to the size of the viewing plane. Nearest neighbor sampling is used by default.

## MODAL

Set this keyword to block processing of events from other widgets until the user quits XVOLUME. The MODAL keyword does not require a group leader to be specified. If no group leader is specified, and the MODAL keyword is set, XVOLUME fabricates an invisible group leader for you.

**Note**

To be modal, XVOLUME does not require that its caller specify a group leader. This is unlike other IDL widget procedures such as XLOADCT, which, to be modal, do require that their caller specify a group leader. These other procedures were implemented this way to encourage the caller to create a modal widget that will be well-behaved with respect to layering and iconizing. (See "Iconizing, Layering, and Destroying Groups of Top-Level Bases" on page 2128 for more information.)

To provide a simple means of invoking XVOLUME as a modal widget in applications that contain no other widgets, XVOLUME can be invoked as MODAL without specifying a group leader, in which case XVOLUME fabricates an invisible group leader for you. For applications that contain multiple widgets, however, it is good programming practice to supply an appropriate group leader when invoking XVOLUME, /MODAL. As with other IDL widget procedures with names prefixed with "X", specify the group leader via the GROUP keyword.

## RENDERER

Set this keyword to an integer value indicating which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL (the default)
- 1 = IDL's software implementation

## REPLACE

If this keyword is set, and there is a current instance of XVOLUME running, the volume displayed in XVOLUME is replaced with the volume specified by *Vol*. For example, display volume1 using the command

```
XVOLUME, volume1
```

To replace volume1 with volume2, you would use the command

```
XVOLUME, volume2, /REPLACE
```

## SCALE

Set this keyword to the zoom factor for the initial view. The default is 1/SQRT(3). This default value provides the largest possible view of the volume, while ensuring that no portion of the volume will be clipped by the XVOLUME window, regardless of the volume's orientation.

When using the SCALE keyword for XVOLUME, you can scale with a 3-element array of values [x, y, z].

### TEST

If set, the *Vol* argument is not required (and is ignored if provided). A volume of random numbers is displayed instead. This allows you to test code that uses XVOLUME without having to specify volume data.

### XSIZE

The width of the drawable area in pixels.

### YSIZE

The height of the drawable area in pixels.

## Examples

Create a volume and display using XVOLUME:

```
; Create a volume:
vol = BYTSCL(RANDOMU((SEED=0),5,5,5))
vol = CONGRID(vol, 30,30,30)

; Display volume:
XVOLUME, vol
```

## Version History

Introduced: 5.4

## See Also

IVOLUME, XVOLUME_ROTATE, XVOLUME_WRITE_IMAGE, IDLgrVolume, INTERPOLATE, ISOSURFACE, SHADE_VOLUME, SLICER3, “Volume Objects” in Chapter 32 of the *Using IDL* manual.

# XVOLUME_ROTATE

The XVOLUME_ROTATE procedure is used to programmatically rotate the volume currently displayed in XVOLUME. XVOLUME must be called prior to calling XVOLUME_ROTATE. This procedure can be used to create animations of volumes and isosurfaces.

This routine is written in the IDL language. Its source code can be found in the file `xvolume_rotate.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XVOLUME_ROTATE, *Axis*, *Angle* [, /PREMULTIPLY]

## Arguments

### Axis

A 3-element vector of the form [*x*, *y*, *z*] describing the axis about which the model is to be rotated.

### Angle

The amount of rotation, measured in degrees.

## Keywords

### PREMULTIPLY

Set this keyword to cause the rotation matrix specified by *Axis* and *Angle* to be pre-multiplied to the model's transformation matrix. By default, the rotation matrix is post-multiplied.

## Examples

The following example creates an animation of the volume currently displayed in XVOLUME. It does this by rotating the volume through 360 degrees in increments of 10 degrees using XVOLUME_ROTATE, and writing the volume to a BMP file for each increment using XVOLUME_WRITE_IMAGE. It then loops through the images and uses TV to display each image.

First, display a volume as follows:

```
; Create a volume:
vol = BYTSCL(RANDOMU((SEED=0),5,5,5))
vol = CONGRID(vol, 30,30,30)

; Display volume:
XVOLUME, vol
```

Now, use the XVOLUME interface to modify the orientation and appearance of the volume or isosurface as desired. Once you have the volume or isosurface displayed the way you want it, run the following program:

```
PRO spin_volume

   inc = 10. ; degrees.
   ; Create images
   FOR i=0,(360./inc)-2 DO BEGIN
      XVOLUME_WRITE_IMAGE, $
         'spin' + STRCOMPRESS(i, /REMOVE_ALL) + '.bmp', 'bmp'
      XVOLUME_ROTATE, [0,0,1], inc, /PREMULTIPLY
   ENDFOR
   XVOLUME_ROTATE, [0,0,1], inc, /PREMULTIPLY

   ; Read images
   img = READ_BMP('spin0.bmp')
   siz = SIZE(img, /DIM)
   arr = BYTARR(3, siz[1], siz[2], 360./inc-1)
   FOR i=0,360./inc-2 DO BEGIN
      img = READ_BMP( $
         'spin' + STRCOMPRESS(i, /REMOVE_ALL) + '.bmp', /RGB)
      arr[0,0,0, i] = img
      PRINT, i
   ENDFOR

   ; Display animation
   FOR i=0,2 DO BEGIN ; num rotations
      FOR j=0,(360./inc)-2 DO BEGIN
         TV, arr[*,*,*,j], /TRUE
      ENDFOR
   ENDFOR

   TV, arr[*,*,*,0], /TRUE

END
```

# Version History

Introduced: 5.4

## See Also

XVOLUME, XVOLUME_WRITE_IMAGE

# XVOLUME_WRITE_IMAGE

The XVOLUME_WRITE_IMAGE procedure is used to write the volume currently displayed in XVOLUME to an image file with the specified name and file format. XVOLUME must be called prior to calling XVOLUME_WRITE_IMAGE.

This routine is written in the IDL language. Its source code can be found in the file `xvolume_write_image.pro` in the `lib/utilities` subdirectory of the IDL distribution.

## Syntax

XVOLUME_WRITE_IMAGE, *Filename*, *Format* [, DIMENSIONS=*[x, y]* ]

## Arguments

### Filename

A scalar string containing the name of the file to write.

### Format

A scalar string containing the name of the file format to write. See QUERY_IMAGE for a list of supported formats.

## Keywords

### DIMENSIONS

Set this keyword to a 2-element vector of the form [*x*, *y*] specifying the size of the output image, in pixels. If this keyword is not specified, the image will be written using the dimensions of the current XVOLUME draw widget.

## Examples

See XVOLUME_ROTATE.

## Version History

Introduced: 5.4

## See Also

XVOLUME, XVOLUME_ROTATE

# XYOUTS

The XYOUTS procedure draws text on the currently-selected graphics device starting at the designated coordinate.

Arguments *X*, *Y*, and *String* can be any combination of scalars or arrays. If the arguments are arrays, multiple strings are output.

If the optional *X* and *Y* arguments are omitted, the text is positioned at the end of the most recently output text string.

Important keywords that control the appearance and positioning of the text include: ALIGNMENT, the justification of the text; CHARSIZE, the size of the text; FONT, chooses between vector drawn and hardware fonts; COLOR, the color of the text; and ORIENTATION, the angle between the baseline of the text and the horizontal. With hardware fonts, most of the text attributes, (e.g., size and orientation), are predetermined and not changeable.

**Note**

Specify the Z coordinate with the Z keyword when positioning text in three dimensions.

## Syntax

XYOUTS, [*X*, *Y*,] *String* [, ALIGNMENT=*value*{0.0 to 1.0}] [, CHARSIZE=*value*] [, CHARTHICK=*value*] [, TEXT_AXES={0 | 1 | 2 | 3 | 4 | 5}] [, WIDTH=*variable*]

**Graphics Keywords:**[, CLIP=*[$X_0$, $Y_0$, $X_1$, $Y_1$]*] [, COLOR=*value*][, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*]
[, ORIENTATION=*ccw_degrees_from_horiz*] [, /NOCLIP] [, /T3D] [, Z=*value*]

## Arguments

### X, Y

The horizontal and vertical coordinates used to position the string(s). *X* and *Y* are normally interpreted in data coordinates. The DEVICE and NORMAL keywords can be used to specify the coordinate units.

*X* and *Y* can be arrays of positions if *String* is an array.

### String

The string(s) to be output. This argument can be a scalar string or an array of strings. If this argument is not a string, it is converted prior to use using the default formatting rules. If *String* is an array, *X*, *Y*, and the COLOR keyword can also be arrays so that each string can have a separate location and color.

## Keywords

### ALIGNMENT

Specifies the alignment of the text baseline. An alignment of 0.0 (the default) aligns the left edge of the text baseline with the given (*x*, *y*) coordinate. An alignment of 1.0 right-justifies the text, while 0.5 results in text centered over the point (*x*, *y*).

### CHARSIZE

The overall character size for the annotation. A CHARSIZE of 1.0 is normal. Setting CHARSIZE = -1 suppresses output of the text string. This keyword has no effect when used with the hardware drawn fonts; for exceptions, see "Scaled Hardware Fonts" on page 2490.

### CHARTHICK

The line thickness of the vector drawn font characters. This keyword has no effect when used with the hardware drawn fonts; for exceptions, see "Scaled Hardware Fonts" on page 2490. The default value is 1.0.

### TEXT_AXES

This keyword specifies the plane of vector drawn text when three-dimensional plotting is enabled. By default, text is drawn in the plane of the XY axes. The horizontal text direction is in the X plane, and the vertical text direction is in the Y plane. Values for this keyword can range from 0 to 5, with the following effects: 0 for XY, 1 for XZ, 2 for YZ, 3 for YX, 4 for ZX, and 5 for ZY. The notation ZY means that the horizontal direction of the text lies in the Z plane, and the vertical direction of the text is drawn in the Y plane.

### WIDTH

Set this keyword to a named variable in which to return the width of the text string, in normalized coordinate units.

### Graphics Keywords Accepted

See Appendix B, “Graphics Keywords” for the description of graphics and plotting keywords not listed above. CLIP, COLOR, DATA, DEVICE, FONT, NOCLIP, NORMAL, ORIENTATION, T3D, Z.

## Examples

Print the string “This is text” at device coordinate position (100,100):

```
XYOUTS, 100, 100, 'This is text', /DEVICE
```

Print an array of strings with each element of the array printed at a different location. Use larger text than in the previous example:

```
XYOUTS, [0, 200, 250], [200, 50, 100], $
   ['This', 'is', 'text'], CHARSIZE = 3, /DEVICE
```

Determine the text size for a window device before opening an on-screen window:

```
WINDOW, /FREE, /PIXMAP, XSIZE=myWinXSize, YSIZE=myWinYSize
XYOUTS, 'Check this out', WIDTH=w
WDELETE
```

*myWinXSize* and *myWinYSize* are chosen to match your onscreen window. Since we can not know the characteristics of a given device (such as character size) until a window has been opened, the PIXMAP keyword to WINDOW allows you to compute appropriate dimensions for text with an invisible window before displaying a window on your screen.

## Scaled Hardware Fonts

One example of hardware fonts which can be scaled are PostScript fonts. If you are using PostScript fonts, the keywords CHARTHICK and CHARSIZE will have an effect on a call to XYOUTS. Of the devices we provide that support hardware fonts, only the PostScript device uses scalable PostScript fonts for its “hardware” font system. All other devices use a bitmapped font technology.

Scaling is related to whether or not a device supports Hershey formatting commands when hardware fonts are used. Formatting requires the ability to scale the text on a per-character basis (i.e. for subscripting). To see if a given device supports Hershey formatting when hardware fonts are used, look at bit 12 of !D.FLAGS. You can also use this indicator to determine whether or not the hardware fonts will be scaled.

## Version History

Introduced: Original

## See Also

ANNOTATE, PRINT/PRINTF

# ZOOM

The ZOOM procedure displays part of an image from the current window enlarged in a new (“zoom”) window. The cursor is used to mark the center of the zoom area, and different zoom factors can be specified interactively.

**Note**

ZOOM only works with color systems.

This routine is written in the IDL language. Its source code can be found in the file `zoom.pro` in the `lib` subdirectory of the IDL distribution.

### Using ZOOM

After calling ZOOM, place the mouse cursor over an image in an IDL graphics window. Click the left mouse button to display a magnified version of the image in a new window. The zoomed image is centered around the pixel selected in the original window. Click the middle mouse button to display a menu of zoom factors. Click the right mouse button to exit the procedure.

### Using ZOOM with Draw Widgets

Note that the ZOOM procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain a zooming effect in a draw widget, use the CW_ZOOM function.

## Syntax

ZOOM [, /CONTINUOUS] [, FACT=*integer*] [, /INTERP] [, /KEEP]
[, /NEW_WINDOW] [, XSIZE=*value*] [, YSIZE=*value*]
[, ZOOM_WINDOW=*variable*]

## Arguments

None.

## Keywords

### CONTINUOUS

Set this keyword to make the zoom window track the mouse without requiring the user to press the left mouse button. This feature only works well on fast computers.

### FACT

Use this keyword to specify the zoom factor, which must be an integer. The default zoom factor is 4.

### INTERP

Set this keyword to use bilinear interpolation. The default is to use pixel replication.

### KEEP

Set this keyword to keep the zoom window after exiting the procedure.

### NEW_WINDOW

Normally, if ZOOM is called with KEEP and then called again, it will use the same window to display the new zoomed image. Set the NEW_WINDOW keyword to force ZOOM to create a new window for this purpose.

### XSIZE

Use this keyword to specify the X size of the zoom window. The default is 512.

### YSIZE

Use this keyword to specify the Y size of the zoom window. The default is 512.

### ZOOM_WINDOW

Set this keyword to a named variable that will contain the index of the zoom window. KEEP must also be set. If KEEP is not set, ZOOM_WINDOW will contain the integer -1.

## Version History

Introduced: Original

## See Also

CW_ZOOM, ZOOM_24

# ZOOM_24

The ZOOM_24 procedure displays part of a 24-bit color image from the current window expanded in a new (“zoom”) window, and provides information about cursor location and color values in an auxiliary (“data”) window. The cursor is used to mark the center of the zoom area, and different zoom factors can be specified interactively.

**Note**

ZOOM only works on 24-bit color systems.

This routine is written in the IDL language. Its source code can be found in the file `zoom_24.pro` in the `lib` subdirectory of the IDL distribution.

## Using ZOOM_24

After calling ZOOM_24, windows titled “Zoomed Image” (the zoom window) and “Pixel Values” (the data window) appear on the screen. Place the mouse cursor over a 24-bit color image in an IDL graphics window and click the left mouse button to display a magnified version of the image in the zoom window. The zoomed image is centered around the pixel selected in the original window. Move the mouse cursor in the zoom window to determine the coordinates (in the original image) and color values of individual pixels.

With the cursor located in the zoom window, click the right mouse button to return to selection mode, which allows you to either choose a new zoom center, change the zoom factor, or exit the procedure. Move the cursor to the original image and click the middle mouse button to display a menu of zoom factors, or click the right mouse button to exit the procedure.

## Using ZOOM_24 with Draw Widgets

Note that the ZOOM_24 procedure is only for use with IDL graphics windows. It should not be used with draw widgets. To obtain a zooming effect in a draw widget, use the CW_ZOOM function.

# Syntax

ZOOM_24 [, FACT=*integer*] [, /RIGHT] [, XSIZE=*value*] [, YSIZE=*value*]

# Arguments

None.

# Keywords

## FACT

Use this keyword to specify the zoom factor, which must be an integer. The default zoom factor is 4.

## RIGHT

Set this keyword to position the zoom and data windows to the right of the original window.

## XSIZE

Use this keyword to specify the X size of the zoom window. The default is 512.

## YSIZE

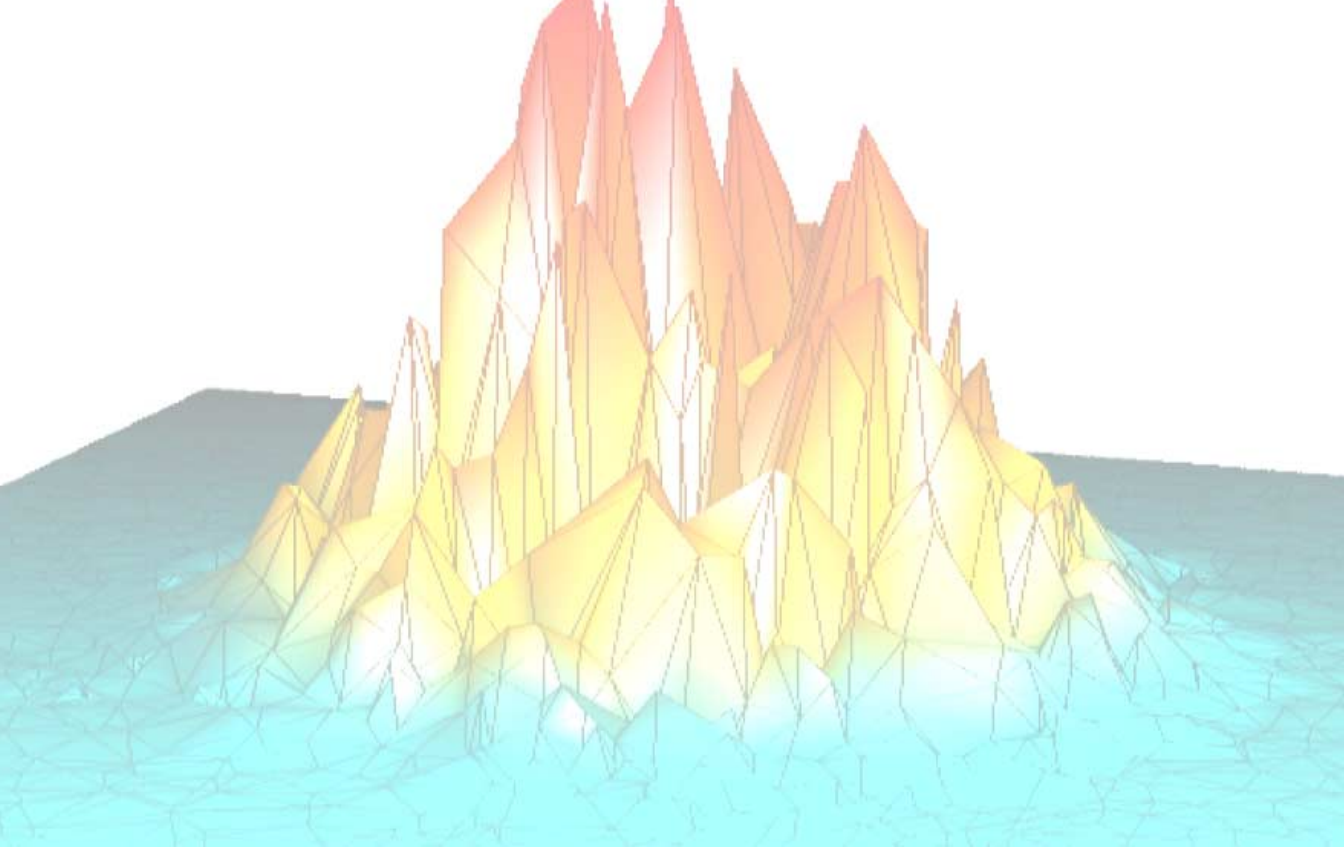
Use this keyword to specify the Y size of the zoom window. The default is 512.

# Version History

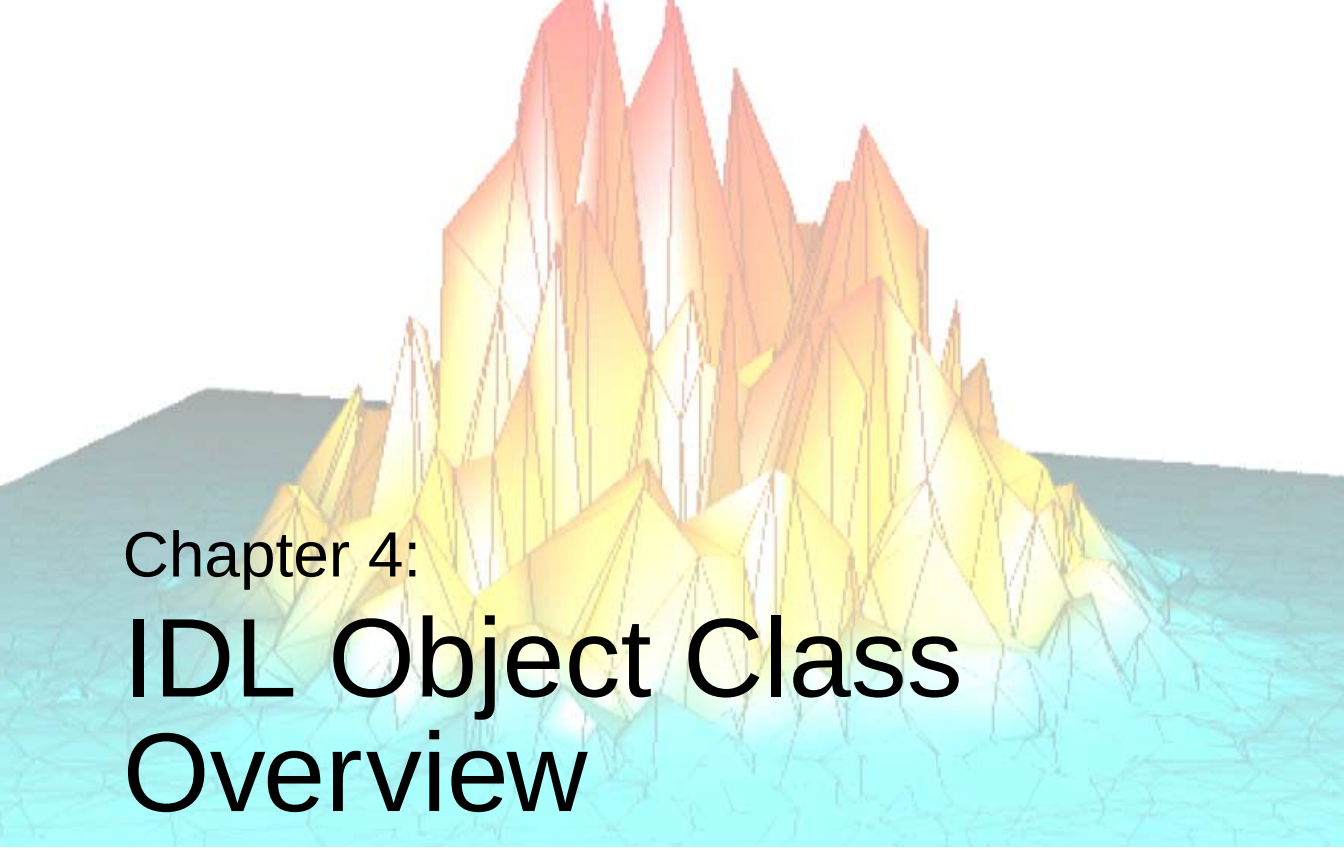
Introduced: Pre 4.0

# See Also

CW_ZOOM, ZOOM



# Part II: Object Class and Method Reference



# Chapter 4: IDL Object Class Overview

This section describes IDL's object class library.

# Using the Class Reference

IDL's object class library is documented in this section. The page or pages describing each class include references to any superclasses of the class, to the properties of the class, and to the methods associated with the class. Class methods are documented alphabetically following the description of the class itself.

A description of each method follows its name. Beneath the general description of the method are a number of sections that describe the Syntax for the method, its arguments (if any), its keywords (if any). These sections are described below.

## Syntax

The Syntax section shows the proper syntax for calling the method.

### Procedure Methods

IDL procedure methods have the syntax:

*Obj -> Procedure_Name*, *Argument* [, *Optional_Arguments*]

where *Obj* is a valid object reference, *Procedure_Name* is the name of the procedure method, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter to the procedure method. The square brackets around optional arguments are not used in the actual call to the procedure, they are simply used to denote the optional nature of the arguments within this document.

### Function Methods

IDL function methods have the syntax:

*Result* = *Obj -> Function_Name*(*Argument* [, *Optional_Arguments*])

where *Obj* is a valid object reference, *Result* is the returned value of the function method, *Function_Name* is the name of the function method, *Argument* is a required parameter, and *Optional_Argument* is an optional parameter. The square brackets around optional arguments are not used in the actual call to the function, they are simply used to denote the optional nature of the arguments within this document.

**Note**

All arguments and keywords to functions should be supplied *within* the parentheses that follow the function's name.

# Arguments

The *Arguments* section describes each valid argument to the method.

**Note**

These arguments are positional parameters that must be supplied in the order indicated by the method's syntax.

## Named Variables

Often, arguments that contain values upon return from the function or procedure method ("output arguments") are described as accepting "named variables." A named variable is simply a valid IDL variable name. This variable *does not* need to be defined before being used as an output argument. Note, however that when an argument calls for a named variable, only a named variable can be used—sending an expression causes an error.

## Keywords

The *Keywords* section describes each valid keyword argument to the method.

**Note**

Keyword arguments are formal parameters that can be supplied in any order.

Keyword arguments are supplied to IDL methods by including the keyword name followed by an equal sign ("=") and the value to which the keyword should be set. Note that keywords can be abbreviated to their shortest unique length. For example, the XSTYLE keyword can be abbreviated to XST.

**Note**

In the case of Init, GetProperty and SetProperty methods, keywords often correspond to object *properties*. See "Object Properties" on page 2503 for additional discussion.

## Setting Keywords

When the documentation for a keyword says something similar to, "Set this keyword to enable logarithmic plotting," the keyword is simply a switch that turns an option on and off. Usually, setting such keywords equal to 1 causes the option to be turned on. Explicitly setting the keyword to zero (or not including the keyword) turns the option off.

There is a “shortcut” that can be used to set a keyword equal to 1 without the usual syntax (i.e., `KEYWORD=1`). To “set” a keyword, simply preface it with a slash character (“/”). For example, to create a surface object with a skirt around it, set the SKIRT keyword to the SURFACE routine as follows:

```
mySurface = OBJ_NEW('IDLgrSurface', DIST(10), /SKIRT)
```

## Creating Objects from the Class Library

To create an object from the IDL object class library, use the OBJ_NEW function. See “OBJ_NEW” on page 1396. The Init method for each class describes the arguments and keywords available when you are creating a new object.

For example, to create a new object from the IDLgrAxis class, use the following call to OBJ_NEW along with the arguments and keywords accepted by the IDLgrAxis::Init method:

```
myAxis = OBJ_NEW(IDLgrAxis, DIRECTION = 1, RANGE = [0.0, 40.0])
```

# Object Properties

Some IDL objects have *properties* associated with them — things like color, line style, size, and so on. Properties are set or changed by supplying property-value pairs in a call to the object class' Init or SetProperty method:

```
Obj -> OBJ_NEW('ObjectClass', PROPERTY = value, ... )
```

*or*

```
Obj -> SetProperty, PROPERTY = value, ...
```

where *PROPERTY* is the name of a property and *value* is the associated property value.

Property values are retrieved by supplying property-value pairs in a call to the object class' GetProperty method:

```
Obj -> GetProperty, PROPERTY = variable, ...
```

where *PROPERTY* is the name of a property and *variable* is the name of an IDL variable that will hold the associated property value.

**Note**

Property-value pairs behave in exactly the same way as Keyword-value pairs. This means that you can set the value of a boolean property to 1 by preceding the name of the property with a "/" character. The following are equivalent:

```
Obj -> SetProperty, PROPERTY = 1

Obj -> SetProperty, /PROPERTY
```

If you are familiar with IDL Direct Graphics, you will note that many of the properties of IDL objects correspond to keywords to the Direct Graphics routines. Unlike IDL Direct Graphics, the IDL Object Graphics system allows you to change the value of an object's properties without re-creating the entire object. Objects must be redrawn, however, with a call to the destination object's Draw method, for the changes to become visible.

## Properties and the Property Sheet Interface

In addition to being able to set and change object property values programmatically, IDL provides a way for users to change property values via a graphical user interface. The WIDGET_PROPERTYSHEET function creates a user interface that allows users to select and change property values using the mouse and keyboard.

For an object property to be displayed in a property sheet, the property must be registered. See “Registered Properties” on page 2507 for additional discussion.

## Setting Properties at Initialization

Often, you will set an object’s properties when creating the object for the first time, which is done by specifying any keywords to the object’s Init method directly in the call of OBJ_NEW that creates the object. For example, suppose you are creating a plot and wish to use a red line to draw the plot line. You could specify the COLOR keyword to the IDLgrPlot::Init method directly in the call to OBJ_NEW:

```
myPlot = OBJ_NEW('IDLgrPlot', xdata, ydata, COLOR = [255, 0, 0])
```

In most cases, an object’s Init method cannot be called directly. Arguments to OBJ_NEW are passed directly to the Init method when the object is created.

For some graphics objects, you can specify a keyword that has the same meaning as an argument. In Object Graphics, the value of the keyword overrides the value set by the argument. For example,

```
myPlot = OBJ_NEW('IDLgrPlot', xdata, ydata, DATAX = newXData)
```

The Plot object uses the data in `newXData` for the plot’s X data.

## Setting Properties of Existing Objects

After you have created an object, you can also set its properties using the object’s SetProperty method. For example, the following two statements duplicate the single call to OBJ_NEW shown above:

```
myPlot = OBJ_NEW('IDLgrPlot', xdata, ydata)
myPlot -> SetProperty, COLOR = [255, 0, 0]
```

**Note**

Not all keywords available when the object is being initialized are necessarily available via the SetProperty method. Keywords available when using an object’s SetProperty method are noted with the word “Set” in the table included after the text description of the property.

## Retrieving Property Settings

You can retrieve the value of a particular property using an object’s GetProperty method. The GetProperty method accepts a list of keyword-variable pairs and returns

the value of the specified properties in the variables specified. For example, to return the value of the COLOR property of the plot object in our example, use the statement:

```
myPlot -> GetProperty, COLOR = plotcolor
```

The value of the COLOR property is returned in the IDL variable `plotcolor`.

You can retrieve the values of all of the properties associated with a graphics object by using the ALL keyword to the object's GetProperty method. The following statement:

```
myPlot -> GetProperty, ALL = allprops
```

returns an anonymous structure in the variable `allprops`; the structure contains the values of all of the retrievable properties of the object.

**Note**

Not all keywords available when the object is being initialized are necessarily available via the GetProperty method. Keywords available when using an object's GetProperty method are noted with the word "Get" in the table included after the text description of the property.

# About Object Property Descriptions

In the documentation for the IDL object class library, the description of each class is followed by a section describing the properties of the class. Each property description is followed by a table that looks like this:

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | Hide | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

where

- **Property Type** describes the property type associated with the property. If the property is *registered*, the property type will be one of the types described in "Registered Property Data Types" on page 2508. If the property is not registered, this field will describe the generic IDL data type of the property value.
- **Name String** is the default value of the Name property attribute. If the property is registered, this is the value that appears in the left-hand column when the property is displayed in a property sheet widget. If the property is not registered, this field will contain the words *not displayed*.

- **Get**, **Set**, and **Init** describe whether the property can be specified as a keyword to the GetProperty, SetProperty, and Init methods, respectively.
- **Registered** describes whether the property is registered for display in a property sheet widget. See “Registered Properties” on page 2507 for details on registered properties.

# Registered Properties

In order for an object property to be displayed in the WIDGET_PROPERTYSHEET interface, which makes it possible for a user to interactively change the value of the property using the mouse and keyboard, the following two conditions must be met:

- The property must belong to an object that subclasses from the IDLitComponent class. IDLitComponent provides the infrastructure necessary to display property sheets.
- The property must be *registered*. Properties that are not registered will never be displayed in a property sheet. (Note that registered properties can also be *hidden*, which prevents them from being displayed in a property sheet.)

**Note**

This section provides a brief overview of property registration. See Chapter 4, "Property Management" in the *iTool Developer's Guide* manual for a more in-depth discussion.

## Registering a Property

To register a property, use the RegisterProperty method of the IDLitComponent class:

```
Obj -> IDLitComponent::RegisterProperty, PropertyIdentifier, $
   [, TypeCode] [, ATTRIBUTE = value]
```

where *PropertyIdentifier* is a string that uniquely identifies the property, *TypeCode* is an integer between 0 and 9 specifying the property data type, and *ATTRIBUTE* is a property attribute.

Property identifier strings must obey certain rules; see "Property Identifiers" in Chapter 4 of the *iTool Developer's Guide* manual for details. Property type codes are discussed in "Registered Property Data Types" on page 2508. Property attributes are discussed in "Property Attributes" in Chapter 4 of the *iTool Developer's Guide* manual.

## Registering All Available Properties

Some of the classes in the IDL object class library include a mechanism to register all available properties in a single operation. If an object class has a REGISTER_PROPERTIES property, then setting that property to 1 when creating the object automatically registers all properties that can be registered. If a property

contains a “Yes” in the Registered box of the property description table, it will be registered automatically if the REGISTER_PROPERTIES property is set when the object is created. (See “About Object Property Descriptions” on page 2505 for a description of the property description table.)

## Registered Property Data Types

Registered properties must be of one of the data types listed in Table 4-1.

**Note**

Properties of objects that are *not* registered (that is, properties that can not appear in a property sheet) can be of any IDL data type.

| Type Code | Type | Description |
|---|---|---|
| 0 | USERDEF | User Defined properties can contain values of any IDL type, but must also include a string value that will be displayed in the property sheet. See “Property Data Types” in Chapter 4 of the *iTool Developer’s Guide* manual for additional discussion of User Defined property types. |
| 1 | BOOLEAN | Boolean properties contain either the integer 0 or the integer 1. |
| 2 | INTEGER | Integer properties contain an integer value. If a property of integer data type has a VALID_RANGE attribute that includes an increment value, the property is displayed in a property sheet using a slider. If no increment value is supplied, the property sheet allows the user to edit values manually. |
| 3 | FLOAT | Float properties contain a double-precision floating-point value. If a property of float data type has a VALID_RANGE attribute that includes an increment value, the property is displayed in a property sheet using a slider. If no increment value is supplied, the property sheet allows the user to edit values manually. |
| 4 | STRING | String properties contain a scalar string value |

*Table 4-1: iTools property data types.*

| Type Code | Type | Description |
|---|---|---|
| 5 | COLOR | Color properties contain an RGB color triple |
| 6 | LINESTYLE | Linestyle properties contain an integer value between 0 and 6, corresponding to the following IDL line styles:<br>• 0 = Solid<br>• 1 = Dotted<br>• 2 = Dashed<br>• 3 = Dash Dot<br>• 4 = Dash Dot Dot<br>• 5 = Long Dashes<br>• 6 = No Line<br>See Appendix B, "Property Controls" in the *iTool User's Guide* manual for a visual example of the available line styles. |
| 7 | SYMBOL | Symbol properties contain an integer value between 0 and 8, corresponding to the following IDL symbol types:<br>• 0 = No symbol<br>• 1 = Plus sign<br>• 2 = Asterisk<br>• 3 = Period (Dot)<br>• 4 = Diamond<br>• 5 = Triangle<br>• 6 = Square<br>• 7 = X<br>• 8 = Arrow Head<br>See Appendix B, "Property Controls" in the *iTool User's Guide* manual for a visual example of the available symbols. |

*Table 4-1: iTools property data types.*

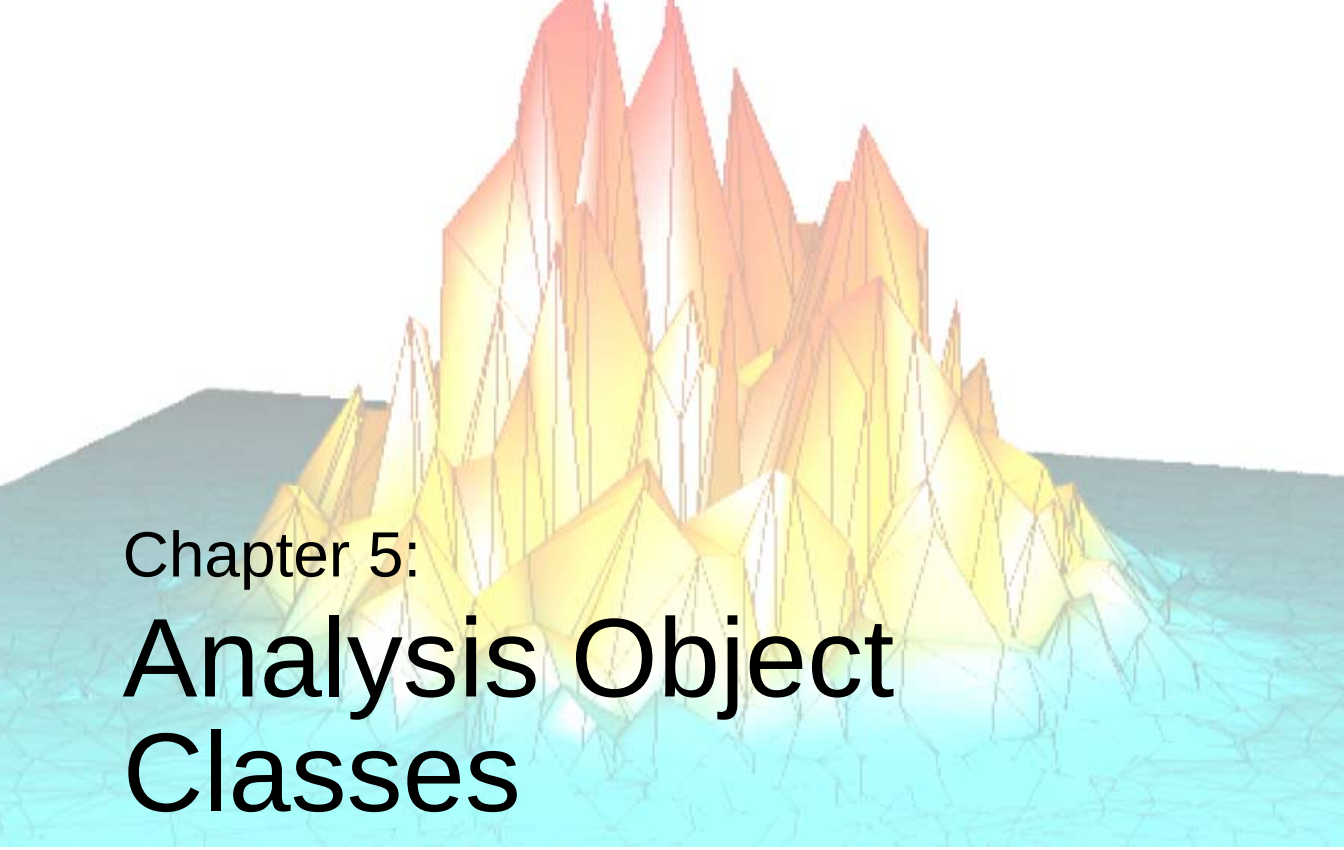
| Type Code | Type | Description |
|---|---|---|
| 8 | THICKNESS | Thickness properties contain an integer value between 1 and 10, corresponding to the thickness (in pixels) of the line. |
| 9 | ENUMLIST | Enumerated List properties contain an array of string values defined when the property is registered. The GetProperty method returns the zero-based index of the selected item. |

*Table 4-1: iTools property data types.*

# Undocumented Object Classes

Some of IDL's object classes are subclassed from more generic IDL objects. You may see references to the generic IDL objects when using IDL's HELP procedure to get information on an object, or when you use the OBJ_ISA or OBJ_CLASS functions. You may also notice that the generic objects are not documented in this section. This is not an oversight.

We have chosen not to document the workings of the more generic objects from which the IDL graphics objects are subclassed because we reserve the right to make changes to their operation. We strongly recommend that you do not use the undocumented object classes directly, or subclass your own object classes from them. RSI does not guarantee that user-written code that uses undocumented features will continue to function in future releases of IDL.



# Chapter 5: Analysis Object Classes

This chapterdescribes IDL’s built-in analysis class library.

# IDLanROI

The IDLanROI object class represents a region of interest.

**Note**

The IDLan* naming convention is used for objects in the analysis domain.

Regions of interest are described as a set of vertices that may be connected to generate a path or a polygon, or may be treated as separate points. This object may be used as a source for analytical computations on regions. (For additional information about display of ROIs in Object Graphics, refer to the IDLgrROI object class.)

## Superclasses

None

## Creation

See IDLanROI::Init.

## Properties

Objects of this class have the following properties. See “IDLanROI Properties” on page 2516 for details on individual properties.

- ALL
- BLOCK_SIZE
- DATA
- DOUBLE
- INTERIOR
- N_VERTS
- ROI_XRANGE
- ROI_YRANGE
- ROI_YRANGE
- ROI_ZRANGE
- TYPE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

The IDLanROI class has the following methods.

- IDLanROI::AppendData
- IDLanROI::Cleanup
- IDLanROI::ComputeGeometry
- IDLanROI::ComputeMask
- IDLanROI::ContainsPoints
- IDLanROI::GetProperty
- IDLanROI::Init
- IDLanROI::RemoveData
- IDLanROI::ReplaceData
- IDLanROI::Rotate
- IDLanROI::Scale
- IDLanROI::SetProperty
- IDLanROI::Translate

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.3

# IDLanROI Properties

IDLanROI objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLanROI::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLanROI::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLanROI::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the state of this object. State information about the object includes things like block size, type, etc., but not vertex data.

**Note**

The fields in this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BLOCK_SIZE

The number of vertices to allocate per block as needed for the region. When additional vertices are required, an additional block is allocated. The default is 100.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATA

A *2 x n* or a *3 x n* array that defines the 2-D or 3-D vertex data, respectively. DATA is equivalent to the optional arguments, X, Y, and Z. This property is stored as double

precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is stored as single precision floating point.

| **Property Type** | Array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DOUBLE

A non-zero value that indicates whether or not data should be stored in this object in double precision floating point. Set this keyword to zero to indicate that the data should be stored in single precision floating point, which is the default. The DOUBLE property controls the precision used for storing the data in the AppendData, Init, and ReplaceData methods via the X, Y, and Z arguments and in SetProperty method via the DATA keyword. IDL converts any data already stored in the object to the requested precision, if necessary. Note that this keyword does not need to be set if any of the X, Y, or Z arguments or the DATA parameters are of type DOUBLE. However, setting this keyword may be desirable if the data consists of large integers that cannot be accurately represented in single precision floating point. This property is also automatically set to one if any of the X, Y or Z arguments or the DATA parameter is stored using a variable of type DOUBLE.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## INTERIOR

A Boolean variable that marks this region as an interior region (i.e., a region treated as a hole). By default, the region is treated as an exterior region.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## N_VERTS

An integer that contains the number of vertices currently being used by the region.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ROI_XRANGE

A two-element double-precision floating-point vector of the form [*xmin, xmax*] that specifies the range of X data coordinates covered by the region.

| | | | |
|---|---|---|---|
| **Property Type** | Vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ROI_YRANGE

A two-element double-precision floating-point vector of the form [*ymin, ymax*] specifying the range of Y data coordinates covered by the region.

| | | | |
|---|---|---|---|
| **Property Type** | Vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ROI_ZRANGE

A two-element double-precision floating-point vector of the form [*zmin, zmax*] specifying the range of Z data coordinates covered by the region.

| | | | |
|---|---|---|---|
| **Property Type** | Vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## TYPE

An integer that indicates the type of the region. The TYPE keyword determines how computational operations, such as mask generation, are performed. Valid values include:

- 0 = points
- 1 = path
- 2 = closed polygon (the default)

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLanROI::AppendData

The IDLanROI::AppendData procedure method appends vertices to the region.

## Syntax

*Obj* -> [IDLanROI::]AppendData, *X* [, *Y*] [, *Z*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

## Arguments

### X

A vector providing the X components of the vertices to be appended. If the Y and Z arguments are not specified, X must be a two-dimensional array with the leading dimensions either 2 or 3 ([2,*] or [3,*]), in which case, X[0,*] represents the X values, X[1,*] represents the Y values, and X[2,*] represents the Z values. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

### Y

A vector providing the Y components of the vertices to be appended. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

### Z

A vector providing the Z components of the vertices to be appended. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

# Keywords

## XRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*xmin, xmax*], representing the *X* range of the modification to the region. The reported range accounts for the last vertex in the region before the append occurred, as well as all vertices appended. This data is returned in double-precision floating-point.

## YRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*ymin, ymax*], representing the *Y* range of the modification to the region. The reported range accounts for the last vertex in the region before the append occurred, as well as all vertices appended. This data is returned in double-precision floating-point.

## ZRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*zmin, zmax*], representing the *Z* range of the modification to the region. The reported range accounts for the last vertex in the region before the append occurred, as well as all vertices appended. This data is returned in double-precision floating-point.

# Version History

Introduced: 5.3

# IDLanROI::Cleanup

The IDLanROI::Cleanup procedure method performs all cleanup for a region of interest object.

**Note**

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLanROI::]Cleanup (In a subclass' Cleanup method only)

## Arguments

None.

## Keywords

None.

## Version History

Introduced: 5.3

# IDLanROI::ComputeGeometry

The IDLanROI::ComputeGeometry function method computes the geometrical values for area, perimeter, and/or centroid of the region.

## Syntax

*Result* = *Obj* `->` [IDLanROI::]ComputeGeometry( [, AREA=*variable*] [, CENTROID=*variable*] [, PERIMETER=*variable*] [, SPATIAL_OFFSET=*vector*] [, SPATIAL_SCALE=*vector*] )

## Return Value

### Result

This function method returns a 1 for success, or a 0 for failure. Each computed value is returned in the *variable* name assigned to each keyword.

## Arguments

None.

## Keywords

### AREA

Set this keyword to a named variable that upon return contains a double-precision floating-point value representing the area of the region. Interior regions (holes) return a negative area.

Note that the computed area represents the geometric area described by the region's vertex data. A pixel-based area can be computed as follows:

1. Compute a mask for the region.

```
mask = oROI -> ComputeMask()
```

2. Call IMAGE_STATISTICS to count number of samples within the mask.

```
IMAGE_STATISTICS, myImage, MASK = mask, COUNT = nSamples
```

3. Compute pixel area.

```
pixelArea = nSamples * pixelXSize * pixelYSize
```

### CENTROID

Set this keyword to a named variable that upon return contains a double-precision floating-point vector [*x*,*y*,*z*] representing the centroid for the region. If the TYPE of the region is 0 (points), the centroid is computed as the average of each of the vertices in the region. If the TYPE of the region is 1 (path), the centroid is computed as the weighted average of each of the midpoints of the lines in the region. Weights are proportional to the length of the lines. If the TYPE of the region is 2 (polygon), the centroid is computed as a weighted average of the centroids of the polygons making up the ROI (interior centroids use negative weights). Weights are proportional to the polygon area.

### PERIMETER

Set this keyword to a named variable that upon return contains a double-precision floating-point value representing the perimeter of the region.

### SPATIAL_OFFSET

Set this keyword to a two or three-element vector, [*tx*, *ty*] or [*tx*, *ty, tz*], representing the spatial calibration offset factors to be applied for the geometry calculations. The value of SPATIAL_SCALE is applied before the spatial offset values are applied. The default is [0.0, 0.0, 0.0]. IDL converts and maintains this value in double-precision floating-point.

### SPATIAL_SCALE

Set this keyword to a two or three-element vector, [*sx*, *sy*] or [*sx*, *sy, sz*], representing the spatial calibration scaling factors to be applied for the geometry calculations. The spatial calibration scale is applied first, then the value of SPATIAL_OFFSET is applied. The default is [1.0, 1.0, 1.0]. IDL converts and maintains this value in double-precision floating-point.

## Version History

Introduced: 5.3

# IDLanROI::ComputeMask

The IDLanROI::ComputeMask function method prepares a two-dimensional mask for the region.

## Syntax

*Result* = *Obj* -> [IDLanROI::]ComputeMask( [, INITIALIZE={ –1 | 0 | 1 }] [, DIMENSIONS=*[xdim, ydim]*] | [, MASK_IN=*array*] [, LOCATION=*[x, y* [, *z]]*] [, MASK_RULE={ 0 | 1 | 2 }] [, PIXEL_CENTER=*[x, y]*] [, PLANE_NORMAL=*[x, y, z]*] [, PLANE_XAXIS=*[x,y,z]*] [, /RUN_LENGTH] )

## Return Value

### Result

The return value is a two-dimensional array of bytes whose values range from 0 to 255. The mask is computed by applying the following formula to the current mask for each mask point contained within the ROI:

$$M_{out} = \mathrm{MAX}(\mathrm{MIN}(255, (M_{\mathrm{roi}} * Ext) + M_{\mathrm{in}}), 0)$$

where $M_{\mathrm{roi}}$ is 255 and *Ext* is 1 for points within an exterior region and –1 for points within an interior region.

If the TYPE of the region is 0 (points), a single mask pixel is set for each region vertex that falls within the bounds of the mask.

If the TYPE of the region is 1 (path), one-pixel-wide line segments are set within the mask.

If the TYPE of the region is 2 (closed polygon), a mask pixel is set if that pixel is on the plane of a region, and the pixel falls within the region (according to the MASK_RULE).

## Arguments

None.

# Keywords

## DIMENSIONS

Set this keyword to a two-element vector, [*xdim*, *ydim*], specifying the requested dimensions of the returned mask. If MASK_IN is provided, the value of this keyword is ignored and the dimensions of that mask are used. Otherwise, the default dimensions are [100, 100].

## INITIALIZE

Set this keyword to indicate how the mask should be initialized. Valid values include:

- –1 = The mask is not initialized. This option is useful when updating an already existing mask. This is the default if the MASK_IN keyword is set.
- 0 = The mask is initialized so that each pixel is set to 0. This is the default if the MASK_IN keyword is not set.
- 1 = The mask is initialized so that each pixel is set to 255.

## LOCATION

Set this keyword to a vector of the form [*X*, *Y*[, *Z*]] specifying the location of the origin of the mask. The default is [0, 0, 0]. IDL converts and maintains this value in double-precision floating-point.

## MASK_IN

Set this keyword to a two-dimensional array representing a mask that is already allocated and to be updated for this region. If the variable specified by this keyword is of type BYTE and is also specified as the function result, then this method updates the mask data in-place without copying. If this keyword is not provided, a mask is allocated by default to match the dimensions specified via the DIMENSIONS keyword.

### MASK_RULE

Set this keyword to an integer specifying the rule used to determine whether a given pixel should be set within the mask. Valid values include:

- 0 = Boundary only. All pixels falling on a region's boundary are set.
- 1 = Interior only. All pixels falling within the region's boundary, but not on the boundary, are set.
- 2 = Boundary + Interior. All pixels falling on or within a region's boundary are set.

### PIXEL_CENTER

Set this keyword to a 2-element vector, [*x*, *y*], to indicate where the lower-left mask pixel is to centered relative to a Cartesian grid. The default value is [0.0, 0.0], indicating that the lower-left pixel is centered at [0.0, 0.0].

### PLANE_NORMAL

Set this keyword to a three-element vector, [*x*, *y*, *z*], specifying the normal vector for the plane on which the mask is to be computed. The default is [0, 0, 1].

### PLANE_XAXIS

Set this keyword to a three-element vector, [*x*, *y*, *z*], specifying the direction vector along which each row of mask pixels is to be computed (starting at LOCATION). The default is [1, 0, 0].

### RUN_LENGTH

Set this keyword to a non-zero value to return a run-length encoded representation of the mask, stored in a one-dimensional unsigned long array. When run-length encoded, each element with an even subscript contains the length of the run, and the following element contains the starting index of the run.

## Version History

Introduced: 5.3

RUN_LENGTH keyword: 5.6

# IDLanROI::ContainsPoints

The IDLanROI::ContainsPoints function method determines whether the given data coordinates are contained within the closed polygon region.

## Syntax

*Result* = *Obj* -> [IDLanROI::]ContainsPoints( *X* [, *Y* [, *Z*]] )

## Return Value

The return value is a vector of values, one per provided point, indicating whether that point is contained. Valid values within this return vector include:

- 0 = Exterior. The point lies strictly out of bounds of the ROI.
- 1 = Interior. The point lies strictly inside the bounds of the ROI.
- 2 = On edge. The point lies on an edge of the ROI boundary.
- 3 = On vertex. The point matches a vertex of the ROI.

A point is considered to be exterior if:

- the point falls within the boundary of an interior region (hole).
- the point does not lie in the plane of the region.
- the region TYPE property is set to 0 (points) or 1 (path).

## Arguments

### X

A vector providing the *X* components of the points to be tested. If the *Y* and *Z* arguments are not specified, *X* must be a two-dimensional array with the leading dimension either 2 or 3 ([2,*] or [3,*]), in which case, *X*[0,*] represents the *X* values, *X*[1,*] represents the *Y* values, and *X*[2,*] represents the *Z* values.

### Y

A vector providing the *Y* components of the points to be tested.

### Z

A scalar or vector providing the *Z* component(s) of the points to be tested. If not provided, the *Z* components default to 0.0.

## Keywords

None.

## Version History

Introduced: 5.3

# IDLanROI::GetProperty

The IDLanROI::GetProperty procedure method retrieves the value of a property or group of properties for the region.

## Syntax

*Obj* -> [IDLanROI::]GetProperty [, ALL=*variable*] [, N_VERTS=*variable*] [, ROI_XRANGE=*variable*] [, ROI_YRANGE=*variable*] [, ROI_ZRANGE=*variable*]

## Arguments

None.

## Keywords

Any property listed under “IDLanROI Properties” on page 2516 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 5.3

# IDLanROI::Init

The IDLanROI::Init function method initializes a region of interest object.

**Note**

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW( 'IDLanROI' [, *X* [, *Y* [, *Z* ]]] [, BLOCKSIZE{Get, Set}=*vertices*] [, DATA{Get, Set}=*array*] [, /DOUBLE{Get, Set}] [, /INTERIOR{Get, Set}] [, TYPE{Get}={ 0 | 1 | 2 }] )

or

*Result* = *Obj* -> [IDLanROI::]Init( [*X* [, *Y* [, *Z* ]]] ) (*Only in a subclass' Init method.*)

**Note**

Keywords can be used in either form. They are omitted in the second form for brevity.

## Arguments

### X

A vector providing the *X* components of the vertices for the region. If the *Y* and *Z* arguments are not specified, *X* must be a two-dimensional array with the leading dimension either 2 or 3 ([2,*] or [3,*]), in which case, *X*[0,*] represents the *X* values, *X*[1,*] represents the *Y* values, and *X*[2,*] represents the *Z* values. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise, it is converted to single-precision floating-point.

### Y

A vector providing the *Y* components of the vertices. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise, it is converted to single-precision floating-point.

### Z

A scalar or vector providing the *Z* component(s) of the vertices. If not provided, *Z* values default to 0.0. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise, it is converted to single-precision floating-point.

## Keywords

Any property listed under “IDLanROI Properties” on page 2516 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.3

# IDLanROI::RemoveData

The IDLanROI::RemoveData procedure method removes vertices from the region.

## Syntax

*Obj* -> [IDLanROI::]RemoveData[, COUNT=*vertices*] [, START=*index*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

## Arguments

None.

## Keywords

### COUNT

Set this keyword to the number of vertices to remove. The default is one vertex.

### START

Set this keyword to an index (into the region's current vertex list) where the removal is to begin. By default, the final vertex is removed.

### XRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*xmin, xmax*], that represents the *X* range of the modification to the region. The reported range accounts for the vertex just before the removal (if any), the vertex just after the removal (if any), and the removed vertices. This data is returned in double-precision floating-point.

### YRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*ymin, ymax*], that represents the *Y* range of the modification to the region. The reported range accounts for the vertex just before the removal (if any), the vertex just after the removal (if any), and the removed vertices. This data is returned in double-precision floating-point.

### ZRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*zmin*, *zmax*], that represents the *Z* range of the modification to the region. The reported range accounts for the vertex just before the removal (if any), the vertex just after the removal (if any), and the removed vertices. This data is returned in double-precision floating-point.

## Version History

Introduced: 5.3

# IDLanROI::ReplaceData

The IDLanROI::ReplaceData procedure method replaces vertices in the region with alternate values. The number of replacement values need not match the number of values being replaced.

## Syntax

*Obj* -> [IDLanROI::]ReplaceData, *X*[, *Y*[, *Z*]] [, START=*index*] [, FINISH=*index*] [, XRANGE=*variable*] [, YRANGE=*variable*] [, ZRANGE=*variable*]

## Arguments

### X

A vector providing the X components of the new replacement vertices. If the Y and Z arguments are not specified, X must be a two-dimensional array with the leading dimensions either 2 or 3 ([2, *] or [3, *]), in which case, X[0, *] represents the X values, X[1, *] represents the Y values, and X[2, *] represents the Z values. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

### Y

A vector providing the Y components of the new replacement vertices. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

### Z

A vector providing the Z components of the new replacement vertices. If the DOUBLE property is non-zero, the data is converted to double precision and is appended to the existing double precision data. Otherwise it is converted to single precision floating point and appended to the existing single precision data.

# Keywords

## FINISH

Set this keyword to the index of the region's current subregion vertex list where the replacement ends. If the START keyword value is ≥ 0, the default FINISH is given by

FINISH = ((START + N_NEW – 1) MOD N_OLD)

where N_NEW is the number of replacement vertices provided via the [*X*, *Y*, *Z*] arguments and N_OLD is the number of vertices (prior to replacement) in the current subregion.

If the START keyword is not set or is negative, the default FINISH is given by

FINISH = N_OLD – 1

FINISH may be less than START in which case the vertices, including and following START and the vertices preceding and including FINISH, are replaced with the new values.

## START

Set this keyword to an index of the region's current subregion vertex list where the replacement begins. If the FINISH keyword value is ≥ 0, the default START is given by

START = ((FINISH – N_NEW + 1) MOD N_OLD)

where N_NEW is the number of replacement vertices provided via the [*X*, *Y*, *Z*] arguments and N_OLD is the number of vertices (prior to replacement) in the current subregion.

If the FINISH keyword is not set (or negative), the default START is clamped to 0 and is given by

N_OLD – N_NEW

## XRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*xmin*, *xmax*], representing the *X* range of the modification to the region. The reported range accounts for the replaced vertices, the vertex just before the replacement (if any), the vertex just after the replacement (if any), and the new replacement vertices. This data is returned in double-precision floating-point.

### YRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*ymin, ymax*], representing the *Y* range of the modification to the region. The reported range accounts for the replaced vertices, the vertex just before the replacement (if any), the vertex just after the replacement (if any), and the new replacement vertices. This data is returned in double-precision floating-point.

### ZRANGE

Set this keyword to a named variable that upon return contains a two-element vector, [*zmin, zmax*], representing the *Z* range of the modification to the region. The reported range accounts for the replaced vertices, the vertex just before the replacement (if any), the vertex just after the replacement (if any), and the new replacement vertices. This data is returned in double-precision floating-point.

## Version History

Introduced: 5.3

# IDLanROI::Rotate

The IDLanROI::Rotate procedure method modifies the vertices for the region by applying a rotation.

## Syntax

*Obj* -> [IDLanROI::]Rotate, *Axis*, *Angle* [, CENTER=*[x, y*[, *z*]*]*]

## Arguments

### Axis

A three-element vector of the form [*x, y, z*] describing the axis about which the region is to be rotated.

### Angle

The angle, measured in degrees, by which the rotation is to occur.

## Keywords

### CENTER

Set this keyword to a two or three-element vector of the form [*x, y*], or [*x, y, z*] specifying the center of rotation. The default is [0, 0, 0]. IDL converts and applies this data in double-precision floating-point.

## Version History

Introduced: 5.3

# IDLanROI::Scale

The IDLanROI::Scale procedure method modifies the vertices for the region by applying a scale.

## Syntax

*Obj* -> [IDLanROI::]Scale, *Sx*[, *Sy*[, *Sz*]]

## Arguments

### Sx

The *X* scale factor. If the *Sy* and *Sz* arguments are not specified, *Sx* must be a two or three-element vector, in which case *Sx*[0] represents the scale in *X*, *Sx*[1] represents the scale in *Y*, *Sx*[2] represents the scale in *Z*. IDL converts and applies this data in double-precision floating-point.

### Sy

The *Y* scale factor. IDL converts and applies this data in double-precision floating-point.

### Sz

The *Z* scale factor. IDL converts and applies this data in double-precision floating-point.

## Keywords

None.

## Version History

Introduced: 5.3

# IDLanROI::SetProperty

The IDLanROI::SetProperty procedure method sets the value of a property or group of properties for the region.

## Syntax

*Obj* -> [IDLanROI::]SetProperty

## Arguments

None.

## Keywords

Any property listed under “IDLanROI Properties” on page 2516 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.3

# IDLanROI::Translate

The IDLanROI::Translate procedure method modifies the vertices for the region by applying a translation.

## Syntax

*Obj* -> [IDLanROI::]Translate, *Tx*[, *Ty*[, *Tz*]]

## Arguments

### Tx

The X translation factor. If the *Ty* and *Tz* arguments are not specified, *Tx* must be a two or three-element vector, in which case *Tx*[0] represents translation in *X*, *Tx*[1] represents translation in *Y*, *Tx*[2] represents translation in *Z*. IDL converts and applies this data in double-precision floating-point.

### Ty

The *Y* translation factor. IDL converts and applies this data in double-precision floating-point.

### Tz

The *Z* translation factor. IDL converts and applies this data in double-precision floating-point.

## Keywords

None.

## Version History

Introduced: 5.3

# IDLanROIGroup

The IDLanROIGroup object class is an analytical representation of a group of regions of interest.

## Superclasses

This class is a subclass of TrackBall.

## Creation

See IDLanROIGroup::Init.

## Properties

Objects of this class have the following properties. See “IDLanROIGroup Properties” on page 2544 for details on individual properties.

- ALL
- ROIGROUP_XRANGE
- ROIGROUP_YRANGE
- ROIGROUP_ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

The IDLanROIGroup class has the following methods:

- IDLanROIGroup::Add
- IDLanROIGroup::Cleanup
- IDLanROIGroup::ComputeMask
- IDLanROIGroup::ComputeMesh
- IDLanROIGroup::ContainsPoints
- IDLanROIGroup::GetProperty
- IDLanROIGroup::Init
- IDLanROIGroup::Rotate

- IDLanROIGroup::Scale
- IDLanROIGroup::Translate

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.3

# IDLanROIGroup Properties

IDLanROIGroup objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via “IDLanROIGroup::GetProperty” on page 2555. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via “IDLanROIGroup::Init” on page 2556.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure with the values of all of the properties associated with the state of this object.

**Note**

The fields in this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ROIGROUP_XRANGE

A two-element double-precision floating-point vector of the form [*xmin, xmax*] specifying the range of X data coordinates covered by the region.

| **Property Type** | Vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ROIGROUP_YRANGE

A two-element double-precision floating-point vector of the form [*ymin, ymax*] specifying the range of Y data coordinates covered by the region.

| | | | |
|---|---|---|---|
| **Property Type** | Vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ROIGROUP_ZRANGE

A two-element double-precision floating-point vector of the form [*zmin, zmax*] specifying the range of Z data coordinates covered by the region.

| | | | |
|---|---|---|---|
| **Property Type** | Vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLanROIGroup::Add

The IDLanROIGroup::Add procedure method adds a region to the region group. Only objects of the IDLanROI class may be added to the group. The regions in the group must all be of the same type: all points, all paths, or all polygons.

## Syntax

*Obj* -> [IDLanROIGroup::]Add, *ROI*

## Arguments

### ROI

A reference to an instance of the IDLanROI object class representing the region of interest to be added to the group.

## Keywords

Accepts all keywords accepted by the IDL_Container::Add method.

## Version History

Introduced: 5.3

# IDLanROIGroup::Cleanup

The IDLanROIGroup::Cleanup procedure method performs all cleanup for a region of interest group object.

**Note**

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLanROIGroup::]Cleanup (In a subclass' Cleanup method only.)

## Arguments

None.

## Keywords

None.

## Version History

Introduced: 5.3

# IDLanROIGroup::ComputeMask

The IDLanROIGroup::ComputeMask function method prepares a two-dimensional mask for this group of regions.

# Syntax

*Result* = *Obj* -> [IDLanROIGroup::]ComputeMask( [, INITIALIZE={ -1 | 0 | 1 }] [, DIMENSIONS=*[xdim, ydim]*] | [, MASK_IN=*array*] [, LOCATION=*[x, y* [, *z]]*] [, MASK_RULE={ 0 | 1 | 2 }] [, /RUN_LENGTH] )

# Return Value

## Result

The return value is a two-dimensional array of bytes whose values range from 0 to 255. The mask is computed by applying the following formula to the current mask for each mask point contained within the ROI:

$$M_{out} = \text{MAX}(\text{MIN}(0, (M_{roi} * Ext) + M_{in}), 255)$$

where $M_{roi}$ is 255 and *Ext* is 1 for points within an exterior region and –1 for points within an interior region.

If the TYPE of the contained regions is 0 (points), a single mask pixel is set for each region vertex that falls within the bounds of the mask.

If the TYPE of the contained regions is 1 (path), each pixel along the paths of the regions is set if it falls within the mask.

If the TYPE of the region is 2 (closed polygon), a mask pixel is set if that pixel is on the plane of a contained region, and the pixel falls within that region (according to the MASK_RULE).

# Arguments

None.

# Keywords

## DIMENSIONS

Set this keyword to a two-element vector, [*xdim*, *ydim*], specifying the requested dimensions of the returned mask. If MASK_IN is provided, the value of this keyword

is ignored, and the dimensions of that mask are used. Otherwise, the default dimensions are [100, 100].

## INITIALIZE

Set this keyword to indicate how the mask should be initialized. Valid values include:

- –1 = The mask is not initialized; the default if the MASK_IN keyword is set. This option is useful when updating an already existing mask.
- 0 = The mask is initialized with each pixel set to 0; the default if the MASK_IN keyword is not set.
- 1 = The mask is initialized with each pixel set to 255.

## LOCATION

Set this keyword to a vector of the form [*X, Y*[, *Z*]] specifying the location of the origin of the mask. The default is [0, 0, 0].

## MASK_IN

Set this keyword to a two-dimensional array representing a mask that is already allocated and to be updated for this region. If the variable specified by this keyword is of type BYTE and is also specified as the function result, then this method updates the mask data in-place without copying. If this keyword is not provided, a mask is allocated by default to match the dimensions specified via the DIMENSIONS keyword.

## MASK_RULE

Set this keyword to an integer specifying the rule used to determine whether a given pixel should be set within the mask. Valid values include:

- 0 = Boundary Only. All pixels falling on a region’s boundary are set.
- 1 = Interior Only. All pixels falling within the region’s boundary, but not on the boundary, are set.
- 2 = Boundary + Interior. All pixels falling on or within a region’s boundary are set.

## PLANE_NORMAL

Set this keyword to a three-element vector, [*x, y, z*], specifying the normal vector for the plane on which the mask is to be computed. The default is [0, 0, 1].

### PLANE_XAXIS

Set this keyword to a three-element vector, [*x*, *y*, *z*], specifying the direction vector along which each row of mask pixels is to be computed (starting at LOCATION). The default is [1, 0, 0].

### RUN_LENGTH

Set this keyword to a non-zero value to return a run-length encoded representation of the mask, stored in a one-dimensional unsigned long array. When run-length encoded, each element with an even subscript contains the length of the run, and the following element contains the starting index of the run.

## Version History

Introduced: 5.3

RUN_LENGTH keyword: 5.6

# IDLanROIGroup::ComputeMesh

The IDLanROIGroup::ComputeMesh function method triangulates a surface mesh with optional capping from the stack of regions contained within this group.

**Note**

The contained regions may be concave. However, this method will fail under the following conditions:

- The region group contains fewer than two regions.
- The TYPE property of the contained regions is 0 (points) or 1 (path).
- Any of the contained regions are not simple (i.e., a region is self-intersecting).
- The region group contains interior regions (holes).
- More than one region lies on the same plane (i.e., the region group contains branches).

Each region pair is normalized by perimeter and the triangulation is computed by walking the contours in parallel, keeping the normalized progress along each contour in sync. The returned triangulation minimizes the mesh surface area. Each vertex may appear only once in the output, and the resulting polygon mesh is solid with outward facing normals computed via the right-hand rule. If capping is requested, it is computed using the IDLgrTessellator on the top and bottom regions, and/or the regions on either side of an inter-slice gap.

# Syntax

*Result* = *Obj*->[IDLanROIGroup::]ComputeMesh( *Vertices*, *Conn* [, CAPPED={ 0 | 1 | 2}] [, SURFACE_AREA=*variable*] )

# Return Value

## Result

The return value of this function method is the number of triangles generated if the surface mesh triangulation is successful, or zero if unsuccessful.

# Arguments

## Vertices

An output [3, n] array of vertices. If all regions in the group are defined with single precision vertices (DOUBLE property is zero), then IDL returns a single precision floating point array. Otherwise, if any of the regions in the group are defined with double precision vertices (DOUBLE property is non-zero), then IDL returns a double precision floating point array.

## Conn

An output polygon mesh connectivity array.

# Keywords

## CAPPED

Set this keyword to a value to indicate whether flat caps are to be computed at the top-most or bottom-most regions (as selected by a counter-clockwise rule), or at the regions on either side of an inter-slice gap. The value of this keyword is a bit-wise OR of the values shown below. For example, to cap the top-most and bottom-most regions only, set the CAPPED keyword to 3. The default is 0 (no caps).

- 0 = no caps
- 1 = cap the top-most region
- 2 = cap the bottom-most region

## SURFACE_AREA

Set this keyword to a named variable that upon return contains the overall surface area of the computed triangulation. This value was minimized in the computation of the triangulation. IDL returns this value in a double-precision floating-point variable.

# Version History

Introduced: 5.3

# IDLanROIGroup::ContainsPoints

The IDLanROIGroup::ContainsPoints function method determines whether the given points (in data coordinates) are contained within this region group.

The regions within this group must have a TYPE of 2 (closed polygon) and must fall on parallel planes for successful containment testing to occur.

For each point to be tested:

- If the point lies directly on one of the region planes, it is tested for containment within each of the regions that fall on that plane.
- If the point lies between two of the region planes, it is projected onto the nearest region plane, and tested for containment within each of the regions on that plane.
- If the point lies above or below the stack of parallel region planes, the point will be considered to be exterior to the region group.

On a given plane, a point will be considered to be exterior if either of the following conditions are true:

- The point does not fall within any of the regions on that plane.
- The point falls within as many or more holes than non-hole regions on that plane.

## Syntax

*Result* = *Obj* `->` [IDLanROIGroup::]ContainsPoints( *X*[, *Y*[, *Z*]] )

## Return Value

The return value is a vector of values, one per provided point, indicating whether that point is contained. Valid values within this return vector include:

- 0 = Exterior. The point lies strictly outside the bounds of the ROI.
- 1 = Interior. The point lies strictly inside the bounds of the ROI.
- 2 = On Edge. The point lies on an edge of the ROI boundary.
- 3 = On Vertex. The point matches a vertex of the ROI.

# Arguments

## X

A vector providing the *X* components of the points to be tested. If the *Y* and *Z* arguments are not specified, *X* must be a two-dimensional array with the leading dimension either 2 or 3 ([2,*] or [3,*]), in which case, *X*[0,*] represents the *X* values, *X*[1,*] represents the *Y* values, and *X*[2,*] represents the *Z* values.

## Y

A vector providing the *Y* components of the points to be tested.

## Z

A scalar or vector providing the *Z* components of the points to be tested. If not provided, the *Z* components default to 0.0.

# Keywords

None.

# Version History

Introduced: 5.3

# IDLanROIGroup::GetProperty

The IDLanROIGroup::Get Property procedure method retrieves the value of a property or group of properties for the region group.

## Syntax

*Obj* -> [IDLanROIGroup::]GetProperty[, ALL=*variable*]
[, ROIGROUP_XRANGE=*variable*] [, ROIGROUP_YRANGE=*variable*]
[, ROIGROUP_ZRANGE=*variable*]

## Arguments

None.

## Keywords

Any property listed under “IDLanROIGroup Properties” on page 2544 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 5.3

# IDLanROIGroup::Init

The IDLanROIGroup::Init function method initializes a region of interest group object.

**Note**

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLanROIGroup')

or

*Result* = *Obj* -> [IDLanROIGroup::]Init( ) (*Only in a subclass' Init method*.)

## Arguments

None.

## Keywords

Any property listed under "IDLanROIGroup Properties" on page 2544 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.3

# IDLanROIGroup::Rotate

The IDLanROIGroup::Rotate procedure method modifies the vertices for all regions within the group by applying a rotation.

## Syntax

*Obj* -> [IDLanROIGroup::]Rotate, *Axis*, *Angle*[, CENTER=*[ x, y*[, *z* ]*]* ]

## Arguments

### Axis

A three-element vector of the form [*x, y, z*] describing the axis about which the region group is to be rotated.

### Angle

The angle, measured in degrees, by which to rotate the ROI group.

## Keywords

### CENTER

Set this keyword to a two or three-element vector of the form [*x, y*], or [*x, y, z*] specifying the center of rotation. The default is [0, 0, 0]. IDL converts and applies this data in double-precision floating-point.

## Version History

Introduced: 5.3

# IDLanROIGroup::Scale

The IDLanROIGroup::Scale procedure method modifies the vertices for the region by applying a scale.

## Syntax

*Obj* -> [IDLanROIGroup::]Scale, *Sx*[, *Sy*[, *Sz*]]

## Arguments

### Sx

The *X* scale factor. If the *Sy* and *Sz* arguments are not specified, *Sx* must be a two or three-element vector, in which case *Sx*[0] represents the scale in *X*, *Sx*[1] represents the scale in *Y*, *Sx*[2] represents the scale in *Z*. IDL converts and applies this data in double-precision floating-point.

### Sy

The *Y* scale factor. IDL converts and applies this data in double-precision floating-point.

### Sz

The *Z* scale factor. IDL converts and applies this data in double-precision floating-point.

## Keywords

None.

## Version History

Introduced: 5.3

# IDLanROIGroup::Translate

The IDLanROIGroup::Translate procedure method modifies the vertices of all regions within the group by applying a translation.

## Syntax

*Obj* -> [IDLanROIGroup::]Translate, *Tx*[, *Ty*[, *Tz*]]

## Arguments

### Tx

The *X* translation factor. If the *Ty* and *Tz* arguments are not specified, *Tx* must be a two or three-element vector, in which case *Tx*[0] represents translation in *X*, *Tx*[1] represents translation in *Y, Tx*[2] represents translation in *Z*. IDL converts and applies this data in double-precision floating-point.

### Ty

The *Y* translation factor. IDL converts and applies this data in double-precision floating-point.

### Tz

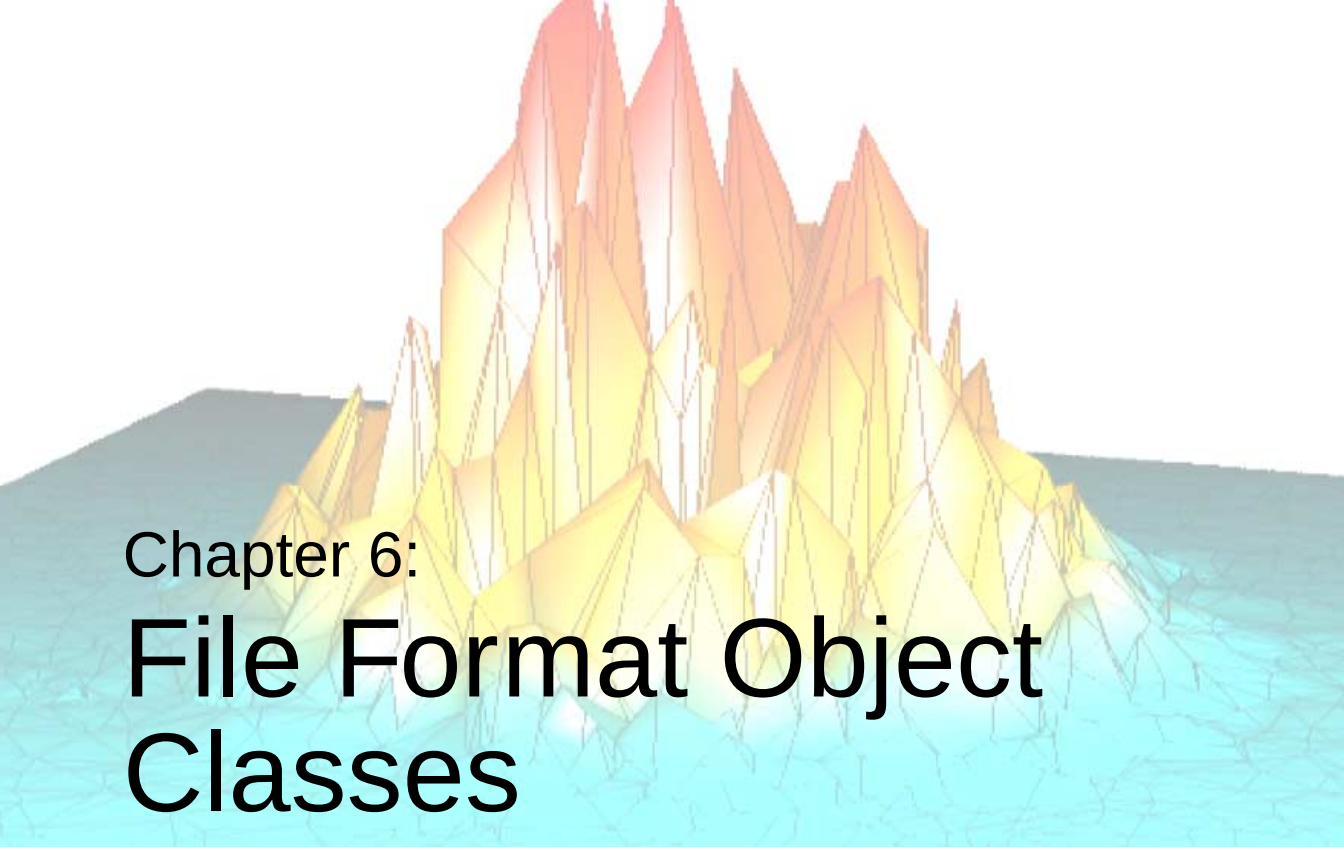
The *Z* translation factor. IDL converts and applies this data in double-precision floating-point.

## Keywords

None.

## Version History

Introduced: 5.3



# Chapter 6: File Format Object Classes

This chapter describes IDL's built-in file format class library.

# IDLffDICOM

An IDLffDICOM object contains the data for one or more images embedded in a DICOM Part 10 file. The API to the IDLffDICOM object provides accessor methods to the basic data elements of a DICOM file, namely the group/element tag, value representation, length, and data values. Additional methods deal with the file header preamble, data dictionary description for individual elements, and embedded sequences of elements. Most methods take a DICOM group/element tag as a parameter. An alternative parameter to the DICOM tag in some methods is the reference. A reference value is a LONG integer that is unique to each element in the DICOM object. This value can be used to directly access a specific element and to differentiate between elements in the DICOM file that have the same group/element tag. Valid reference values are always positive.

See "IDL DICOM v3.0 Conformance Summary" on page 2564 for information regarding IDL DICOM file reading support.

## Superclasses

This class has no superclasses.

## Creation

See "IDLffDICOM::Init" on page 2591.

## Properties

Objects of this class have the following properties. See "IDLffDICOM Properties" on page 2568 for details on individual properties.

- VERBOSE

## Methods

This class has the following methods:

- IDLffDICOM::Cleanup
- IDLffDICOM::DumpElements
- IDLffDICOM::GetChildren
- IDLffDICOM::GetDescription

- IDLffDICOM::GetElement
- IDLffDICOM::GetGroup
- IDLffDICOM::GetLength
- IDLffDICOM::GetParent
- IDLffDICOM::GetPreamble
- IDLffDICOM::GetReference
- IDLffDICOM::GetValue
- IDLffDICOM::GetVR
- IDLffDICOM::Init
- IDLffDICOM::Read
- IDLffDICOM::Reset

## Version History

Introduced: 5.2

# IDL DICOM v3.0 Conformance Summary

## Introduction

This section is an abbreviated DICOM conformance statement for IDL, and specifies the compliance of RSI IDL DICOM file reading support to the DICOM v3.0 standard. As described in the DICOM Standard PS 3.2 (Conformance), the purpose of this document is to outline the level of conformance to the DICOM standard and to enumerate the supported DICOM Service Classes, Information Objects, and Communications Protocols supported by this implementation.

IDL does not contain or support any of the DICOM services such as Storage, Query/Retrieve, Print, Verification, etc., so there will be no conformance claims relating to these services and no mention of any Application Entities for these services. Communications Protocol profiles will also be absent from this document for the same reasons. The remainder of this document will describe how IDL handles the various Information Objects it is capable of reading.

## Reading of DICOM Part 10 files

IDL supports reading files that conform to the DICOM Standard PS 3.10 DICOM File Format. This format provides a means to encapsulate in a file the Data Set representing a SOP (Service Object Pair) Instance related to a DICOM IOD (Information Object Definition). Files written to disk in this DICOM File Format will be referred to as DICOM Part 10 files for the remainder of this document. Note that IDL does NOT support the writing of files in this DICOM File Format, only reading.

## Encapsulated Transfer Syntaxes Supported

IDL supports reading DICOM Part 10 files whose contents have been written using the following Transfer Syntaxes. The Transfer Syntax UID is in the file's DICOM Tag field (0002,0010).

| UID Value | UID Name |
|---|---|
| 1.2.840.10008.1.2 | Implicit VR Little Endian: Default Transfer Syntax for DICOM |
| 1.2.840.10008.1.2.1 | Explicit VR Little Endian |
| 1.2.840.10008.1.2.2 | Explicit VR Big Endian |

*Table 0-1: Encapsulated Transfer Syntaxes Supported*

## Encapsulated Transfer Syntaxes NOT Supported

IDL does NOT support reading DICOM Part 10 files whose contents have compressed data that has been written using the following Transfer Syntaxes. IDL will NOT be able to access the data element (DICOM Tag field (7FE0,0010)) of files with these types of compressed data. The Transfer Syntax UID is in the file's DICOM Tag field (0002,0010).

| UID Value | UID Name |
|---|---|
| 1.2.840.10008.1.2.4.50 | JPEG Baseline (Process 1): Default Transfer Syntax for Lossy JPEG 8 Bit Image Compression |
| 1.2.840.10008.1.2.4.51 | JPEG Extended (Process 2 & 4): Default Transfer Syntax for Lossy JPEG 12 Bit Image Compression (Process 4 only) |
| 1.2.840.10008.1.2.4.52 | JPEG Extended (Process 3 & 5) |
| 1.2.840.10008.1.2.4.53 | JPEG Spectral Selection, Non-Hierarchical (Process 6 & 8) |
| 1.2.840.10008.1.2.4.54 | JPEG Spectral Selection, Non-Hierarchical (Process 7 & 9) |
| 1.2.840.10008.1.2.4.55 | JPEG Full Progression, Non-Hierarchical (Process 10 & 12) |
| 1.2.840.10008.1.2.4.56 | JPEG Full Progression, Non-Hierarchical (Process 11 & 13) |
| 1.2.840.10008.1.2.4.57 | JPEG Lossless, Non-Hierarchical (Process 14) |
| 1.2.840.10008.1.2.4.58 | JPEG Lossless, Non-Hierarchical (Process 15) |
| 1.2.840.10008.1.2.4.59 | JPEG Extended, Hierarchical (Process 16 & 18) |
| 1.2.840.10008.1.2.4.60 | JPEG Extended, Hierarchical (Process 17 & 19) |
| 1.2.840.10008.1.2.4.61 | JPEG Spectral Selection, Hierarchical (Process 20 & 22) |
| 1.2.840.10008.1.2.4.62 | JPEG Spectral Selection, Hierarchical (Process 21 & 23) |
| 1.2.840.10008.1.2.4.63 | JPEG Full Progression, Hierarchical (Process 24 & 26) |
| 1.2.840.10008.1.2.4.64 | JPEG Full Progression, Hierarchical (Process 25 & 27) |
| 1.2.840.10008.1.2.4.65 | JPEG Lossless, Hierarchical (Process 28) |

*Table 0-2: Encapsulated Transfer Syntaxes NOT Supported*

| UID Value | UID Name |
|---|---|
| 1.2.840.10008.1.2.4.66 | JPEG Lossless, Hierarchical (Process 29) |
| 1.2.840.10008.1.2.4.70 | JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1]): Default Transfer Syntax for Lossless JPEG Image Compression |
| 1.2.840.10008.1.2.5 | RLE Lossless |

*Table 0-2: Encapsulated Transfer Syntaxes NOT Supported (Continued)*

## Encapsulated SOP Classes Supported

IDL supports reading DICOM Part 10 files whose contents encapsulate the data of the following SOP Classes. The SOP Class UID is in the file's DICOM Tag field (0008,0016).

| UID Value | UID Name |
|---|---|
| 1.2.840.10008.5.1.4.1.1.1 | CR Image Storage |
| 1.2.840.10008.5.1.4.1.1.2 | CT Image Storage |
| 1.2.840.10008.5.1.4.1.1.4 | MR Image Storage |
| 1.2.840.10008.5.1.4.1.1.6.1 | Ultrasound Image Storage |
| 1.2.840.10008.5.1.4.1.1.7 | Secondary Capture Image Storage |
| 1.2.840.10008.5.1.4.1.1.12.1 | X-Ray Angiographic Image Storage |
| 1.2.840.10008.5.1.4.1.1.12.2 | X-Ray Radiofluoroscopic Image Storage |
| 1.2.840.10008.5.1.4.1.1.20 | Nuclear Medicine Image Storage |
| 1.2.840.10008.5.1.4.1.1.128 | Positron Emission Tomography Image Storage |

*Table 0-3: Encapsulated SOP Classes Supported*

## Handling of odd length data elements

The DICOM Standard PS 3.5 (Data Structures and Encoding) specifies that the data element values which make up a DICOM data stream must be padded to an even length. The toolkit upon which IDL’s DICOM reading functionality is built strictly enforces this specification. If IDL encounters an incorrectly formed odd length data field while reading a DICOM Part 10 file it will report an error and stop the reading process.

## Handling of undefined VRs

The VR (Value Representation) of a data element describes the data type and format of that data element's values. If IDL encounters an undefined VR while reading a DICOM Part 10 file, it will set that data element's VR to be UN (unknown).

## Handling of retired and private data elements

Certain data elements are no longer supported under the v3.0 of the DICOM standard and are denoted as retired. Also, some DICOM implementations may require the communication of information that cannot be contained in standard data elements, and thus create private data elements to contain such information. Retired and private data elements should pose no problem to IDL’s DICOM Part 10 file reading capability. When IDL encounters a retired or private data element tag during reading a DICOM Part 10 file, it will treat it just like any standard data element: read the data value and allow it to be accessed via the IDLffDICOM::GetValue method.

# IDLffDICOM Properties

IDLffDICOM objects have the following properties. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLffDICOM::Init.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## VERBOSE

A Boolean value that indicates whether informational messages are printed to the Output Log during the operational life of the object. If this value is true, the informational messages are printed to the Output Log. Otherwise, the messages are not printed.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLffDICOM::Cleanup

The IDLffDICOM::Cleanup procedure method destroys the IDLffDICOM object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLffDICOM::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Examples

```
; Create a DICOM object, read a DICOM file and dump its contents:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER="*"))
obj->DumpElements
OBJ_DESTROY, obj

; Executing this statement should produce an invalid object
; reference error since obj no longer exists:
obj->DumpElements
```

## Version History

Introduced: 5.2

# IDLffDICOM::DumpElements

The IDLffDICOM::DumpElements procedure method dumps a description of the DICOM data elements of the IDLffDICOM object to the screen or to a file.

## Syntax

*Obj* -> [IDLffDICOM::]DumpElements [, *Filename*]

## Arguments

### Filename

A scalar string containing the full path and filename of the file to which to dump the elements. The file is written as ASCII text.

## Keywords

None

## Examples

The columns output by DumpElements are the element reference, the (group, element) tuple, the value representation, the description, the value length, and some of the data values.

```
; Create a DICOM object, read a DICOM file and dump its contents:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER='*'))
obj->DumpElements

; Dump the contents of the current DICOM object to a file under
; Windows:
obj->DumpElements, 'c:\rsi\elements.dmp'

; Dump the contents of the current DICOM object to a file under
; UNIX:
obj->DumpElements, '/rsi/elements.dmp'

OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetChildren

The IDLffDICOM::GetChildren function method is used to find the member element references of a DICOM sequence. It takes as an argument a scalar reference to a DICOM element representing the parent of the sequence.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetChildren(*Reference*)

## Return Value

Returns an array of references to the elements of the object that are members of that sequence. The scalar parent reference is possibly obtained by a previous call to GetReference or any method that generates a reference list. Any member of a sequence may also itself be the parent of another sequence. If the scalar reference argument is not the parent of a sequence, the method returns -1.

## Arguments

### Reference

A scalar reference to a DICOM element that is known to be the parent of a DICOM sequence.

## Keywords

None

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get a list of references to all elements that are sequences:
refs = obj->GetReference(VR='SQ')

; Cycle through the returned list and print out the immediate
; children references and descriptions of each sequence:
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
   IF (refs[i] NE -1) THEN $
      BEGIN
         children = obj->GetChildren(refs[i])
```

```
            FOR j = 0, N_ELEMENTS(children)-1 DO $
               BEGIN
                  PRINT,children[j]
                    PRINT,obj->GetDescription(REFERENCE=children[j])
            ENDFOR
      ENDIF
   ENDFOR
   OBJ_DESTROY,obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetDescription

The IDLffDICOM::GetDescription function method takes optional DICOM group and element arguments and returns an array of STRING descriptions.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetDescription([*Group* [, *Element*]] [, REFERENCE=*list of element references*])

## Return Value

Returns an array of strings describing the field's contents as per the data dictionary in the DICOM specification PS 3.6. If no arguments or keywords are specified, the returned array contains the descriptions for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no DICOM elements can be found matching the search criteria, -1 will be returned.

## Arguments

### Group

An optional argument representing the value for the DICOM group to search for, i.e. '0018'x. If this argument is omitted, then all of the DICOM array elements are returned.

### Element

An optional argument specified only if the *Group* argument has also been specified. Set this argument to the value for the DICOM element for which to search, such as '0010'x. If this argument is omitted and the *Group* argument was specified, then all elements of the specified *Group* are returned.

## Keywords

### REFERENCE

Set this keyword to a list of element reference values from which to return description values.

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the description of the patient name element:
arr = obj->GetDescription('0010'x,'0010'x)
PRINT, arr

; Get array of all of the descriptions from the patient info group:
arr = obj->GetDescription('0010'x)
FOR i = 0, N_ELEMENTS(arr)-1 DO BEGIN
   PRINT, arr[i]
ENDFOR

OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetElement

The IDLffDICOM::GetElement function method takes optional DICOM group and/or element arguments and returns an array of DICOM Element numbers for those parameters.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetElement([*Group* [, *Element*]] [, REFERENCE=*list of element references*])

## Return Value

Returns an array of integers representing the DICOM Element numbers for the parameters of the *Group* and *Element* arguments. If no arguments or keywords are specified, the returned array contains Element numbers for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

## Arguments

### Group

An optional argument representing the value for the DICOM group to search for, i.e. ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

### Element

An optional argument specified only if the Group argument has also been specified. Set this argument to the value for the DICOM element to search for, such as ‘0010’x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

## Keywords

### REFERENCE

Set this keyword to a list of element reference values from which to return element number values.

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get references to all elements with "patient" in the description:
refs = obj->GetReference(DESCRIPTION='patient')

; Get the element numbers of the elements containing "patient":
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
   num = obj->GetElement(REFERENCE=refs[i])
   PRINT,num
ENDFOR

; Get the element numbers from the Patient Info group, 0010:
elements = obj->GetElement('0010'x)
PRINT, elements

OBJ_DESTROY,obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetGroup

The IDLffDICOM::GetGroup function method takes optional DICOM group and/or element arguments and returns an array of DICOM Group numbers for those parameters.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetGroup([*Group*[, *Element*]]
[, REFERENCE=*list of element references*])

## Return Value

Returns an array of integers representing the DICOM Group numbers for *Group* parameters. If no arguments or keywords are specified, the returned array contains Group numbers for all groups in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

## Arguments

### Group

An optional argument representing the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

### Element

An optional argument specified only if the *Group* argument has also been specified. Set this to the value for the DICOM element for which to search, such as ‘0010’x. If this argument is omitted and the *Group* argument was specified, then all elements of the specified *Group* are returned.

## Keywords

### REFERENCE

Set this keyword to a list of element references from which to return group number values.

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get references to all elements with "patient" in the description:
refs = obj->GetReference(DESCRIPTION='patient')

; Get the group numbers of the elements containing "patient":
FOR i = 0, N_ELEMENTS(refs)-1 DO BEGIN
   num = obj->GetGroup(REFERENCE=refs[i])
   PRINT, num
ENDFOR

; Get the group numbers from the Patient Info group, 0010:
grp = obj->GetGroup('0010'x)
PRINT, grp

OBJ_DESTROY,obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetLength

The IDLffDICOM::GetLength function method takes optional DICOM group and/or element arguments and returns an array of LONGs.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetLength([*Group* [, *Element*]] [, REFERENCE=*list of element references*])

## Return Value

Returns an array of longword integers. The length is the field length that explicitly exists in the DICOM file, and represents the length of the element value in bytes. If no arguments or keywords are specified, the returned array contains the lengths for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

## Arguments

### Group

An optional argument representing the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, all DICOM array elements are returned.

### Element

An optional argument specified only if the *Group* argument has also been specified. Set this to the value for the DICOM element for which to search, such as ‘0010’x. If this argument is omitted and the *Group* argument was specified, then all elements of the specified *Group* are returned.

## Keywords

### REFERENCE

Set this keyword to a list of element references from which to return length values.

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the length of the patient name element:
arr = obj->GetLength('0010'x,'0010'x)
PRINT, arr

; Get an array of all of the lengths from the patient info group:
arr = obj->GetLength('0010'x)
PRINT, arr
OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetParent

The IDLffDICOM::GetParent function method is used to find the parent references of a set of elements in a DICOM sequence.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetParent(*ReferenceList*)

## Return Value

Returns the parent references of a set of elements in a DICOM sequence. It takes as an argument an array of references that represent DICOM elements. If no members of the *ReferenceList* are members of a sequence, a -1 is returned, and for each member of the *ReferenceList* which is not a member of a sequence, a -1 is returned.

## Arguments

### ReferenceList

An array of references to DICOM elements that are known to be members of a DICOM sequence.

## Keywords

None

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj -> Read(DIALOG_PICKFILE(FILTER = '*'))

; Get the reference to the Referenced Study Sequence
; element, if it exists:
ref = obj -> GetReference('0008'x, '1110'x)
PRINT, ref
PRINT, obj -> GetDescription(REFERENCE = ref)

; Get and print the parent sequence, if it exists.
; This should result in a -1 since this element is not
; a member of a sequence:
parent = obj -> GetParent(ref)
PRINT, parent
```

```
PRINT, obj -> GetDescription(REFERENCE=parent)

; Get the children of the  Referenced Study Sequence
; element, if it exists:
refs = obj -> GetChildren(ref[0])
PRINT, refs
PRINT, obj -> GetDescription(REFERENCE = refs)
OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetPreamble

The IDLffDICOM::GetPreamble function method returns the preamble of a DICOM v3.0 Part 10 file.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetPreamble()

## Return Value

Returns a 128-element byte array containing the preamble, which is a fixed 128 byte field available for implementation specified usage. If it is not used by the implementor of the file, it will be set to all zeroes.

## Arguments

None

## Keywords

None

## Examples

```
; Create a DICOM object, read a DICOM file:
obj = OBJ_NEW('IDLffDICOM')
var  = obj -> Read(DIALOG_PICKFILE(FILTER = '*'))

; Get an array of the byte contents of the DICOM file preamble:
arr = obj -> GetPreamble()
PRINT, arr

OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetReference

The IDLffDICOM::GetReference function method takes optional DICOM group and/or element arguments and returns an array of references to matching elements in the object.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetReference([*Group* [, *Element*]] [, DESCRIPTION=*string*] [, VR=*DICOM VR string*])

## Return Value

Returns an array referencing the matching elements in the object. References are opaque, meaning that they have no specific significance other than a correspondence to the element they refer to. If no arguments or keywords are specified, the returned array contains references to all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

## Arguments

### Group

An optional argument representing the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

### Element

An optional argument specified only if the *Group* argument has also been specified. Set this to the value for the DICOM element to search for, such as ‘0010’x. If this argument is omitted and the *Group* argument was specified, then all elements of the specified *Group* are returned.

## Keywords

### DESCRIPTION

Set this keyword to a string containing text to be searched for in each element’s DICOM description. An element will be returned only if the text in this string can be found in the description. The text comparison is case-insensitive.

### VR

Set this keyword to a DICOM VR string. An element will be returned only if its value representation matches this string.

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj -> Read(DIALOG_PICKFILE(FILTER = '*'))

; Get the reference to the patient name element:
ref = obj -> GetReference('0010'x,'0010'x)
PRINT, ref

; Get references to all elements with "patient" in the description:
refs = obj -> GetReference(DESCRIPTION = 'patient')
FOR i = 0, (N_ELEMENTS(refs) - 1) DO BEGIN
   PRINT, refs[i]
   PRINT, obj -> GetDescription(REFERENCE = refs[i])
ENDFOR

; Get references to all elements with a VR of DA (date):
refs = obj -> GetReference(vr = 'DA')
FOR i = 0, (N_ELEMENTS(refs) - 1) DO BEGIN
   PRINT, refs[i]
   PRINT, obj -> GetDescription(REFERENCE = refs[i])
ENDFOR

OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::GetValue

This method takes optional DICOM group and/or element arguments and returns an array of POINTERs to the values of the elements matching those parameters.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]GetValue([*Group* [, *Element*]]
[, REFERENCE=*list of element references*] [, /NO_COPY])

## Return Value

Returns an array of pointers to the values of the elements matching the *Group* and *Element* parameters. If no arguments or keywords are specified, the returned array contains pointers to all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

## Arguments

### Group

Set this optional argument to the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

### Element

This optional argument can be specified only if the Group argument has also been specified. Set this to the value for the DICOM element for which to search, such as ‘0010’x. If this argument is omitted and the Group argument was specified, then all elements of the specified Group are returned.

## Keywords

### REFERENCE

Set this keyword to a list of element references from which to return pointer values.

### NO_COPY

If this keyword is set, the pointers returned point to the actual data in the object for the specified DICOM fields. If not set (the default), the pointers point to copies of the data instead, and need to be freed by using PTR_FREE.

## Examples

### Example 1

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the image data
array = obj->GetValue('7fe0'x, '0010'x)
OBJ_DESTROY, obj

TVScl, *array[0]
PTR_FREE, array
```

### Example 2

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get all of the image data element(s), 7fe0,0010, from the file:
array = obj->GetValue('7fe0'x,'0010'x,/NO_COPY)

; Get the row & column size of the image(s):
rows = obj->GetValue('0028'x,'0010'x,/NO_COPY)
cols = obj->GetValue('0028'x,'0011'x,/NO_COPY)

; If the image has a samples per pixel value greater than 1
; it is most likely a color image, get the samples per pixel:
isColor = 0
samples = obj->GetValue('0028'x,'0002'x,/NO_COPY)
IF (SIZE(samples,/N_DIMENSIONS) NE 0) THEN BEGIN
   IF (*samples[0] GT 1) THEN isColor = 1
ENDIF

; Next, we need to differentiate between files with color data
; that is either color-by-plane or color-by-pixel, get the planar
; configuration:
IF (isColor EQ 1) THEN BEGIN
   isPlanar = 0
   planar = obj->GetValue('0028'x,'0006'x, /NO_COPY)
   IF (SIZE(planar, /N_DIMENSIONS) NE 0) THEN BEGIN
```

```
      IF (*planar[0] EQ 1) THEN isPlanar = 1
   ENDIF
ENDIF

; Display the first NumWin images from the file:
IF N_ELEMENTS(array) GT 10 THEN NumWin = 10 $
ELSE NumWin = N_ELEMENTS(array)
offset = 0
FOR index = 0, NumWin-1 DO BEGIN
   ; Create window for each image that is the size of the image:
   WINDOW,index,XSize=*cols[0],YSize=*rows[0],XPos=offset,YPos=0
   WSET,index
   ; Display the image data
   IF (isColor EQ 1) THEN $
       IF (isPlanar EQ 1) THEN $
          ; color-by-plane
          TVScl,TRANSPOSE(*array[index],[2,0,1]),/TRUE $
       ELSE $
          ; color-by-pixel
          TVScl,*array[index],/TRUE $
   ELSE $
      ; monochrome
      TVScl,*array[index]
      offset = offset+10
ENDFOR

; Clean up
OBJ_DESTROY,obj
```

# Version History

Introduced: 5.2

# IDLffDICOM::GetVR

The IDLffDICOM::GetVR function method takes optional DICOM group and/or element arguments and returns an array of VR (Value Representation) STRINGs for those parameters.

## Syntax

*array* = *Obj* -> [IDLffDICOM::]GetVR([*Group* [, *Element*]]
[, REFERENCE=*list of references*])

## Return Value

Returns an array of strings containing VRs (Value Representations) for the *Group* and *Element* parameters. A VR is a DICOM value representation as described in the DICOM specification PS 3.5. If no arguments or keywords are specified, the returned array contains VRs for all elements in the object. The effect of multiple keywords and parameters is to AND their results. If no matching elements can be found, the function returns -1.

## Arguments

### Group

An optional argument representing the value for the DICOM group for which to search, such as ‘0018’x. If this argument is omitted, then all of the DICOM array elements are returned.

### Element

An optional argument specified only if the *Group* argument has also been specified. Set this to the value for the DICOM element for which to search, such as ‘0010’x. If this argument is omitted and the *Group* argument was specified, then all elements of the specified *Group* are returned.

## Keywords

### REFERENCE

Use the specified list of references from which to return VR STRING values.

## Examples

```
obj = OBJ_NEW('IDLffDICOM')
read = obj->Read(DIALOG_PICKFILE(FILTER='*'))

; Get the VR of the patient name element:
arr = obj->GetVR('0010'x,'0010'x)
PRINT, arr

; Get an array of all of the VRs from the patient info group:
arr = obj->GetVR('0010'x)
PRINT, arr

OBJ_DESTROY,obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::Init

The IDLffDICOM::Init function method creates a new IDLffDICOM object and optionally reads the specified file as defined in the IDLffDICOM::Read method.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Result* = OBJ_NEW( 'IDLffDICOM' [, *Filename*] [, *PROPERTY=value*])

or

*Result = Obj* -> [IDLffDICOM::]Init([*Filename*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Filename

An optional scalar string argument containing the full path and filename of a DICOM v3.0 Part 10 file to open, read into memory, then close, when the object is created. It is the same as calling: result -> Read(Filename).

## Keywords

Any property listed under “IDLffDICOM Properties” on page 2568 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Examples

```
; Create a DICOM object:
obj = OBJ_NEW( 'IDLffDICOM' )

; Create a DICOM object and read in a DICOM file named ct_head.dcm
; under Microsoft Windows:
obj = OBJ_NEW( 'IDLffDICOM', $
   'c:\rsi\idl52\examples\data\mr_brain.dcm' )

; Create a DICOM object and allow the user to choose a DICOM file
; to be read:
obj = OBJ_NEW( 'IDLffDICOM', DIALOG_PICKFILE(FILTER='*'))
```

## Version History

Introduced: 5.2

# IDLffDICOM::Read

The IDLffDICOM::Read function method opens and reads from the specified disk file, places the information into the DICOM object, then closes the file.

## Syntax

*Result* = *Obj* -> [IDLffDICOM::]Read(*Filename* [, ENDIAN={1 | 2 | 3 | 4}])

## Return Value

Return a 1 if successful and 0 otherwise.

## Arguments

### Filename

A scalar string argument containing the full path and filename of a DICOM Part 10 file to open and read into memory.

## Keywords

### ENDIAN

Set this keyword to configure the endian format when reading a DICOM file.

- 1 = Implicit VR Little Endian
- 2 = Explicit VR Little Endian
- 3 = Implicit VR Big Endian
- 4 = Explicit VR Big Endian

## Examples

```
; Create a DICOM object and read a DICOM file:
obj = OBJ_NEW('IDLffDICOM')
var  = obj -> Read(DIALOG_PICKFILE(FILTER = '*'))
OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDICOM::Reset

The IDLffDICOM::Reset procedure method removes all of the elements from the IDLffDICOM object, leaving the object otherwise intact.

## Syntax

*Obj* -> [IDLffDICOM::]Reset

## Arguments

None

## Keywords

None

## Examples

```
; Create a DICOM object, read a DICOM file and dump its contents:
obj = OBJ_NEW( 'IDLffDICOM' )
var  = obj->Read(DIALOG_PICKFILE(FILTER='*'))
obj->DumpElements
obj->Reset

; DumpElements should produce no output here:
obj->DumpElements
OBJ_DESTROY, obj
```

## Version History

Introduced: 5.2

# IDLffDXF

An IDLffDXF object contains geometry, connectivity and attributes for graphics primitives.

**Note**

IDL supports version 2.003 of the DXF Library.

This object treats a DXF file as a list of entities. Note, these are not directly mapped to DXF entity types, rather they are an abstraction of the DXF types. The Read method is used to read the contents of a DXF file into the current entity list. The user may then query this list using the GetContents method to determine the types and number of entities in the file. The user may retrieve arrays of entities from the list using the GetEntity method and add additional entities using the PutEntity method. Entities can also be removed from the list (RemoveEntity) or the entire list destroyed (Reset). The current list of entities can also be written to disk as a DXF file. Note, this object converts DXF entities to IDL entities and back. This conversion is not reversible; thus, if a DXF file is read and then written, the data in the file is not changed, but the internal DXF entity types may be changed by IDL. As an example, DXF face3d entities may be written as DXF polyline entities.

The object has one attribute which can be modified using the Get/SetPalette methods. This palette is used to convert color index values. The palette is not actually written to the DXF file. So, if the user wanted to specify entity colors from a 256 entry table, that table would be set using SetPalette, but the actual colors written to the file are the closest colors matched to the fixed AutoCAD color palette. There are two special color values: (0) = color by block color, (256) = color by layer color.

In this object, blocks and layers are treated as named entities with attributes, but are special in that all other entities have a block and layer entity reference in them. This allows the user to use these entity names as filters for many operations. There is a default block and a default layer. The default block has the name “” (the null string), and the default layer is '0'. The user may change the (non-name) attributes for these implicit blocks using PutEntity.

## Superclasses

This class has no superclass.

## Creation

See “IDLffDXF::Init” on page 2616

## Properties

Objects of this class have no properties of their own.

## Methods

This class has the following methods:

- IDLffDXF::Cleanup
- IDLffDXF::GetContents
- IDLffDXF::GetEntity
- IDLffDXF::GetPalette
- IDLffDXF::Init
- IDLffDXF::PutEntity
- IDLffDXF::Read
- IDLffDXF::RemoveEntity
- IDLffDXF::Reset
- IDLffDXF::SetPalette
- IDLffDXF::Write

## Version History

Introduced: 5.2

# IDLffDXF Properties

Objects of this class have no properties of their own.

# IDLffDXF::Cleanup

The IDLffDXF::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLffDXF::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.2

# IDLffDXF::GetContents

The IDLffDXF::GetContents function method returns a description of the content of the DXF file.

See the Examples following the GetEntity method description for an illustration of the difference between the GetContents and the GetEntity methods.

The Read or PutEntity methods must have been called previously for the results of this method to be valid.

| Valid DXF ENTITY Types | DXF_TYPE ( 0=default) |
|---|---|
| ARC | 1 |
| CIRCLE | 2 |
| ELLIPSE | 3 |
| LINE | 4 |
| LINE3D | 5 |
| TRACE | 6 |
| POLYLINE | 7 |
| LWPOLYLINE | 8 |
| POLYGON | 9 |
| FACE3D | 10 |
| SOLID | 11 |
| RAY | 12 |
| XLINE | 13 |
| TEXT | 14 |
| MTEXT | 15 |
| POINT | 16 |
| SPLINE | 17 |

*Table 0-4: DXF Entity Types*

| Valid DXF ENTITY Types | DXF_TYPE ( 0=default) |
|---|---|
| BLOCK | 18 |
| INSERT | 19 |
| LAYER | 20 |

*Table 0-4: DXF Entity Types (Continued)*

This object uses a small number of IDL named structures to return the data associated which each entity. This means that several of these DXF types are returned in the same structures, using different values of the DXF_TYPE field. The mapping of DXF entities to IDL named structures is as follows (each of these structures is documented in the GetEntity method):

| IDL Structure | DXF Entity |
|---|---|
| IDL_DXF_ELLIPSE | arc, circle, ellipse |
| IDL_DXF_POLYLINE | line, line3d, trace, polyline, lwpolyline |
| IDL_DXF_POLYGON | face3d, solid, polyline (3-d mesh) |
| IDL_DXF_POINT | point |
| IDL_DXF_XLINE | ray, xline |
| IDL_DXF_SPLINE | spline |
| IDL_DXF_TEXT | text, multitext |
| IDL_DXF_BLOCK | block |
| IDL_DXF_INSERT | insert |
| IDL_DXF_LAYER | layer |

*Table 0-5: DXF mapping to IDL structures*

# Syntax

*Result* = *Obj*-> [IDLffDXF::]GetContents( [*Filter*] [BLOCK=*string*] [, COUNT=*variable*] [LAYER=*string*] )

# Return Value

Returns an integer array containing the DXF entity type codes and the number of occurrences of each entity type contained in the object

# Arguments

## Filter

An integer array of the DXF entity types to which the return types are restricted. If set, Result can contain only types given in this argument and count will also reflect that restriction.

# Keywords

## BLOCK

Set this keyword to a string value containing the block name to obtain the entities from. The default is all blocks.

## COUNT

A long array containing the number of each entity type contained within the DXF object. If the Filter argument was provided, the numbers reflect the reduced set of entities caused by the Filter argument.

## LAYER

Set this keyword to a string value containing the layer name to obtain the entities from. The default is all layers.

# Version History

Introduced: 5.2

# IDLffDXF::GetEntity

The IDLffDXF::GetEntity function method returns an array of data for the requested entity type.

## Syntax

*Result* = *Obj*-> [IDLffDXF::]GetEntity(*Type* [, BLOCK=*string*] [, INDEX=*value*] [, LAYER=*string*])

## Return Value

Returns one of the named structure formats described in “Structure Formats” on page 2604.

## Arguments

### Type

The integer DXF entity type from which to obtain the geometry information.

## Keywords

### BLOCK

Set this keyword to a block name specifying the graphic block from which to obtain the entity geometry information. The default is all blocks. Setting this keyword to the null string " " will cause this method to only return entities from the default DXF entity block.

### INDEX

Set this keyword to a scalar index or a long array of indices of entities of the given type to return. If not set, this method returns all entities for the given type.

### LAYER

Set this keyword to a string value containing the layer name to obtain the entities from. The default is all layers.

# Fields Common to All Structures

## BLOCK

The name of the block this entity is in (these may be in the default block “”).

## COLOR

A color index value into the current object palette with 0=use block color and 256=use layer color.

## EXTRUSION

The DXF extrusion vector (if any).

## LAYER

The name of the layer this entity is in (the default layer is '0').

## LINESTYLE

Defined the same as the user linestyle for IDLgrPolyline::Init.

**Note**

IDL will always return a solid line regardless of the linestyle in DXF

## THICKNESS

In AutoCAD units.

## DXF_TYPE

Set to one of the values listed in IDLffDXF::GetContents.

**Note**

It is the user’s responsibility to free all the pointers returned in these structures when the entity is no longer needed.

# Structure Formats

## Structure IDL_DXF_ELLIPSE

| Field | Data Type |
|---|---|
| PT0 | Double [3] |
| PT1_OFFSET | Double [3] |
| MIN_TO_MAJ_RATIO | Double |
| START_ANGLE | Double |
| END_ANGLE | Double |
| EXTRUSION | Double [3] |
| LINESTYLE | Integer [2] |
| THICKNESS | Double |
| COLOR | Integer |
| DXF_TYPE | Integer |
| BLOCK | String |
| LAYER | String |

*Table 0-6: Fields of the IDL_DXF_ELLIPSE Structure*

This object is centered at PT0 and has a radius defined by the vector PT1_OFFSET. This vector determines the length and orientation of the major axis of an ellipse as well.

The MIN_TO_MAJ_RATIO value specifies the length of the minor axis as a fraction of the major axis length. For a circle, this value is 1.0.

The START_ANGLE and END_ANGLE values select the portion of the curve to be drawn. If they are equal, the entire circle or ellipse is drawn.

## Structure IDL_DXF_POLYGON

| Field | Data Type |
|---|---|
| VERTICES | Pointer (to an array of 3-D points) |
| CONNECTIVITY | Pointer (to an array of integers) |
| VERTEX_COLORS | Pointer (to an array of integers) |
| MESH_DIMS | Integer [2] |
| CLOSED | Integer [2] |
| COLOR | Integer |
| EXTRUSION | Double [3] |
| FIT_TYPE | Integer |
| CURVE_FIT | Integer |
| SPLINE_FIT | Integer |
| DXF_TYPE | Integer |
| BLOCK | String |
| LAYER | String |

*Table 0-7: Fields of the IDL_DXF_POLYGON Structure*

VERTICES is a pointer to an array of dimension [3, n] containing the points for this entity.

CONNECTIVITY is the array used to connect these points into polygons (see the POLYGONS keyword for IDLgrPolygon::Init). If this array is not present, the connectivity is implicit in (U, V) space defined by the values in MESH_DIMS; the vertices represent a quad mesh of dimensions (MESH_DIMS[0], MESH_DIMS[1]).

VERTEX_COLORS points to an array of color index values for each of the vertices. If a quad mesh is being returned, it can be closed in either dimension according to the CLOSED array.

FIT_TYPE, CURVE_FIT, and SPLINE_FIT return the type of curve fit (if any) this polygon assumes.

## Structure IDL_DXF_POLYLINE

| Field | Data Type |
|---|---|
| VERTICES | Pointer (to an array of 3-D points) |
| CONNECTIVITY | Pointer (to an array of integers) |
| VERTEX_COLORS | Pointer (to an array of integers) |
| COLOR | Integer |
| MESH_DIMS | Integer [2] |
| CLOSED | Integer [2] |
| THICKNESS | Double |
| LINESTYLE | Integer [2] |
| EXTRUSION | Double [3] |
| FIT_TYPE | String |
| CURVE_FIT | Integer |
| SPLINE_FIT | Integer |
| DXF_TYPE | Integer |
| BLOCK | String |
| LAYER | String |

*Table 0-8: Fields of the IDL_DXF_POLYLINE Structure*

VERTICES is a pointer to an array of dimension [3, n] containing the points for this entity.

CONNECTIVITY is the array used to connect these points into polylines (see the POLYLINES keyword for IDLgrPolyline::Init). If this array is not present, the connectivity is implicit in (U, V) space defined by the values in MESH_DIMS; the vertices represent a quad mesh of dimensions (MESH_DIMS[0], MESH_DIMS[1]).

VERTEX_COLORS points to an array of color index values for each of the vertices. If a quad mesh is being returned, it can be closed in either dimension according to the CLOSED array.

FIT_TYPE, CURVE_FIT, and SPLINE_FIT return the type of curve fit (if any) this polyline assumes.

## Structure IDL_DXF_POINT

| Field | Data Type |
|---|---|
| PT0 | Double [3] |
| UCSX_ANGLE | Double |
| THICKNESS | Double |
| COLOR | Integer |
| DXF_TYPE | Integer |
| BLOCK | String |
| LAYER | String |

*Table 0-9: Fields of the IDL_DXF_POINT Structure*

PT0 is the location of the point in space.

UCSX_ANGLE is an internal DXF orientation parameter used for symbol plotting.

## Structure IDL_DXF_SPLINE

| Field | Data Type |
|---|---|
| CTR_PTS | Pointer |
| FIT_PTS | Pointer |
| KNOTS | Pointer |
| WEIGHTS | Pointer |
| COLOR | Integer |
| DEGREE | Integer |
| PERIODIC | Integer |
| RATIONAL | Integer |
| PLANAR | Integer |
| LINEAR | Integer |
| KNOT_TOLERANCE | Double |
| CTL_TOLERANCE | Double |
| FIT_TOLERANCE | Double |
| START_TANGENT | Double [3] |
| END_TANGENT | Double [3] |
| THICKNESS | Double |
| LINESTYLE | Integer [2] |
| EXTRUSION | Double [3] |
| DXF_TYPE | Integer |
| BLOCK | String |
| LAYER | String |

*Table 0-10: Fields of the IDL_DXF_SPLINE Structure*

This structure is returned verbatim from the DXF spline structure without interpretation. It is up to the user to interpret these values.

## Structure IDL_DXF_TXT

| Field | Data Type |
|---|---|
| PT0 | Double [3] |
| TEXT_STR | String |
| COLOR | Integer |
| HEIGHT | Double |
| WIDTH_FACTOR | Double |
| BOX_WIDTH | Double |
| DIRECTION | Double [3] |
| ROT_ANGLE | Double |
| JUSTIFICATION | Integer (0=left, 1=center, 2=right, 3=aligned, 4=middle, 5=fit) |
| VERTICAL_ALIGN | Integer (0=baseline, 1=bottom, 2=middle, 3=top) |
| SHAPE_FILE | String |
| THICKNESS | Double |
| EXTRUSION | Double [3] |
| DXF_TYPE | Integer |
| BLOCK | String |
| LAYER | String |

*Table 0-11: Fields of the IDL_DXF_TXT Structure*

PT0 is the location of the text string.

TEXT_STR is the actual string.

HEIGHT specifies the overall scaling of the glyphs while WIDTH_FACTOR is a correction in the baseline direction (anisotropic scaling). For multi-line text, BOX_WIDTH determines where the line breaks should be placed (0.0 for single line text).

The text baseline is specified by DIRECTION and its rotation about the *z*-axis is specified by ROT_ANGLE. Justification is specified by JUSTIFICATION and VERTICAL_ALIGN. SHAPE_FILE is the name of the glyph file used to image this string. The shape file is NOT read by IDL.

## Structure IDL_DXF_XLINE

| Field | Data Type |
|---|---|
| PT0 | Double [3] |
| UNIT_VEC | Double [3] |
| COLOR | Integer |
| THICKNESS | Double |
| LINESTYLE | Integer [2] |
| EXTRUSION | Double [3] |
| DXF_TYPE | Integer |
| BLOCK | String |
| LAYER | String |

*Table 0-12: Fields of the IDL_DXF_XLINE Structure*

PT0 is the start of a ray or a point on a infinite line in space in the case of an XLINE entity.

UNIT_VEC determines the direction of the line in space.

## Structure IDL_DXF_INSERT

| Field | Data Type |
|---|---|
| SCALE | Double [3] |
| PT0 | Double [3] |
| ROTATION | Double |
| INSTANCE_BLOCK | String |
| NUM_ROW_COL | Integer [2] |
| DISTANCE_BETWEEN | Double [2] |
| DXF_TYPE | Integer |
| BLOCK | String |
| COLOR | Integer |
| LAYER | String |

*Table 0-13: Fields of the IDL_DXF_INSERT Structure*

The insert entity allows for the “instancing” of a block in a grid fashion.

INSTANCE_BLOCK is the name of a block to repeat.

The block is scaled by SCALE and rotated about the Z axis by ROTATION. The grid begins at PT0 and contains the number of rows and columns specified by NUM_ROW_COL (Note: 0 rows or columns will always give a single instance of the block).

The spacing of the grid is specified by DISTANCE_BETWEEN.

### Structure IDL_DXF_BLOCK

| Field | Data Type |
|---|---|
| PT0 | Double [3] |
| COLOR | Integer |
| NAME | String |
| DXF_TYPE | Integer |

*Table 0-14: Fields of the IDL_DXF_BLOCK Structure*

This entity specifies a BLOCK. Blocks have a location in space (PT0) [objects in the block are interpreted relative to this point], a name, and a COLOR. They are not contained in layers or other blocks, so these fields are not present.

### Structure IDL_DXF_LAYER

| Field | Data Type |
|---|---|
| COLOR | Integer |
| NAME | String |
| DXF_TYPE | Integer |

*Table 0-15: Fields of the IDL_DXF_LAYER Structure*

This entity specifies a LAYER. Layer is a NAME and a COLOR. They are not contained in layers or other blocks, so these fields are not present.

## Examples

This example illustrates the difference between the GetEntity and GetContents methods within the IDLffDXF object method. The GetContents method gives a description of the content of the file read, listing the entity types and the number of occurrences. GetEntity accesses the values returned by GetContents and determines how the entities can be logically combined into common structures for drawing efficiency.

```
PRO view_heart
; Determine path to data file.
heartFile = FILEPATH('heart.dxf', $
   SUBDIRECTORY = ['examples', 'data'])
; Initialize DXF data access object.
oHeart = OBJ_NEW('IDLffDXF')
; Read data within DXF file into access object.
status = oHeart -> Read(heartFile)
; Determine what type of entities (and how many of
; each entity) exist in the file.
heartTypes = oHeart -> GetContents(COUNT = heartCounts)
PRINT, 'Entity Types:   ', heartTypes
PRINT, 'Count of Types: ', heartCounts
; Initialize a model for displaying polygon and polyline
; objects.
oModel = OBJ_NEW('IDLgrModel')
; Obtain the tissue data.  The tissue is accessed into
; IDL as a single polygon.
tissue = oHeart -> GetEntity(heartTypes[1])
HELP, tissue
HELP, tissue, /STRUCTURE
; Initialize color parameter.
tissueColor = [255, 0, 0]
; Initialize polygon data.
vertices = tissue.vertices
connectivity = tissue.connectivity
; Initialize the polygon object.
oTissue = OBJ_NEW('IDLgrPolygon', $
   *vertices, POLYGONS = *connectivity, $
   COLOR = tissueColor)
; Add the polygon to the model.
oModel -> Add, oTissue
; Clean-up all the related pointers.
PTR_FREE, tissue.vertices, tissue.connectivity, $
   tissue.vertex_colors
PTR_FREE, vertices, connectivity
; Display the polylines and the polygon in the XOBJVIEW
; utility.
XOBJVIEW, oModel, /BLOCK, SCALE = 0.75
; Clean-up the object references.
OBJ_DESTROY, [oHeart, oModel]
END
```

An XOBJVIEW window with the mesh heart object appears when this program is compiled and run. The following lines are found in the IDLDE Output Log window.

```
IDL> view_heart
% Compiled module: VIEW_HEART.
% Compiled module: FILEPATH.
```

```
% Loaded DLM: DXF.
Entity Types:              7          10          18          20
Count of Types:           13        1624           1           2
```

The Entity Types (7, 10, 18, and 20) are the GetContents method return values corresponding to the occurrence of DXF ENTITY types found in the object: POLYLINES, FACE3D, BLOCK, and LAYER, respectively. Note there are a total of 1624 FACE3D entity types, but for efficiency and speed IDL logically combines all of the similar entities into a single structure that can be used in an IDLgrPolygon object. This is illustrated by the output resulting from the first Help command in the program as shown below.

```
TISSUE          STRUCT    = -> IDL_DXF_POLYGON Array[1]
** Structure IDL_DXF_POLYGON, 13 tags, length=72:
   EXTRUSION       DOUBLE    Array[3]
   VERTICES        POINTER   <PtrHeapVar3>
   CONNECTIVITY    POINTER   <PtrHeapVar4>
   VERTEX_COLORS   POINTER   <PtrHeapVar5>
   MESH_DIMS       INT       Array[2]
   CLOSED          INT       Array[2]
   COLOR           INT            256
   FIT_TYPE        INT             -1
   CURVE_FIT       INT              0
   SPLINE_FIT      INT              0
   DXF_TYPE        INT             10
   BLOCK           STRING    ''
   LAYER           STRING    '0----'
% Compiled module: XOBJVIEW.
% Compiled module: UNIQ.
% Compiled module: IDENTITY.
% Compiled module: XMANAGER.
```

Note that the tissue is represented as an array of polygons having 1 element. This is evident by the mesh representation of the heart object showing the 1624 individual polygons as a single object.

## Version History

Introduced: 5.2

# IDLffDXF::GetPalette

The IDLffDXF::GetPalette procedure method returns the current color table in the object.

## Syntax

*Obj*->[IDLffDXF::]GetPalette, *Red*, *Green*, *Blue*

## Arguments

### Red

Returns an array of the red components to the current color table.

### Green

Returns an array of the green components to the current color table.

### Blue

Returns an array of the blue components to the current color table.

## Keywords

None

## Version History

Introduced: 5.2

# IDLffDXF::Init

The IDLffDXF::Init function method initializes the DXF object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Result* = OBJ_NEW('IDLffDXF' [, *Filename*] )

or

*Result* = *Obj* -> [IDLffDXF::]Init( [*Filename*] ) (*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Filename

A scalar string optional argument containing the full path and filename of a DXF file to be read as the object is created.

## Keywords

None

## Version History

Introduced: 5.2

# IDLffDXF::PutEntity

The IDLffDXF::PutEntity procedure method inserts an entity into the DXF object. The type of the entity is determined from the DXF_TYPE field of the entity structure. If DXF_TYPE is set to 0, the type is implied by the entity structure.

**Note**

Line3D entity types will be written as Line entities due to the obsolete status of Line3D. Polyline entities will be automatically converted to Lightweight Polylines where applicable.

## Syntax

*Obj* -> [IDLffDXF::]PutEntity, *Data*

## Arguments

### Data

An array of Entity structures as defined by the GetEntity method.

**Note**

If the entity references a non-existent block or layer, one will automatically be created. Blocks and layers can also be created by passing IDL_DXF_BLOCK or IDL_DXF_LAYER structures to this routine.

## Keywords

None

## Version History

Introduced: 5.2

# IDLffDXF::Read

The IDLffDXF::Read function method reads a file, parsing the DXF object information contained in the file, and inserts it into itself.

## Syntax

*Result* = *Obj*`->` [IDLffDXF::]Read(*Filename*)

## Return Value

Returns a 1 indicating success in reading the file, otherwise 0.

## Arguments

### Filename

A scalar string containing the full path and filename of the DXF file to be read.

## Keywords

None

## Examples

```
; Read all the lines from the electrical layer:
oDXF = OBJ_NEW('IDLffDXF')
IF (oDXF->Read('myDXF.dxf')) THEN BEGIN
   contents = oDXF->GetContents(4,COUNT=numLines, $
      LAYER='Electrical')
   IF (numLines ne 0) THEN BEGIN
      lines = oDXF->GetEntity(4,LAYER='Electrical')
   ENDIF
ENDIF
```

## Version History

Introduced: 5.2

# IDLffDXF::RemoveEntity

The IDLffDXF::RemoveEntity procedure method removes the specified entity or entities from the DXF object.

## Syntax

*Obj* -> [IDLffDXF::]RemoveEntity[, *Type*] [, INDEX=*value*]

## Arguments

### Type

An optional scalar string containing the DXF type to be removed from the DXF object.

**Note**

Specifying a block or layer entity will cause all the entities in that layer or block to be removed.

## Keywords

### INDEX

Set this keyword to a scalar long or a long array of indices to remove from the DXF object. If not set, or set negative, all entities of the given type are removed.

## Version History

Introduced: 5.2

# IDLffDXF::Reset

The IDLffDXF::Reset procedure method removes all the entities from the DXF object.

## Syntax

*Obj*->[IDLffDXF::]Reset

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.2

# IDLffDXF::SetPalette

The IDLffDXF::SetPalette procedure method sets the current color table in the object.

## Syntax

*Obj*->[IDLffDXF::]SetPalette, *Red*, *Green*, *Blue*

## Arguments

### Red

Sets the red components of the current color table to this array.

### Green

Sets the green components of the current color table to this array.

### Blue

Sets the blue components of the current color table to this array.

## Keywords

None

## Version History

Introduced: 5.2

# IDLffDXF::Write

The IDLffDXF::Write function method writes a file for the DXF entity information this object contains.

## Syntax

*Result* = *Obj*`->` [IDLffDXF::]Write(*Filename*)

## Return Value

Returns a 1 if successful in writing the file, 0 otherwise.

## Arguments

### Filename

A scalar string containing the full path and filename of the DXF file to be written.

## Keywords

None

## Examples

```
; Write a square to a new DXF file using lines:
oDXF = OBJ_NEW('IDLffDXF')
lines = {IDL_DXF_POLYLINE}
lines.dxf_type = 4
lines.layer='myLayer'
lines.thickness = 1.0

; Create clockwise square:
lines = REPLICATE(lines, 4)
lines[0].vertices = PTR_NEW([[0.0,0.0,0.0], $
     [0.0,1.0,0.0]])
lines[0].connectivity = PTR_NEW([0,1])
lines[1].vertices = PTR_NEW([[0.0,1.0,0.0], $
    [1.0,1.0,0.0]])
lines[1].connectivity = PTR_NEW([0,1])
lines[2].vertices = PTR_NEW([[1.0,1.0,0.0], $
    [1.0,0.0,0.0]])
lines[2].connectivity = PTR_NEW([0,1])
lines[3].vertices = PTR_NEW([[1.0,0.0,0.0], $
```

```
    [0.0,0.0,0.0]])
lines[3].connectivity = PTR_NEW([0,1])
oDXF->PutEntity, lines
IF (not oDXF->Write('mySquare.dxf')) THEN $
   PRINT, 'Write Failed.'
   ; Clean up the memory in the structs:
   OBJ_DESTROY, oDXF
   FOR i=0,3 DO BEGIN
      PTR_FREE, lines[i].vertices, lines[i].connectivity
ENDFOR
```

## Version History

Introduced: 5.2

# IDLffLanguageCat

The IDLffLanguageCat object provides an interface to IDL language catalog files.

**Note**

This object is not savable. Restored IDLffLanguageCat objects may contain invalid data.

**Note**

This object is not intended to be created with OBJ_NEW. The MSG_CAT_OPEN function is used to return the correct object reference.

## Superclasses

This class has no superclasses.

## Creation

See MSG_CAT_OPEN.

## Properties

Objects of this class have no properties of their own.

## Methods

This class has the following methods:

- IDLffLanguageCat::IsValid
- IDLffLanguageCat::Query
- IDLffLanguageCat::SetCatalog

## Version History

Introduced: 5.2.1

## See Also

MSG_CAT_CLOSE, MSG_CAT_COMPILE, MSG_CAT_OPEN

# IDLffLanguageCat Properties

Objects of this class have no properties of their own.

# IDLffLanguageCat::IsValid

The IDLffLanguageCat::IsValid function method is used to determine whether the object has a valid catalog.

## Syntax

*Result* = *Obj* ->[IDLffLanguageCat::]IsValid()

## Return Value

Returns a 1 if the file is valid, 0 otherwise.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.2.1

# IDLffLanguageCat::Query

The IDLffLanguageCat::Query function method is used to return the language string associated with the given key.

## Syntax

*Result* = *Obj* ->[IDLffLanguageCat::]Query(*Key* [, DEFAULT_STRING=*string*])

## Return Value

Returns a string representing the language associated with the given key. If the key is not found in the given catalog, the default string is returned.

## Arguments

### Key

The scalar or array of (string) keys associated with the desired language string. If key is an array, *Result* will be a string array of the associated language strings.

## Keywords

### DEFAULT_STRING

Set this keyword to the desired value of the return string if the key cannot be found in the catalog file. The default value is the empty string.

## Version History

Introduced: 5.2.1

# IDLffLanguageCat::SetCatalog

The IDLffLanguageCat::SetCatalog function method is used to set the appropriate catalog file.

## Syntax

*Result* = *Obj* ->[IDLffLanguageCat::]SetCatalog(*Application* [, FILENAME=*string*] [, LOCALE=*string*] [, PATH=*string*])

## Return Value

Returns 1 upon success, and 0 on failure

## Arguments

### Application

A scalar string representing the name of the desired application's catalog file.

## Keywords

### FILENAME

Set this keyword to a scalar string containing the full path and filename of the catalog file to open. If this keyword is set, *application*, PATH, and LOCALE are ignored.

### LOCALE

Set this keyword to the desired locale for the catalog file. If not set, the current locale is used.

### PATH

Set this keyword to a scalar string containing the path to search for language catalog files. The default is the current directory.

## Version History

Introduced: 5.2.1

# IDLffMrSID

An IDLffMrSID object class is used to query information about and load image data from a MrSID (`.sid`) image file.

## Superclasses

This class has no superclasses.

## Creation

See IDLffMrSID::Init

## Properties

Objects of this class have the following properties. See “IDLffMrSID Properties” on page 2630 for details on individual properties.

- QUIET

## Methods

This class has the following methods:

- IDLffMrSID::Cleanup
- IDLffMrSID::GetDimsAtLevel
- IDLffMrSID::GetImageData
- IDLffMrSID::GetProperty
- IDLffMrSID::Init

## Version History

Introduced: 5.5

# IDLffMrSID Properties

IDLffMrSID objects have the following properties. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLffMrSID::Init.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## QUIET

A Boolean value to indicate whether error messages are suppressed while constructing the IDLffMrSID object. If this value is true, the errors messages are suppressed. Otherwise, the messages are printed to the Output Log.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLffMrSID::Cleanup

The IDLffMrSID::Cleanup procedure method deletes all MrSID objects, closing the MrSID file in the process. It also deletes the IDL objects used to communicate with the MrSID library.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLffMrSID::]Cleanup (*Only in subclass' Cleanup metho*d.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.5

# IDLffMrSID::GetDimsAtLevel

The IDLffMrSID::GetDimsAtLevel function method is used to retrieve the dimensions of the image at a given level. This can be used, for example, to determine what level is required to fit the image into a certain area.

## Syntax

*Result* = *Obj* -> [IDLffMrSID::]GetDimsAtLevel (*Level*)

## Return Value

Returns a floating-point two-element vector containing the dimensions of the image at a given level.

## Arguments

### Level

A scalar integer specifying the level at which the dimensions are to be determined. This level must be in the range returned by the LEVELS keyword of IDLffMrSID::GetProperty.

## Keywords

None

## Examples

Initialize the MrSID file object.

```
oFile = OBJ_NEW('IDLffMrSID', FILEPATH('test_gs.sid', $
   SUBDIRECTORY = ['examples', 'data']))
```

Get the range of levels of resolution contained within the file.

```
oFile -> GetProperty, LEVELS = lvls
PRINT, lvls
```

IDL prints,

```
-9   4
```

Print the image dimensions at the lowest image resolution where image level = 4.

```
imgLevelA = MAX(lvls)
dimsAtA = oFile -> GetDimsAtLevel(imgLevelA)
PRINT, 'Dimensions of lowest resolution image is', dimsAtA
```

IDL prints,

```
32   32
```

Print the image dimensions at full resolution where image level = 0

```
dimsAtFull = oFile -> GetDimsAtLevel(0)
PRINT, 'Dimensions of full resolution image is', dimsAtFull
```

IDL prints,

```
512   512
```

Print the image dimensions at the highest resolution where image level = -9

```
highestLvl = MIN(lvls)
dimsAtHighest = oFile -> GetDimsAtLevel(highestLvl)
PRINT, 'Dimensions of highest resolution image is', dimsAtHighest
```

IDL prints,

```
262144   262144
```

Clean up object references.

```
OBJ_DESTROY, [oFile]
```

## Version History

Introduced: 5.5

# IDLffMrSID::GetImageData

The IDLffMrSID::GetImageData function method extracts and returns the image data from the MrSID file at the specified level and location.

## Syntax

*Result* = *Obj* -> [IDLffMrSID::]GetImageData ([, LEVEL = *lvl*] [, SUB_RECT = *rect*])

## Return Value

Returns an *n*-by-*w*-by-*h* array containing the image data where *n* is 1 for grayscale or 3 for RGB images, *w* is the width and *h* is the height.

**Note**

The returned image is ordered bottom-up, the first pixel returned is located at the bottom-left corner of the image. This differs from how data is stored in the MrSID file where the image is top-down, meaning the pixel at the start of the file is located at the top-left corner of the image.

## Arguments

None

## Keywords

### LEVEL

Set this keyword to an integer that specifies the level at which to read the image.

If this keyword is not set, the maximum level is used which returns the minimum resolution (see the LEVELS keyword to IDLffMrSID::GetProperty).

### SUB_RECT

Set this keyword to a four-element vector [*x, y, xdim, ydim*] specifying the position of the lower left-hand corner and the dimensions of the sub-rectangle of the MrSID image to return. This is useful for displaying portions of a high-resolution image.

If this keyword is not set, the whole image will be returned. This may require significant memory if a high-resolution image level is selected.

If the sub-rectangle is greater than the bounds of the image at the selected level the area outside the image bounds will be set to black.

**Note**

The elements of SUB_RECT are measured in pixels at the current level. This means the point x = 10, y = 10 at level 1 will be located at x = 20, y = 20 at level 0 and x = 5, y = 5 at level 2.

# Examples

```
PRO MrSID_GetImageData

; Initialize the MrSID file object.
oFile = OBJ_NEW('IDLffMrSID', FILEPATH('test_gs.sid', $
   SUBDIRECTORY = ['examples', 'data']))

; Get the range of levels of resolution contained within the file.
oFile -> GetProperty, LEVELS = lvls
PRINT, lvls
; IDL prints, -9, 4

; Get the image data at level 0.
imgDataA = oFile -> GetImageData(LEVEL = 0)
HELP, 'image array data at full resolution', imgDataA
;IDL prints, Array[1, 512, 512] indicating a grayscale 512 x 512
array.

; Display the full resolution image.
oImgA = OBJ_NEW('IDLgrImage', imgDataA)
oModelA = OBJ_NEW('IDLgrModel')
oModelA -> Add, oImgA
XOBJVIEW, oModelA, BACKGROUND = [0,0,0], $
   TITLE = 'Full Resolution Image', /BLOCK

; Get the image data of a higher resolution image,
imgDataB = oFile -> GetImageData(LEVEL = -2)
HELP, imgDataB
; IDL returns [1,2048,2048] indicating a grayscale 2048 x 2048
array.
```

```
; To save processing time, display only a 1024 x 1024 portion of
; the high resolution, using 512,512 as the origin..
imgDataSelect = oFile -> GetImageData(LEVEL = -2,$
   SUB_RECT = [512, 512, 1024, 1024])
oImgSelect = OBJ_NEW('IDLgrImage', imgDataSelect)
oModel = OBJ_NEW('IDLgrModel')
oModel -> Add, oImgSelect

XOBJVIEW, oModel, BACKGROUND = [0,0,0], $
   TITLE = 'Detail of High Resolution Image', /BLOCK

; Clean up object references.
OBJ_DESTROY, [oFile, oImgA, oModelA, oImgSelect, oModel]

END
```

## Version History

Introduced: 5.5

# IDLffMrSID::GetProperty

The IDLffMrSID::GetProperty function method is used to query properties associated with the MrSID image.

## Syntax

*Obj* -> [IDLffMrSID::]GetProperty [, CHANNELS=*nChannels*] [, DIMENSIONS=*Dims*] [, LEVELS=*Levels*] [, PIXEL_TYPE=*pixelType*] [, TYPE=*strType*] [, GEO_VALID=*geoValid*] [, GEO_PROJTYPE=*geoProjType*] [, GEO_ORIGIN=*geoOrigin*] [, GEO_RESOLUTION=*geoRes*]

## Arguments

None

## Keywords

### CHANNELS

Set this keyword to a named variable that will contain the number of image bands. For RGB images this is 3, for grayscale it is 1.

### DIMENSIONS

Set this keyword equal to a named variable that will contain a two-element long integer array of the form [*width*, *height*] that specifies the dimensions of the MrSID image at level 0 (full resolution).

### LEVELS

Set this keyword equal to a named variable that will contain a two-element long integer array of the form [*minlvl*, *maxlvl*] that specifies the range of levels within the current image. Higher levels are lower resolution. A level of 0 equals full resolution. Negative values specify higher levels of resolution.

### PIXEL_TYPE

Set this keyword to a named variable that will contain the IDL basic type code for a pixel sample. For a list of the data types indicated by each type code, see the “IDL Type Codes” section of the SIZE function.

## TYPE

Set this keyword to a named variable that will contain a string identifying the file format. This should always be MrSID.

## GEO_VALID

Set this keyword to a named variable that will contain a long integer that is set to:

- 1 - If the MrSID image contains valid georeferencing data.
- 0 - If the MrSID image does not contain georeferencing data or the data is in an unsupported format.

**Note**

Always verify that this keyword returns 1 before using the data returned by any other GEO_* keyword.

## GEO_PROJTYPE

Set this keyword to a named variable that will contain an unsigned integer that specifies the geoTIFF projected coordinate system type code. For example, type code 32613 corresponds to PCS_WGS84_UTM_zone_13N.

For more information on the geoTIFF file type and available type codes see:

`http://www.remotesensing.org/geotiff/geotiff.html`

## GEO_ORIGIN

Set this keyword to a named variable that will contain a two-element double precision array of the form [*x*, *y*] that specifies the location of the center of the upper-left pixel.

## GEO_RESOLUTION

Set this keyword to a named variable that will contain a two-element double precision array of the form [*xres*, *yres*] that specifies the pixel resolution.

## Examples

```
PRO MrSID_GetProperty

; Initialize the MrSID object.
oFile = OBJ_NEW('IDLffMrSID', FILEPATH('test_gs.sid', $
   SUBDIRECTORY = ['examples', 'data']))

; Get the property information of the MrSID file
oFile -> GetProperty, CHANNELS = chan, LEVELS = $
   lvls, Pixel_Type = pType, TYPE = fileType, GEO_VALID = geoQuery

; Print MrSID file information.
PRINT, 'Number of image channels = ', chan
; IDL returns 1 indicating one image band.

PRINT, 'Range of image levels = ', lvls
; IDL returns -9, 4, the minimum and maximum level values.

PRINT, 'Type code of image pixels = ', pType
; IDL returns 1 indicating byte data type.

PRINT, 'Image file type = ', FileType
; IDL returns "MrSID"

PRINT, 'Result of georeferencing data query = ', geoQuery
; IDL returns 0 indicating that the image does not contain
; georeferencing  data.

; Destroy object references.
OBJ_DESTROY, [oFile]

END
```

## Version History

Introduced: 5.5

# IDLffMrSID::Init

The IDLffMrSID::Init function method initializes an IDLffMrSID object containing the image data from a MrSID image file.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Result* = OBJ_NEW('IDLffMrSID', *Filename*[, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLffMrSID::]Init(*Filename*[, *PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Filename

A scalar string argument containing the full path and filename of a MrSID file to be accessed through this IDLffMrSID object.

**Note**

This is a required argument; it is not possible to create an IDLffMrSID object without specifying a valid MrSID file.

## Keywords

Any property listed under “IDLffMrSID Properties” on page 2630 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Examples

```
oMrSID = OBJ_NEW('IDLffMrSID', FILEPATH('test_gs.sid', $
   SUBDIRECTORY = ['examples', 'data']))
```

## Version History

Introduced: 5.5

# IDLffShape

An IDLffShape object contains geometry, connectivity and attributes for graphics primitives accessed from ESRI Shapefiles. See “Overview of ESRI Shapefiles” on page 2644 for more details on Shapefiles.

## Superclasses

This class has no superclass.

## Creation

See IDLffShape::Init

## Properties

Objects of this class have the following properties. See “IDLffShape Properties” on page 2654 for details on individual properties.

- ATTRIBUTE_INFO
- ATTRIBUTE_NAMES
- DBF_ONLY
- ENTITY_TYPE
- FILENAME
- IS_OPEN
- N_ATTRIBUTES
- N_ENTITIES
- N_RECORDS
- UPDATE

## Methods

This class has the following methods:

- IDLffShape::AddAttribute
- IDLffShape::Cleanup

- IDLffShape::Close
- IDLffShape::DestroyEntity
- IDLffShape::GetAttributes
- IDLffShape::GetEntity
- IDLffShape::GetProperty
- IDLffShape::Init
- IDLffShape::Open
- IDLffShape::PutEntity
- IDLffShape::SetAttributes

## Version History

Introduced: 5.4

# Overview of ESRI Shapefiles

An ESRI Shapefile stores nontopological geometry and attribute information for the spatial features in a data set.

A Shapefile consists of a main file (`.shp`), an index file (`.shx`), and a dBASE table (`.dbf`). For example, the Shapefile “states” would have the following files:

- states.shp
- states.shx
- states.dbf

## Naming Conventions for a Shapefile

All the files that comprise an ESRI Shapefile must adhere to the 8.3 filename convention and must be lower case. The main file, index file, and dBASE file must all have the same prefix. The prefix must start with an alphanumeric character and can contain any alphanumeric, underscore (_), or hyphen (-). The main file suffix must use the `.shp` extension, the index file the `.shx` extension, and the dBASE table the `.dbf` extension.

## Major Elements of a Shapefile

A Shapefile consists of the following elements that you can access through the IDLffShape class:

- Entities
- Attributes

### Entities

The geometry for a feature is stored as a shape comprising a set of vector coordinates (referred to as ‘entities’). The entities in a Shapefile must all be of the same type. The following are the possible types for entities in a Shapefile:

| Shape Type | Type Code |
|---|---|
| Point | 1 |
| PolyLine | 3 |
| Polygon | 5 |

*Table 0-16: Entity Types*

| Shape Type | Type Code |
|---|---|
| MultiPoint | 8 |
| PointZ | 11 |
| PolyLineZ | 13 |
| PolygonZ | 15 |
| MultiPointZ | 18 |
| PointM | 21 |
| PolyLineM | 23 |
| PolygonM | 25 |
| MultiPointM | 28 |
| MultiPatch | 31 |

*Table 0-16: Entity Types (Continued)*

When retrieving entities using the IDLffShape::GetEntity method, an IDL structure is returned. This structure has the following fields:

| Field | Data Type |
|---|---|
| SHAPE_TYPE | IDL_LONG |
| ISHAPE | IDL_LONG |
| BOUNDS | Double[8] |
| N_VERTICES | IDL_LONG |
| VERTICES | Pointer (to Vertices array) |
| MEASURE | Pointer (to Measure array) |
| N_PARTS | IDL_LONG |
| PARTS | Pointer (to Parts array). |
| PART_TYPES | Pointer (to part types) |
| ATTRIBUTES | Pointer to attribute array. |

*Table 0-17: Entity Structure Field Data Types*

The following table describes each field in the structure:

| Field | Description |
|---|---|
| SHAPE_TYPE | The entity type. |
| ISHAPE | The identifier of the specific entity in the shape object. |
| BOUNDS | A bounding box that specifies the range limits of the entity. This eight element array contains the following information:<br>• Index 0 — X minimum value<br>• Index 1 — Y minimum value<br>• Index 2 — Z minimum value (if Z is supported by type)<br>• Index 3 — Measure minimum value (if measure is supported by entity type)<br>• Index4 — X maximum value<br>• Index5 — Y maximum value<br>• Index6 — Z maximum value (if Z is supported by the entity type)<br>• Index7 — Measure maximum value (if measure is supported by entity type)<br>**Note -** If the entity is a point type, the values contained in the bounds array are also the values of the entity. |
| N_VERTICES | The number of vertices in the entity. If this value is one and the entity is a POINT type (POINT, POINTM, POINTZ), the vertices pointer will be set to NULL and the entity value will be maintained in the BOUNDS field. |

*Table 0-18: Entity Structure Field Descriptions*

| Field | Description |
|---|---|
| VERTICES | An IDL pointer that contains the vertices of the entity. This pointer contains a double array that has one of the following formats:<br>• [2, *N*] - If Z data is not present<br>• [3, *N*] - If Z data is present<br>where *N* is the number of vertices. These array formats can be passed to the polygon and polyline objects of IDL Object Graphics.<br>**Note -** This pointer will be null if the entity is a point type, with the values maintained in the BOUNDS array. |
| MEASURE | If the entity has a measure value (this is dependent on the entity type), this IDL pointer will contain a vector array of measure values. The length of this vector is N_VERTICES.<br>**Note -** This pointer will be null if the entity is of type POINTM, with the values contained in the BOUNDS array. |
| N_PARTS | If the values of the entity are separated into parts, the break points are enumerated in the parts array. This field lists the number of parts in this entity. If this value is 0, the entity is one part and the PARTS pointer will be NULL. |
| PARTS | An IDL pointer that contains an array of indices into the vertex/measure arrays. These values represent the start of each part of the entity. The index range of each entity part is defined by the following:<br>• Start = Parts[I]<br>• End = Parts[I+1]-1 or the end of the array |

*Table 0-18: Entity Structure Field Descriptions (Continued)*

| Field | Description |
|---|---|
| PART_TYPES | This IDL pointer is only valid for entities of type MultiPatch and defines the type of the particular part. If the entity type is not MultiPatch, part types are assumed to be type RING (SHPP_RING).<br>**Note -** This pointer is NULL if the entity is not type MultiPatch. |
| ATTRIBUTES | If the attributes for an entity were requested, this field contains an IDL pointer that contains a structure of attributes for the entity. For more information on this structure, see “Attributes” on page 2648. |

*Table 0-18: Entity Structure Field Descriptions (Continued)*

### Attributes

A Shapefile provides the ability to associate information describing each entity (a geometric element) contained in the file. This descriptive information, called attributes, consists of a set of named data elements for each geometric entity contained in the file. The set of available attributes is the same for every entity contained in a Shapefile, with each entity having it’s own set of attribute values.

An attribute consist of two components:

- A name
- A data value

The name consists of an 11 character string that is used to identify the data value. The data value is not limited to any specific format.

The two components that form an attribute are accessed differently using the shape object. To get the name of attributes for the specific file, the ATTRIBUTE_NAMES keyword to the IDLffShape::GetProperty method is used. This returns a string array that contains the names for the attributes defined for the file.

To get the attribute values for an entity, the IDLffShape::GetAttributes method is called or the ATTRIBUTES keyword of the IDLffShape::GetEntity method is set. In each case, the attribute values for the specified entity is returned as an anonymous IDL structure. The numeric order of the fields in the returned structure map to the numeric order of the attributes defined for the file. The actual format of the returned structure is:

ATTRIBUTE_0 : VALUE,

ATTRIBUTE_1 : VALUE,

ATTRIBUTE_2 : VALUE,

...

ATTRIBUTE_<N-1> : VALUE

To access the values in the returned structure, you can either hardcode the structure field names or use the structure indexing feature of IDL.

## Accessing Shapefiles

The following example shows how to access data in a Shapefile. This example sets up a map to display parts of a Shapefile, opens a Shapefile, reads the entities from the Shapefile, and then plots only the state of Colorado:

```
PRO ex_shapefile

DEVICE, RETAIN=2, DECOMPOSED=0
!P.BACKGROUND=255

;Define a color table
r=BYTARR(256) & g=BYTARR(256) & b=BYTARR(256)
r[0]=0 & g[0]=0 & b[0]=0             ;Definition of black
r[1]=100 & g[1]=100 & b[1]=255       ;Definition of blue
r[2]=0 & g[2]=255 & b[2]=0           ;Definition of green
r[3]=255 & g[3]=255 & b[3]=0         ;Definition of yellow
r[255]=255 & g[255]=255 & b[255]=255 ;Definition of white

TVLCT, r, g, b
black=0 & blue=1 & green=2 & yellow=3 & white=255

; Set up map to plot Shapefile on
MAP_SET, /ORTHO,45, -120,  /ISOTROPIC, $
/HORIZON, E_HORIZON={FILL:1, COLOR:blue}, $
/GRID, COLOR=black, /NOBORDER

; Fill the continent boundaries:
MAP_CONTINENTS, /FILL_CONTINENTS, COLOR=green
```

```
; Overplot coastline data:
MAP_CONTINENTS, /COASTS, COLOR=black

; Show national borders:
MAP_CONTINENTS, /COUNTRIES, COLOR=black

;Open the states Shapefile in the examples directory
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

;Get the number of entities so we can parse through them
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent

;Parsing through the entities and only plotting the state of
;Colorado
FOR x=1, (num_ent-1) DO BEGIN
   ;Get the Attributes for entity x
   attr = myshape -> IDLffShape::GetAttributes(x)
   ;See if 'Colorado' is in ATTRIBUTE_1 of the attributes for
   ;entity x
   IF attr.ATTRIBUTE_1 EQ 'Colorado' THEN BEGIN
      ;Get entity
      ent = myshape -> IDLffShape::GetEntity(x)
      ;Plot entity
      POLYFILL, (*ent.vertices)[0,*], (*ent.vertices)[1,*],
COLOR=yellow
      ;Clean-up of pointers
      myshape -> IDLffShape::DestroyEntity, ent
   ENDIF
ENDFOR

;Close the Shapefile
OBJ_DESTROY, myshape

END
```

This results in the following:

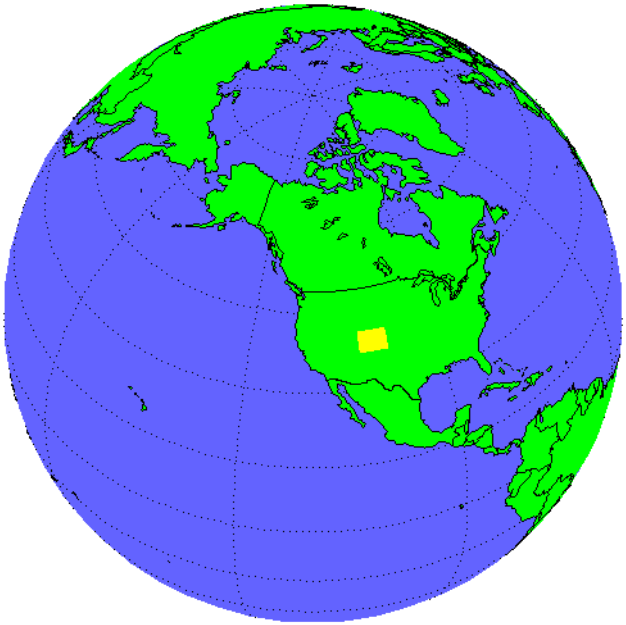


*Figure 0-1: Example Use of Shapefiles*

## Creating New Shapefiles

To create a Shapefile, you need to create a new Shapefile object, define the entity and attributes definitions, and then add your data to the file. For example, the following program creates a new Shapefile (`cities.shp`), defines the entity type to be "Point", defines 2 attributes (CITY_NAME and STATE_NAME), and then adds an entity to the new file:

```
PRO ex_shapefile_newfile

;Create the new shapefile and define the entity type to Point
mynewshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE, ENTITY_TYPE=1)

;Set the attribute definitions for the new Shapefile
mynewshape->IDLffShape::AddAttribute, 'CITY_NAME', 7, 25, $
   PRECISION=0
mynewshape->IDLffShape::AddAttribute, 'STAT_NAME', 7, 25, $
   PRECISION=0
```

```
;Create structure for new entity
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1458
entNew.BOUNDS[0] = -104.87270
entNew.BOUNDS[1] = 39.768040
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -104.87270
entNew.BOUNDS[5] = 39.768040
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

;Create structure for new attributes
attrNew = mynewshape ->IDLffShape::GetAttributes( $
/ATTRIBUTE_STRUCTURE)

;Define the values for the new attributes
attrNew.ATTRIBUTE_0 = 'Denver'
attrNew.ATTRIBUTE_1 = 'Colorado'

;Add the new entity to new shapefile
mynewshape -> IDLffShape::PutEntity, entNew

;Add the Colorado attributes to new shapefile
mynewshape -> IDLffShape::SetAttributes, 0, attrNew

;Close the shapefile
OBJ_DESTROY, mynewshape

END
```

## Updating Existing Shapefiles

You can modify existing Shapefiles with the following:

- Adding new entities
- Adding new attributes (only to Shapefiles without any existing values in any attributes)
- Modifying existing attributes

**Note**

You cannot modify existing entities.

For example, the following program adds an entity and attributes for the city of Boulder to the `cities.shp` file we created in the previous example:

```
PRO ex_shapefile_modify

;Open the cities Shapefile
myshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE)

;Create structure for new entity
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1380
entNew.BOUNDS[0] = -105.25100
entNew.BOUNDS[1] = 40.026878
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -105.25100
entNew.BOUNDS[5] = 40.026878
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

;Create structure for new attributes
attrNew = myshape ->IDLffShape::GetAttributes( $
/ATTRIBUTE_STRUCTURE)

;Define the values for the new attributes
attrNew.ATTRIBUTE_0 = 'Boulder'
attrNew.ATTRIBUTE_1 = 'Colorado'

;Add the new entity to new shapefile
myshape -> IDLffShape::PutEntity, entNew

;Add the Colorado attributes to new shapefile
myshape -> IDLffShape::SetAttributes, 0, attrNew

;Close the shapefile
OBJ_DESTROY, myshape

END
```

# IDLffShape Properties

IDLffShape objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLffShape::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLffShape::Init.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ATTRIBUTE_INFO

A array of structures containing the attribute information for each attribute. The attribute information structures have the following fields:

| Field | Description |
|---|---|
| NAME | A string that contains the name of the attribute. |
| TYPE | The IDL type code of the attribute. |
| WIDTH | The width of the attribute. |
| PRECISION | The precision of the attribute. |

*Table 0-19: ATTRIBUTE_INFO Fields*

The file must be open to obtain this information.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ATTRIBUTE_NAMES

A string array containing the names of each attribute in the Shapefile object.

| **Property Type** | String array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## DBF_ONLY

A non-zero, positive integer value indicating whether the underlying dBASE table (`.dbf`) component of the shapefile is opened while all other entity related files are left closed. The following two values are accepted for this property:

- 1 - Open an existing `.dbf` file,
- Greater than 1 - Create a new `.dbf` file

**Note**

The UPDATE keyword is required to open the `.dbf` file for updating.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## ENTITY_TYPE

If retrieving this property, its value is an integer representing the type code for the entities contained in the Shapefile object. If the value is unknown, this method returns -1. For more information on entity type codes, see “Entities” on page 2644.

If setting this property, its value is an integer representing the entity type of a new Shapefile. Use this setting only when creating a new Shapefile. For more information on entity types, see “Entities” on page 2644.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

## FILENAME

A string representing the fully qualified path name of the Shapefile in the current Shapefile object.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## IS_OPEN

An integer value representing information about the status of a Shapefile. The following values can be returned:

| Value | Description |
|---|---|
| 0 | File is not open. |
| 1 | File is open in read-only mode. |
| 3 | File is open in update mode. |

*Table 0-20: IS_OPEN Values*

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## N_ATTRIBUTES

A longword integer representing the number of attributes associated with a Shapefile object. If the number of attributes is unknown, this property returns 0.

| | | | |
|---|---|---|---|
| **Property Type** | Long | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## N_ENTITIES

A longword integer representing the number of entities contained in Shapefile object. If the number of entities is unknown, this property returns 0.

| | | | |
|---|---|---|---|
| **Property Type** | Long | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## N_RECORDS

A longword integer representing the number of records in the dBASE table (`.dbf`) component of the Shapefile. In a normal operating mode, this process is accomplished by getting the number of entities. However, in DBF_ONLY mode, no entity file exits.

| | | | |
|---|---|---|---|
| **Property Type** | Long | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## UPDATE

A Boolean value indicating whether the file opened for writing. The file is opened for writing if this property is set to true. The default is read-only.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLffShape::AddAttribute

The IDLffShape::AddAttribute method adds an attribute definition to a Shapefile. Adding a the attribute definition is required before adding the actual attribute data to a file. For more information on attributes, see “Attributes” on page 2648.

**Note**

You can only define new attributes to Shapefiles that do not have any existing values in any attributes.

# Syntax

*Obj*->[IDLffShape::]AddAttribute, *Name*, *Type*, *Width* [, PRECISION=*integer*]

# Arguments

## Name

Set to a string that contains the attribute name. Name values are limited to 11 characters. Arguments longer than 11 characters will be truncated.

## Type

Set to the IDL type code that corresponds to the data type that will be stored in the attribute. The valid types are:

| Code | Description |
|---|---|
| 3 | Longword Integer |
| 5 | Double-precision floating-point |
| 7 | String |

*Table 0-21: Type Code Descriptions*

### Width

Set to the width of the field for the data value of the attribute. The following table describes the possible values depending on the defined Type:

| Field Type | Valid Values |
|---|---|
| Longword Integer | Maximum size of the field. |
| Double-precision floating-point | Maximum size of the field. |
| String | Maximum length of the string. |

*Table 0-22: Width Values*

## Keywords

### PRECISION

Set this keyword to the number of positions to be included after the decimal point. The default is 8. This keyword is only valid for fields defined as double-precision floating-point.

## Examples

In the following example, we add the attribute “ELEVATION” to an existing Shapefile. Note that if the file already contains data in an attribute for any of the entities defined in the file, this operation will fail.

```
PRO ex_addattr_shapefile

;Open a shapefile
myshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE)

;Define a new attribute for the Shapefile
myshape->IDLffShape::AddAttribute, 'ELEVATION', 3, 4, $
   PRECISION=0

;Close the shapefile
OBJ_DESTROY, myshape

END
```

## Version History

Introduced: 5.4

# IDLffShape::Cleanup

The IDLffShape::Cleanup procedure method performs all cleanup on a Shapefile object. If the Shapefile being accessed by the object is open and the file has been modified, the new information is written to the file if one of the following conditions is met:

- The file was opened with write permissions using the UPDATE keyword to the IDLffShape::Open method
- It is a newly created file that has not been written previously.

**Note**

Cleanup methods are special lifecycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLffShape::]Cleanup (Only in subclass' Cleanup method.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.4

# IDLffShape::Close

The IDLffShape::Close procedure method closes a Shapefile. If the file has been modified, it is also written to the disk if neither of the following conditions is met:

- The file was opened with write permissions using the UPDATE keyword to the IDLffShape::Open method
- It is a newly created file that has not been written previously.

If the file has been modified and one of the previous conditions is not met, the file is closed and the changes are not written to disk.

## Syntax

*Obj* -> [IDLffShape::]Close

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.4

# IDLffShape::DestroyEntity

The IDLffShape::DestroyEntity procedure method frees memory associated with the entity structure. For more information on the entity structure, see “Entities” on page 2644.

## Syntax

*Obj* -> [IDLffShape::]DestroyEntity, *Entity*

## Arguments

### Entity

A scalar or array of entities to be destroyed.

## Keywords

None

## Examples

In the following example, all of the entities from the `states.shp` Shapefile are read and then the DestroyEntity method is called to clean up all pointers:

```
PRO ex_shapefile

; Open the states Shapefile in the examples directory.
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

; Get the number of entities so we can parse through them.
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent

; Read all the entities.
FOR x=1, (num_ent-1) DO BEGIN
   ;Read the entity x
   ent = myshape -> IDLffShape::GetEntity(x)
   ;Clean-up of pointers
   myshape -> IDLffShape::DestroyEntity, ent
ENDFOR

; Close the Shapefile.
OBJ_DESTROY, myshape
```

```
END
```

## Version History

Introduced: 5.4

# IDLffShape::GetAttributes

The IDLffShape::GetAttributes function method retrieves the attributes for the entities you specify from a Shapefile.

## Syntax

*Result* = *Obj* -> [IDLffShape::]GetAttributes([*Index*] [, /ALL] [, /ATTRIBUTE_STRUCTURE] )

## Return Value

Returns an anonymous structure array. For more information on the structure, see "Attributes" on page 2648.

## Arguments

### Index

A scalar or array of longs specifying the entities for which you want to retrieve the attributes, with 0 being the first entity in the Shapefile.

**Note**

If you do not specify *Index* and the ALL keyword is not set, the attributes for the first entity (0) are returned.

## Keywords

### ALL

Set this keyword to retrieve the attributes for all entities in a Shapefile. If you set this keyword, the *Index* argument is not required.

### ATTRIBUTE_STUCTURE

Set this keyword to return an empty attribute structure that can then be used with the IDLffShape::SetAttributes method to add attributes to a Shapefile.

## Examples

In the first example, we retrieve the attributes associated with entity at location 0 (the first entity in the file):

```
attr = myShape->getAttributes( 0)
```

In the next example, we retrieve the attributes associated with entities 10 through 20:

```
attr = myShape->getAttributes( 10+indgen(11) )
```

In the next example, we retrieve the attributes for entities 1,4, 9 and 70:

```
attr = myShape->getAttributes( [1, 4, 9, 70] )
```

In the next example, we retrieve all the attributes for a Shapefile:

```
attr = myShape->getAttributes( /ALL )
```

## Version History

Introduced: 5.4

# IDLffShape::GetEntity

The IDLffShape::GetEntity function method returns the entities you specify from a Shapefile.

## Syntax

*Result* = *Obj* -> [IDLffShape::]GetEntity([*Index*] [, /ALL] [, /ATTRIBUTES])

## Return Value

Returns a type {IDL_SHAPE_ENTITY} structure array. For more information on the structure, see “Entities” on page 2644.

**Note**

Since an entity structure contains IDL pointers, you must free all the pointers returned in these structures when the entity is no longer needed using the IDLffShape::DestroyEntity method.

**Note**

Since entities cannot be modified in a Shapefile, an entity is read directly from the Shapefile each time you use the IDLffShape::GetEntity method even if you have already read that entity. If you modify the structure array returned by this method for a given entity and then use IDLffShape::GetEntity on that same entity, the modified data will NOT be returned, the data that is actually written in the file is returned.

## Arguments

### Index

A scalar or array of longs specifying the entities for which you want to retrieve with 0 being the first entity in the Shapefile. If the ALL keyword is set, this argument is not required. If you do not specify any entities and the ALL keyword is not set, the first entity (0) is returned.

# Keywords

## ALL

Set this keyword to retrieve all entities from the Shapefile. If this keyword is set, the Index argument is not required.

## ATTRIBUTES

Set this keyword to return the attributes in the entity structure. If not set, the ATTRIBUTES tag in the entity structure will be a null IDL pointer.

# Examples

In the following example, all of the entities from the `states.shp` Shapefile are read:

```
PRO ex_shapefile

; Open the states Shapefile in the examples directory.
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

; Get the number of entities so we can parse through them.
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent

; Read all the entities.
FOR x=1, (num_ent-1) DO BEGIN
   ;Read the entity x
   ent = myshape -> IDLffShape::GetEntity(x)
   ;Clean-up of pointers
   myshape -> IDLffShape::DestroyEntity, ent
ENDFOR

; Close the Shapefile.
OBJ_DESTROY, myshape

END
```

# Version History

Introduced: 5.4

# IDLffShape::GetProperty

The IDLffShape::GetProperty procedure method returns the values of properties associated with a Shapefile object. These properties are:

- Number of entities
- The type of the entities
- The number of attributes associated with each entity
- The names of the attributes
- The name, type, width, and precision of the attributes
- The status of a Shapefile
- The filename of the Shapefile object

## Syntax

*Obj* -> [IDLffShape::]GetProperty [, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLffShape Properties” on page 2654 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Examples

In the following example, the number of entities and the entity type is returned:

```
PRO entity_info

; Open the states Shapefile in the examples directory.
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

; Get the number of entities and the entity type.
myshape -> IDLffShape::GetProperty, N_ENTITIES=num_ent, $
   ENTITY_TYPE=ent_type
```

```
; Print the number of entities and the type.
PRINT, 'Number of Entities: ', num_ent
PRINT, 'Entity Type: ', ent_type

; Close the Shapefile.
OBJ_DESTROY, myshape

END
```

This results in the following:

```
Number of Entities:       51
Entity Type:               5
```

In the next example, the definitions for attribute 1 are returned:

```
PRO attribute_info

; Open the states Shapefile in the examples directory.
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))

; Get the info for all attribute.
myshape -> IDLffShape::GetProperty, ATTRIBUTE_INFO=attr_info

; Print Attribute Info.
PRINT, 'Attribute Number: ', '1'
PRINT, 'Attribute Name: ', attr_info[1].name
PRINT, 'Attribute Type: ', attr_info[1].type
PRINT, 'Attribute Width: ', attr_info[1].width
PRINT, 'Attribute Precision: ', attr_info[1].precision

; Close the Shapefile.
OBJ_DESTROY, myshape

END
```

This results in the following:

```
Attribute Number:           1
Attribute Name:    STATE_NAME
Attribute Type:             7
Attribute Width:           25
Attribute Precision:        0
```

## Version History

Introduced: 5.4

N_RECORDS keyword: 5.6

# IDLffShape::Init

The IDLffShape::Init function method initializes or constructs a Shapefile object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Result* = OBJ_NEW('IDLffShape' [, *Filename*] [, *PROPERTY=value*])

or

*Result = Obj* `->` [IDLffShape::]Init([, *Filename*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Filename

A scalar string containing the full path and filename of a Shapefile (`.shp`) to open. If this file exists, it is opened. If the file does not exist, a new Shapefile object is constructed. You do not need to use IDLffShape::Open to open an existing file when specifying this keyword.

**Note**

The `.shp`, `.shx`, and `.dbx` files must exist in the same directory for you to be able to open and access the file unless the UPDATE keyword is set.

## Keywords

Any property listed under “IDLffShape Properties” on page 2654 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Examples

In the following example, we create a new Shapefile object and open the `examples/data/states.shp` file:

```
myshape=OBJ_NEW('IDLffShape', FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']))
```

## Version History

Introduced: 5.4

DBF_ONLY keyword: 5.6

# IDLffShape::Open

The IDLffShape::Open function method opens a specified Shapefile.

## Syntax

*Result* = *Obj* -> [IDLffShape::]Open( *'Filename'* [, /DBF_ONLY] [, /UPDATE] [, ENTITY_TYPE=*'value'*] )

## Return Value

Returns 1 if the file can be read successfully. If not able to open the file, it returns 0.

## Arguments

### Filename

A scalar string containing the full path and filename of a Shapefile (`.shp`) to open. Note that the `.shp`, `.shx`, and `.dbx` files must exist in the same directory for you to be able to open and access the file unless the UPDATE keyword is set.

## Keywords

### DBF_ONLY

If this keyword is set to a positive value, only the underlying dBASE table (`.dbf`) component of the shapefile is opened. All entity related files are left closed. Two values to this keyword are accepted: 1 - Open an existing `.dbf` file, > 1 - Create a new `.dbf` file

The UPDATE keyword is required to open the `.dbf` file for updating.

### UPDATE

Set this keyword to have the file opened for writing. The default is read-only.

### ENTITY_TYPE

Set this keyword to the entity type of a new Shapefile. Use this keyword only when creating a new Shapefile. For more information on entity types, see "Entities" on page 2644.

## Examples

In the following example, the file `examples/data/states.shp` is opened for reading and writing:

```
status = myShape->Open(FILEPATH('states.shp', $
   SUBDIR=['examples', 'data']), /UPDATE)
```

## Version History

Introduced: 5.4

DBF_ONLY keyword: 5.6

# IDLffShape::PutEntity

The IDLffShape::PutEntity procedure method inserts an entity into the Shapefile object. The entity must be in the proper structure. For more information on the structure, see “Entities” on page 2644.

**Note**

The shape type of the new entity must be the same as the shape type defined for the Shapefile. If the shape type has not been defined for the Shapefile using the ENTITY_TYPE keyword for the IDLffShape::Open or IDLffShape::Init methods, the first entity that is inserted into the Shapefile defines the type.

**Note**

Only new entities can be inserted into a Shapefile. Existing entities cannot be updated.

## Syntax

*Obj* -> [IDLffShape::]PutEntity, *Data*

## Arguments

### Data

A scalar or an array of entity structures.

## Keywords

None

## Examples

In the following example, we create a new shapefile, define a new entity, and then use the PutEntity method to insert it into the new file:

```
PRO ex_shapefile_newfile

; Create the new shapefile and define the entity type to Point.
mynewshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE, ENTITY_TYPE=1)
```

```
; Create structure for new entity.
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity.
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1458
entNew.BOUNDS[0] = -104.87270
entNew.BOUNDS[1] = 39.768040
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -104.87270
entNew.BOUNDS[5] = 39.768040
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

; Add the new entity to new shapefile.
mynewshape -> IDLffShape::PutEntity, entNew

; Close the shapefile.
OBJ_DESTROY, mynewshape

END
```

## Version History

Introduced: 5.4

# IDLffShape::SetAttributes

The IDLffShape::SetAttributes procedure method sets the attributes for a specified entity in a Shapefile object.

## Syntax

*Obj* -> [IDLffShape::]SetAttributes, *Index*, *Attribute_Num*, *Value*

or

*Obj* -> [IDLffShape::]SetAttributes, *Index*, *Attributes*

## Arguments

### Attribute_Num

The field number for the attribute whose value is being set. This value is 0-based.

### Attributes

An Attribute structure whose fields match the fields in the attribute table. If *Attributes* is an array, the entities specified in *Index*, up to the size of the Attributes array, are set. Using this feature, all the attribute values of a set of entities can be set for a Shapefile.

The type of this Attribute structure must match the type that is generated internally for Attribute table. To get a copy of this structure, either get the attribute set for an entity or get the definition using the ATTRIBUTE_STRUCTURE keyword of the IDLffShape::GetProperty method.

### Index

A scalar specifying the entity in which you want to set the attributes. The first entity in the Shapefile object is 0.

### Value

The value that the attribute is being set to. If the value is not of the correct type, type conversion is attempted.

If *Value* is an array and *Index* is a scalar, the value of record is treated as a starting point. Using this feature, all the attribute values of a specific field can be set for a Shapefile.

## Keywords

None

## Examples

In the following example, we create a new shapefile, define the attributes for the new file, define a new entity, define some attributes, insert the new entity, and then use the SetAttributes method to insert the attributes into the new file:

```
PRO ex_shapefile_newfile

; Create the new shapefile and define the entity type to Point.
mynewshape=OBJ_NEW('IDLffShape', FILEPATH('cities.shp', $
   SUBDIR=['examples', 'data']), /UPDATE, ENTITY_TYPE=1)

; Set the attribute definitions for the new Shapefile.
mynewshape->IDLffShape::AddAttribute, 'CITY_NAME', 7, 25, $
   PRECISION=0
mynewshape->IDLffShape::AddAttribute, 'STAT_NAME', 7, 25, $
   PRECISION=0

; Create structure for new entity.
entNew = {IDL_SHAPE_ENTITY}

; Define the values for the new entity
entNew.SHAPE_TYPE = 1
entNew.ISHAPE = 1458
entNew.BOUNDS[0] = -104.87270
entNew.BOUNDS[1] = 39.768040
entNew.BOUNDS[2] = 0.00000000
entNew.BOUNDS[3] = 0.00000000
entNew.BOUNDS[4] = -104.87270
entNew.BOUNDS[5] = 39.768040
entNew.BOUNDS[6] = 0.00000000
entNew.BOUNDS[7] = 0.00000000

; Create structure for new attributes.
attrNew = mynewshape ->IDLffShape::GetAttributes( $
/ATTRIBUTE_STRUCTURE)

; Define the values for the new attributes.
attrNew.ATTRIBUTE_0 = 'Denver'
attrNew.ATTRIBUTE_1 = 'Colorado'

; Add the new entity to new shapefile.
mynewshape -> IDLffShape::PutEntity, entNew
```

```
; Add the Colorado attributes to new shapefile.
mynewshape -> IDLffShape::SetAttributes, 0, attrNew

; Close the shapefile.
OBJ_DESTROY, mynewshape

END
```

## Version History

Introduced: 5.4

# IDLffXMLSAX

An IDLffXMLSAX object uses an XML SAX level 2 parser. The XML parser allows you to read an XML file and store arbitrary data from the file in IDL variables. The parser object's methods are *callbacks*. These methods are called automatically when the parser encounters different types of XML elements or attributes.

**Note**

To use the XML parser, you *must* write a subclass of this object class, overriding the object methods as necessary to process the data in a specific XML file or files. See Chapter 23, "Using the XML Parser Object Class" in the *Building IDL Applications* manual for further information and examples.

The IDLffXMLSAX object encapsulates the Xerces validating XML parser; see `http://xml.apache.org` for details.

## Superclasses

This class has no superclass.

## Subclasses

You *must* write a subclass of this object, overriding object methods as necessary to retrieve information from the XML file.

## Creation

See "IDLffXMLSAX::Init" on page 2705

## Properties

Objects of this class have the following properties. See "IDLffXMLSAX Properties" on page 2683 for details on individual properties.

- FILENAME
- NAMESPACE_PREFIXES
- PARSER_LOCATION
- PARSER_PUBLICID
- PARSER_URI

- SCHEMA_CHECKING
- VALIDATION_MODE

## Methods

This class has the following methods:

- IDLffXMLSAX::AttributeDecl
- IDLffXMLSAX::Characters
- IDLffXMLSAX::Cleanup
- IDLffXMLSAX::Comment
- IDLffXMLSAX::ElementDecl
- IDLffXMLSAX::EndCDATA
- IDLffXMLSAX::EndDocument
- IDLffXMLSAX::EndDTD
- IDLffXMLSAX::EndElement
- IDLffXMLSAX::EndEntity
- IDLffXMLSAX::EndPrefixMapping
- IDLffXMLSAX::Error
- IDLffXMLSAX::ExternalEntityDecl
- IDLffXMLSAX::FatalError
- IDLffXMLSAX::GetProperty
- IDLffXMLSAX::IgnorableWhitespace
- IDLffXMLSAX::Init
- IDLffXMLSAX::InternalEntityDecl
- IDLffXMLSAX::NotationDecl
- IDLffXMLSAX::ParseFile
- IDLffXMLSAX::ProcessingInstruction
- IDLffXMLSAX::SetProperty
- IDLffXMLSAX::SkippedEntity
- IDLffXMLSAX::StartCDATA

- IDLffXMLSAX::StartDocument
- IDLffXMLSAX::StartDTD
- IDLffXMLSAX::StartElement
- IDLffXMLSAX::StartEntity
- IDLffXMLSAX::StartPrefixmapping
- IDLffXMLSAX::StopParsing
- IDLffXMLSAX::UnparsedEntityDecl
- IDLffXMLSAX::Warning

## Version History

Introduced: 5.6

# IDLffXMLSAX Properties

IDLffXMLSAX objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLffXMLSAX::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLffXMLSAX::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLffXMLSAX::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## FILENAME

A string containing the filename of the XML file being parsed.

**Note**

This property is only available during a parse operation.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## NAMESPACE_PREFIXES

A Boolean value indicating whether namespace prefixes are enabled. Namespace prefixes are enabled if this property is set to true. By default, namespace prefixes are disabled.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PARSER_LOCATION

A two-element array containing the approximate location of the parser within the entity being parsed. The first element of the array is set to the line number and the second element is set to the column number.

**Note**

This property is only available during a parse operation

| | | | |
|---|---|---|---|
| **Property Type** | Array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## PARSER_PUBLICID

A string containing the Public ID for the entity being parsed, if it is available. If the Public ID is not available, an empty string is returned.

**Note**

This property is only available during a parse operation

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## PARSER_URI

A string containing the base URI (System ID) for the entity being parsed, if it is available. If the value is available, it is always an absolute URI. If the System ID is not available, an empty string is returned.

**Note**

This property can be used to identify the document or external entity in diagnostics, or to resolve relative URIs. However, it is only available during a parse operation.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## SCHEMA_CHECKING

An integer value to indicating the type of validation the parser should perform. XML *Schemas* describe the structure and allowed contents of an XML document. Schemas are more robust than, and are envisioned as a replacement for, DTDs. By default, the parser will validate the parsed XML file against the specified schema, if one is provided. If no schema is provided, no validation will occur. Possible values are:

| Value | Description |
|---|---|
| 0 | No validation. |
| 1 | Validate only if a schema is provided (the default). |
| 2 | Perform full schema constraint checking, if a schema is provided. This feature checks the schema grammar itself for additional errors. It does not affect the level of checking performed on document instances that use schema grammars. |

*Table 0-23: SCHEMA_CHECKING Values*

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## VALIDATION_MODE

An integer value indicating the type of XML validation that the parser should perform. XML *Document Type Definitions* (DTDs) describe the structure and allowed contents of an XML document. By default, the parser will validate the parsed XML file against the specified DTD, if one is provided; if no DTD is provided, no validation will occur. Possible values are:

| Value | Description |
|---|---|
| 0 | No validation. |
| 1 | Validate only if a DTD is provided (the default). |

*Table 0-24: VALIDATION_MODE Values*

| Value | Description |
|---|---|
| 2 | Always perform validation. If this option is in force and no DTD is provided, every XML element in the document will generate an error. |

*Table 0-24: VALIDATION_MODE Values*

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLffXMLSAX::AttributeDecl

The IDLffXMLSAX::AttributeDecl procedure method is called when the parser detects an `<!ATTLIST ...>` declaration in a DTD. This method is called once for each attribute declared by the tag.

## Syntax

*Obj* -> [IDLffXMLSAX::]AttributeDecl, *eName, aName, Type, Mode, Value*

## Arguments

### eName

A string containing the name of the element for which the attribute is being declared.

### aName

A string containing the name of the attribute being declared.

### Type

A string that specifying the type of attribute being defined. Possible values are:

- 'CDATA'
- 'ID'
- 'IDREF'
- 'IDREFS'
- 'NMTOKEN'
- 'NMTOKENS'
- 'ENTITY'
- 'ENTITIES'

or two types of enumerated values. Enumerated values are encoded with parenthesized strings such as `(a|b|c)` to indicate that strings `a`, `b`, or `c` are permissible. If the string is an enumeration of notation names, the string `"NOTATION "` (note the space after the second “N”) precedes the parenthesized string.

### Mode

A string specifying restrictions on the value of the attribute. Possible values are:

- '#IMPLIED' - the application determines the value
- '#REQUIRED' - the value must be given; defaulting is not permitted
- '#FIXED' - only one value is permitted
- '' - a null string (the value specified by the *Value* argument is used as the default)

### Value

A string containing the default value for the attribute. If *Value* contains a null string, no default value was specified.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::Characters

The IDLffXMLSAX::Characters procedure method is called when the parser detects text in the parsed document.

## Syntax

*Obj* -> [IDLffXMLSAX::]Characters, *Chars*

## Arguments

### Chars

A string containing the text detected by the parser.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::Cleanup

The IDLffXMLSAX::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. In most cases, you cannot call the Cleanup method directly. However, one exception to this rule does exist. If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLffXMLSAX::]Cleanup(*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::Comment

The IDLffXMLSAX::Comment procedure method is called when the parser detects a comment section of the form <!-- ... -->.

## Syntax

*Obj* -> [IDLffXMLSAX::]Comment, *Comment*

## Arguments

### Comment

A string containing the text within the detected comment section, without the delimiting characters ("<!--" and "-->").

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::ElementDecl

The IDLffXMLSAX::ElementDecl procedure method is called when the parser detects an `<!ELEMENT ...>` declaration in the DTD.

## Syntax

*Obj* `->` [IDLffXMLSAX::]ElementDecl, *Name*, *Model*

## Arguments

### Name

A string containing the name of the element.

### Model

A string containing the *content model* (sometimes called the *content specification*) for the element, with all whitespace removed.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::EndCDATA

The IDLffXMLSAX::EndCDATA procedure method is called when the parser detects the end of a `<![CDATA[...]]>` text section.

## Syntax

*Obj* `->` [IDLffXMLSAX::]EndCDATA

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::EndDocument

The IDLffXMLSAX::EndDocument procedure method is called when the parser detects the end of the XML document.

## Syntax

*Obj* -> [IDLffXMLSAX::]EndDocument

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::EndDTD

The IDLffXMLSAX::EndDTD procedure method is called when the parser detects the end of a Document Type Definition (DTD).

## Syntax

*Obj* -> [IDLffXMLSAX::]EndDTD

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::EndElement

The IDLffXMLSAX::EndElement procedure method is called when the parser detects the end of an element.

## Syntax

*Obj* -> [IDLffXMLSAX::]EndElement, *URI*, *Local*, *qName*

## Arguments

### URI

A string containing the namespace URI with which the element is associated, if any.

**Note**

A URI (or Uniform Resource Identifier) refers to the generic set of all names and addresses which are short strings which refer to objects.

### Local

A string containing the element name with any prefix removed, if the element is associated with a namespace URI. If the element is not associated with a namespace URI, this variable will contain an empty string.

### qName

A string containing the element name found in the XML file.

**Note**

If the element is associated with a namespace URI, this variable may contain an empty string.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::EndEntity

The IDLffXMLSAX::EndEntity procedure method is called when the parser detects the end of an internal or external entity expansion.

## Syntax

*Obj* -> [IDLffXMLSAX::]EndEntity, *Name*

## Arguments

### Name

A string containing the name of the entity.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::EndPrefixMapping

The IDLffXMLSAX::EndPrefixMapping procedure method is called when a previously declared prefix mapping goes out of scope.

## Syntax

*Obj* -> [IDLffXMLSAX::]EndPrefixMapping, *Prefix*

## Arguments

### Prefix

A string containing the namespace prefix that is going out of scope.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::Error

The IDLffXMLSAX::Error procedure method is called when the parser detects an error that is not expected to be fatal. This method prints an IDL error string to the IDL output log and allows the parser to continue processing.

For example, a violation of XML validity constraints is generally a non-fatal error.

**Note**

This method will cause error messages to be printed to the IDL output log. If you would like your application to hide error messages from the user (or display them in some other fashion), override this method in your subclass of the IDLffXMLSAX object class. If you do override this method, the error message will not be printed to the output log unless you explicitly call the superclass method.

# Syntax

*Obj* -> [IDLffXMLSAX::]Error, *SystemID*, *LineNumber*, *ColumnNumber*, *Message*

# Arguments

## SystemID

A string containing the URI of the associated text.

## LineNumber

A longword integer representing the line number that contains the error.

## ColumnNumber

A longword integer representing the column number that contains the error.

## Message

A string containing the error message sent to the IDL output log.

# Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::ExternalEntityDecl

The IDLffXMLSAX::ExternalEntityDecl procedure method is called when the parser detects an `<!ENTITY ...>` declarations in the DTD for a parsed external entity.

## Syntax

*Obj* `->` [IDLffXMLSAX::]ExternalEntityDecl, *Name*, *PublicID*, *SystemID*

## Arguments

### Name

A string containing the entity name.

### PublicID

A string containing the Public ID for the entity.

**Note**

If this value is not specified in the entity declaration, this variable will contain an empty string.

### SystemID

A string containing the System ID for the entity, provided as an absolute URI.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::FatalError

The IDLffXMLSAX::FatalError procedure method is called when the parser detects a fatal error. When called, parsing will normally stop, but may sometimes continue long enough to report further errors. This method prints an IDL error string to the IDL output log.

## Syntax

*Obj* -> [IDLffXMLSAX::]FatalError, *SystemID*, *LineNumber*, *ColumnNumber*, *Message*

## Arguments

### SystemID

A string containing the URI of the associated text.

### LineNumber

A longword integer representing the line number that contains the error.

### ColumnNumber

A longword integer representing the column number that contains the error.

### Message

A string containing the error message sent to the IDL output log.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::GetProperty

The IDLffXMLSAX::GetProperty procedure method is used to get the values of various properties of the parser.

## Syntax

*Obj* -> [IDLffXMLSAX::]GetProperty [, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLffXMLSAX Properties” on page 2683 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 5.6

# IDLffXMLSAX::IgnorableWhitespace

The IDLffXMLSAX::IgnorableWhitespace procedure method is called when the parser detects whitespace that separates elements in an element content model.

## Syntax

*Obj* -> [IDLffXMLSAX::]IgnorableWhitespace, *Chars*

## Arguments

### Chars

A string containing the whitespace detected by the parser. Whitespace can consist of spaces, tabs, or newline characters in any combination.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::Init

The IDLffXMLSAX::Init function method initializes an XML parser object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. In most cases, you cannot call the Init method directly. However, one exception to this rule does exist. If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLffXMLSAX' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLffXMLSAX::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLffXMLSAX Properties" on page 2683 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.6

# IDLffXMLSAX::InternalEntityDecl

The IDLffXMLSAX::InternalEntityDecl procedure method is called when the parser detects an `<!ENTITY ...>` declaration in a DTD for (parsed) internal entities. The entity can be either a general entity or a parameter entity.

## Syntax

*Obj* `->` [IDLffXMLSAX::]InternalEntityDecl, *Name*, *Value*

## Arguments

### Name

A string containing the entity name. Names that start with the "%" character are parameter entities; all others are general entities.

### Value

A string containing the entity value. The entity value can contain arbitrary XML content, which will be reparsed when the entity is expanded.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::NotationDecl

The IDLffXMLSAX::NotationDecl procedure method is called when the parser detects a `<!NOTATION ...>` declaration in a DTD.

## Syntax

*Obj* `->` [IDLffXMLSAX::]NotationDecl, *Name*, *PublicID*, *SystemID*

## Arguments

### Name

A string containing the notation name.

### PublicID

A string containing the Public ID for the notation.

**Note**

If this value is not specified in the notation declaration, this variable will contain an empty string.

### SystemID

A string containing the System ID for the notation, provided as an absolute URI.

**Note**

If this value is not specified in the notation declaration, this variable will contain an empty string.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::ParseFile

The IDLffXMLSAX::ParseFile procedure method parses the specified XML file. During the parsing operation, different object methods are called as different items within the XML file are detected. When this method returns, the parse operation is complete.

## Syntax

*Obj* -> [IDLffXMLSAX::]ParseFile, *Filename*

## Arguments

### Filename

A string containing the full path name of the XML file to parse.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::ProcessingInstruction

The IDLffXMLSAX::ProcessingInstruction procedure method is called when the parser detects a processing instruction.

## Syntax

*Obj* -> [IDLffXMLSAX::]ProcessingInstruction, *Target*, *Data*

## Arguments

### Target

A string specifying the target, which is the application that should process the instruction.

### Data

A string specifying the data to be passed to the application specified by *Target*.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::SetProperty

The IDLffXMLSAX::SetProperty procedure method is used to set the values of various properties of the parser.

## Syntax

*Obj* -> [IDLffXMLSAX::]SetProperty [, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLffXMLSAX Properties” on page 2683 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.6

# IDLffXMLSAX::SkippedEntity

The IDLffXMLSAX::SkippedEntity procedure method is called when the parser skips an entity and validation is not being performed. This method is rarely called by SAX parsers.

## Syntax

*Obj* -> [IDLffXMLSAX::]SkippedEntity, *Name*

## Arguments

### Name

A string containing the name of the entity that was skipped.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::StartCDATA

The IDLffXMLSAX::StartCDATA procedure method is called when the parser detects the beginning of a `<![CDATA[...]]>` text section.

## Syntax

*Obj* `->` [IDLffXMLSAX::]StartCDATA

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::StartDocument

The IDLffXMLSAX::StartDocument procedure method is called when the parser begins processing a document, and before any data is processed.

## Syntax

*Obj* -> [IDLffXMLSAX::]StartDocument

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::StartDTD

The IDLffXMLSAX::StartDTD procedure method is called when the parser detects the beginning of a Document Type Definition (DTD).

## Syntax

*Obj* -> [IDLffXMLSAX::]StartDTD, *Name*, *PublicID*, *SystemID*

## Arguments

### Name

A string containing the declared name of the root element for the document.

### PublicID

A string containing the *normalized* version of the Public ID (a URI) declared for the external subset, or an empty string if no external subset was declared. *Normalization* involves removal of unnecessary “.” and “..” segments from the URI.

### SystemID

A string containing the System ID (a URI) of the external subset, or an empty string if no external subset was declared.

**Note**

This URI has not been resolved into an absolute URI.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::StartElement

The IDLffXMLSAX::StartElement procedure method is called when the parser detects the beginning of an element.

## Syntax

*Obj* -> [IDLffXMLSAX::]StartElement, *URI*, *Local*, *qName* [, *attName*, *attValue*]

## Arguments

### URI

A string containing the namespace URI with which the element is associated, if any.

### Local

A string containing the element name with any prefix removed, if the element is associated with a namespace URI. If the element is not associated with a namespace URI, this variable will contain an empty string.

### qName

A string containing the element name found in the XML file.

**Note**

If the element is associated with a namespace URI, this variable may contain an empty string.

### attrName

A string array representing the names of the attributes associated with the element, if any.

### attrValue

A string array representing the values of each attribute associated with the element, if any. The returned array will have the same number of elements as the array returned in the *attrName* keyword variable.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::StartEntity

The IDLffXMLSAX::StartEntity procedure method is called when the parser detects the start of an internal or external entity expansion.

## Syntax

*Obj* -> [IDLffXMLSAX::]StartEntity, *Name*

## Arguments

### Name

A string containing the name of the entity.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::StartPrefixmapping

The IDLffXMLSAX::StartPrefixMapping procedure method is called when the parser detects the beginning of a namespace declaration.

## Syntax

*Obj* -> [IDLffXMLSAX::]StartPrefixmapping, *Prefix*, *URI*

## Arguments

### Prefix

A string containing the prefix, which is being mapped. If the variable specified by *Prefix* contains an empty string, the mapping is for the default element namespace.

### URI

A string containing the URI of the prefix namespace.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::StopParsing

Call the IDLffXMLSAX::StopParsing procedure method during a parse operation to halt the operation and cause the ParseFile method to return. This may be useful when parsing large XML files and the desired information is known to have been returned.

## Syntax

*Obj* -> [IDLffXMLSAX::]StopParsing

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::UnparsedEntityDecl

The IDLffXMLSAX::UnparsedEntityDecl procedure method is called when the parser detects an `<!ENTITY ...>` declaration that includes the NDATA keyword, indicating that the entity is not meant to be parsed. The value of the NDATA keyword generally specifies the name of a *notation*, which in turn specifies the type of data.

## Syntax

*Obj* `->` [IDLffXMLSAX::]UnparsedEntityDecl, *Name*, *PublicID*, *SystemID*, *Notation*

## Arguments

### Name

A string containing the name of the unparsed entity.

### PublicID

A string containing the Public ID of the notation specified by the entity's NDATA keyword, or an empty string if no Public ID was declared.

### SystemID

A string containing the System ID of the notation specified by the entity's NDATA keyword. This value is normally an absolute URI.

### Notation

A string containing the name of the notation specified by the entity's NDATA keyword.

## Keywords

None

## Version History

Introduced: 5.6

# IDLffXMLSAX::Warning

The IDLffXMLSAX::Warning procedure method is called when the parser detects a problem during processing. This method prints an IDL error string to the IDL output log and allows the parser to continue processing.

**Note**

This method will cause error messages to be printed to the IDL output log. If you would like your application to hide error messages from the user (or display them in some other fashion), override this method in your subclass of the IDLffXMLSAX object class. If you do override this method, the error message will not be printed to the output log unless you explicitly call the superclass method.

# Syntax

*Obj* -> [IDLffXMLSAX::]Warning, *SystemID*, *LineNumber*, *ColumnNumber*, *Message*

# Arguments

## SystemID

A string containing the URI of the text that generated the error.

## LineNumber

A longword integer representing the line number that contains the error.

## ColumnNumber

A longword integer representing the column number that contains the error.

## Message

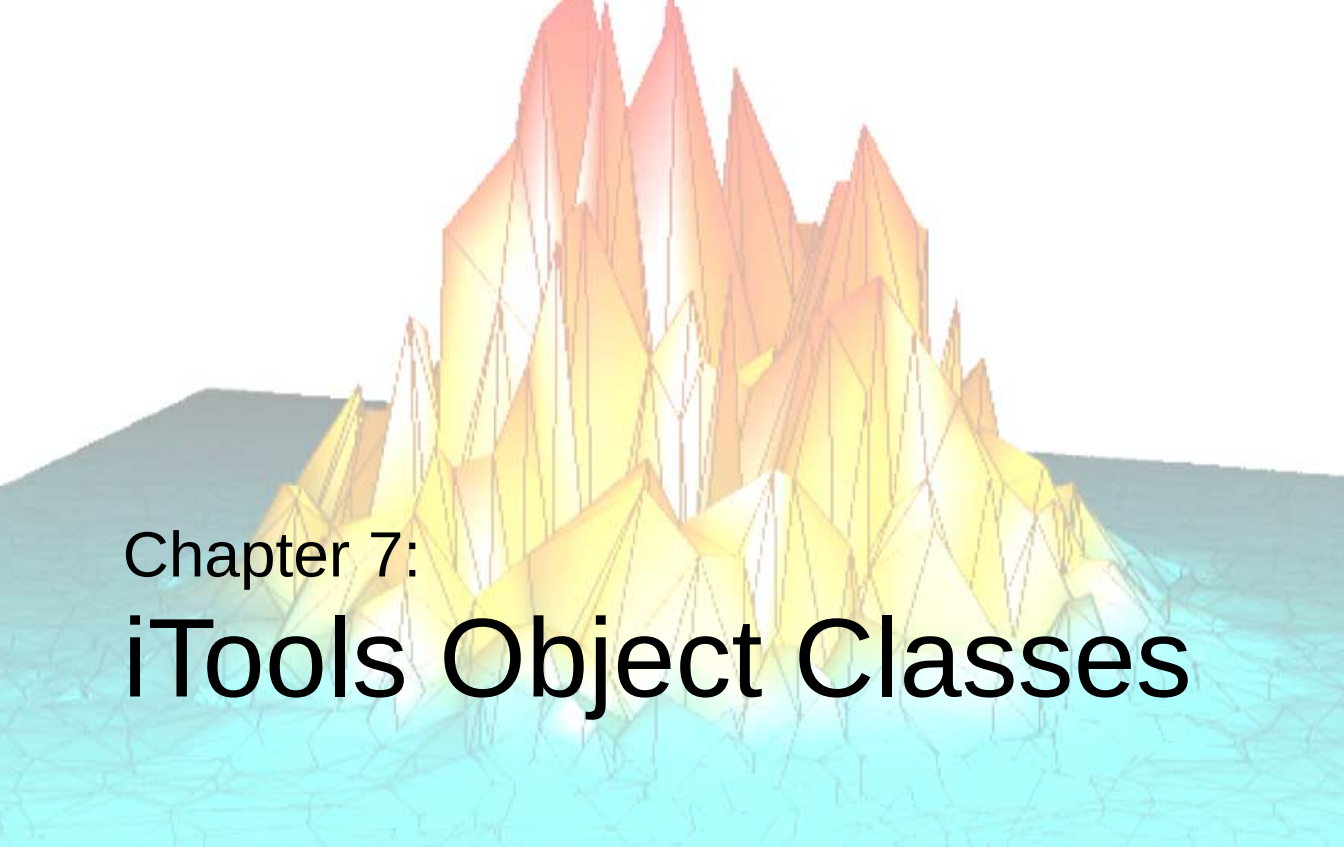
A string containing the error message.

# Keywords

None

## Version History

Introduced: 5.6



# Chapter 7: iTools Object Classes

This chapter describes IDL's built-in annotation class library.

# IDLitCommand

The IDLitCommand class provides a dynamic data dictionary storage system. Its methods and properties allow the iTool developer to store information about the execution of an iTool operation on a single target object. It provides a tag-based mechanism for storing and retrieving this information, which allows the iTool developer to easily implement undo and redo functionality for an operation.

This class is written in the IDL language. Its source code can be found in the file `idlitcommand__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitComponent

## Creation

See "IDLitCommand::Init" on page 2734.

## Properties

Objects of this class have the following properties. See "IDLitCommand Properties" on page 2727 for details on individual properties.

- TARGET_IDENTIFIER
- OPERATION_IDENTIFIER

In addition, objects of this class inherit the properties of the superclass of this class.

## Methods

This class has the following methods:

- IDLitCommand::AddItem
- IDLitCommand::Cleanup
- IDLitCommand::GetItem
- IDLitCommand::GetProperty
- IDLitCommand::GetSize

- IDLitCommand::Init
- IDLitCommand::SetProperty

In addition, this class inherits the methods of its superclass.

## Examples

See "Creating a New Generalized Operation" in Chapter 7 of the *iTool Developer's Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitCommand Properties

IDLitCommand objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLitCommand::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLitCommand::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLitCommand::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## TARGET_IDENTIFIER

The iTool identifier of the *target* object for this command. This is the item on which the operation associated with the command will execute.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## OPERATION_IDENTIFIER

The iTool identifier for the *operation* associated with this command. When an undo-redo operation takes place, the command object is passed to this operation.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLitCommand::AddItem

The IDLitCommand::AddItem function method adds the specified data item to the data dictionary associated with this object.

**Note**

If a data item with the specified identifying string is already in the data dictionary, the new value is not added unless the OVERWRITE keyword is set, in which case the old value is discarded.

## Syntax

*Result* = *Obj* -> [IDLitCommand::]AddItem(*StrItem, Item*[, /OVERWRITE])

## Return Value

Returns 1 if the item was successfully added to the data dictionary, or 0 if the new value was not added.

## Arguments

### StrItem

A scalar string used to identify the data specified by the *Item* argument in the data dictionary. This string is treated in a case-insensitive manner.

### Item

A data item of any IDL data type.

## Keywords

### OVERWRITE

Normally, if an item already exists in the data dictionary of an IDLitCommand object, it is not overwritten. If this keyword is set, the original value will be overwritten.

**Note**

If the item being replaced uses dynamic memory (that is, if it is a pointer or object reference), the memory must be released by calling PTR_FREE or OBJ_DESTROY before overwriting the value.

## Version History

Introduced: 6.0

# IDLitCommand::Cleanup

The IDLitCommand::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitCommand::]Cleanup() *(In a subclass' Init method only.)*

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitCommand::GetItem

The IDLitCommand::GetItem function method retrieves the specified item from the data dictionary associated with this object.

## Syntax

*Result* = *Obj* -> [IDLitCommand::]GetItem(*StrItem*, *Item*)

## Return Value

Returns 1 if the *Item* is retrieved successfully, or 0 if *Item* is not found in the data dictionary.

## Arguments

### StrItem

A scalar string used to identify the data to be retrieved from the data dictionary. This string is treated in a case-insensitive manner.

### Item

A named IDL variable that will contain the IDLitData object retrieved from the data dictionary.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitCommand::GetProperty

The IDLitCommand::GetProperty procedure method retrieves the value of a property or group of properties of a command object.

## Syntax

*Obj* -> [IDLitCommand::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitCommand Properties” on page 2727 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s super-class.

## Version History

Introduced: 6.0

# IDLitCommand::GetSize

The IDLitCommand::GetSize function method returns an approximate value for the amount of memory being used by the items in the data dictionary associated with this object.

## Syntax

*Result* = *Obj* -> [IDLitCommand::]GetSize([, /KILOBYTES])

## Return Value

Returns the number of bytes of memory used by the data dictionary associated with this object. The returned value is an approximation.

## Arguments

None

## Keywords

### KILOBYTES

Set this keyword to return the number of kilobytes of memory being used by the data dictionary. By default, this function returns the number of bytes of memory being used.

## Version History

Introduced: 6.0

# IDLitCommand::Init

The IDLitCommand::Init function method initializes the object and allows specification of items associated with it.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitCommand' [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLitCommand::]Init([*PROPERTY=value*])
*(In a subclass' Init method only.)*

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLitCommand Properties" on page 2727 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object (IDLitComponent).

## Version History

Introduced: 6.0

# IDLitCommand::SetProperty

The IDLitCommand::SetProperty procedure method sets the value of a property or group of properties for the command object.

## Syntax

*Obj* -> [IDLitCommand::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitCommand Properties” on page 2727 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitCommandSet

The IDLitCommandSet class stores a collection of IDLitCommand objects, allowing a group of commands to be managed as a single item. Command sets are useful as containers for IDLitCommand objects generated by the application of an iTool operation to multiple target items; the generated command set objects are used to provide undo/redo functionality to the iTool system.

This class is written in the IDL language. Its source code can be found in the file `idlitcommandset__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

TrackBall

IDLitCommand

## Creation

See "IDLitCommandSet::Init" on page 2742.

## Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

## Methods

This class has the following methods:

- IDLitCommandSet::Cleanup
- IDLitCommandSet::GetSize
- IDLitCommandSet::Init

In addition, this class inherits the methods of its superclasses.

## Examples

See "Creating a New Generalized Operation" in Chapter 7 of the *iTool Developer's Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitCommandSet Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

# IDLitCommandSet::Cleanup

The IDLitCommandSet::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, Obj

or

*Obj* -> [IDLitCommandSet::]Cleanup() (*In a subclass' Init method only.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitCommandSet::GetSize

The IDLitCommandSet::GetSize function method returns an approximate value for the amount of memory being used by the items contained by this command set. When called, the method will call the GetSize method on all of the command objects that it contains and generate a sum of the values.

## Syntax

*Result* = *Obj* -> [IDLitCommand::]GetSize([/KILOBYTES])

## Return Value

Returns the number of bytes of memory used by the data dictionary associated with this object. The returned value is an approximation.

## Arguments

None

## Keywords

### KILOBYTES

Set this keyword to return the number of kilobytes of memory being used. By default, this function returns the number of bytes of memory being used.

## Version History

Introduced: 6.0

# IDLitCommandSet::Init

The IDLitCommandSet::Init function method initializes the object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitCommandSet')

or

*Result* = *Obj* -> [IDLitCommandSet::]Init() (*In a subclass' Init method only.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

All keywords are passed to the superclass of this object (IDLitCommand).

## Version History

Introduced: 6.0

# IDLitComponent

The IDLitComponent class is the base component from which all iTool components should subclass. The IDLitComponent class provides support for property descriptors and property registration, and defines properties that are common to all iTool component objects.

**Note**

This class is now a superclass of all the atomic graphical (IDLgr*) object classes.

## Superclasses

This class has no superclasses.

## Creation

See "IDLitComponent::Init" on page 2755.

## Properties

Objects of this class have the following properties. See "IDLitComponent Properties" on page 2745 for details on individual properties.

- DESCRIPTION
- HELP
- ICON
- IDENTIFIER
- NAME
- UVALUE

## Methods

This class has the following methods:

- IDLitComponent::Cleanup
- IDLitComponent::EditUserDefProperty
- IDLitComponent::GetFullIdentifier

- IDLitComponent::GetProperty
- IDLitComponent::GetPropertyAttribute
- IDLitComponent::GetPropertyByIdentifier
- IDLitComponent::Init
- IDLitComponent::QueryProperty
- IDLitComponent::RegisterProperty
- IDLitComponent::SetProperty
- IDLitComponent::SetPropertyAttribute
- IDLitComponent::SetPropertyByIdentifier

## Version History

Introduced: 6.0

# IDLitComponent Properties

IDLitComponent objects have the following properties. Properties with the word "Yes" in the "Get" column of the property table can be retrieved via IDLitComponent::GetProperty. Properties with the word "Yes" in the "Init" column of the property table can be set via IDLitComponent::Init. Properties with the word "Yes" in the "Set" column in the property table can be set via IDLitComponent::SetProperty.

**Note**

For a discussion of the property description tables shown below, see "About Object Property Descriptions" on page 2505.

## DESCRIPTION

A string giving the full name or description of this object.

| | | | |
|---|---|---|---|
| **Property Type** | STRING | | |
| **Name String** | Description | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ICON

A string specifying the name of an icon to be associated with this object. Typically, this property is the name of a bitmap file used when displaying this object in a tree view. See "System Resources" in Chapter 2 of the *iTool Developer's Guide* manual for details.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HELP

A scalar string representing the help topic associated with this object. If this property is not set, or is set to a null string, then the object class name will be used as the default help topic.

| | |
|---|---|
| **Property Type** | String |

| **Name String** | *not displayed* | | |
|---|---|---|---|
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## IDENTIFIER

A string containing the *object identifier* for this object. If this property is not specified, then the NAME property is used as the identifier. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for details about how identifiers are named.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## NAME

A string giving the human-readable name of this object.

| **Property Type** | STRING | | |
|---|---|---|---|
| **Name String** | Name | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PRIVATE

A boolean value that indicates whether the object should be marked as private. Objects marked private (and all of their children) are not displayed in the graphical iTool browser windows.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## UVALUE

A value of any type containing any information you wish. If you set this user value equal to a pointer or object reference that does not belong to a container, you should

explicitly destroy that pointer or object reference when destroying the object of which this property is a user value.

| | | | |
|---|---|---|---|
| **Property Type** | User Defined | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLitComponent::Cleanup

The IDLitComponent::Cleanup procedure method performs all cleanup on the object, and should be called by the Cleanup method of a subclass.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitComponent::]Cleanup (*only in subclass' Cleanup method*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitComponent::EditUserDefProperty

The IDLitComponent::EditUserDefProperty function method defines the interface that is displayed when a user selects the “Edit” button on a user-defined property in the property sheet interface. Typically, this method will display an interactive dialog that allows the user to change the value of the property.

**Note**

An iTool object class that includes a user-defined property *must* implement this method if the property is displayed in a property sheet — that is, if the property is registered and not hidden. If an iTool object class has no user-defined properties that are displayed in a property sheet, there is no need to supply an EditUserDefProperty method.

See “User Defined Property Types” in Chapter 4 of the *iTool Developer’s Guide* manual for a discussion of how the property sheet interface displays user-defined properties.

## Syntax

*Result* = *Obj* -> [IDLitComponent::] EditUserDefProperty(*iTool*, *PropertyIdentifier*)

## Return Value

Returns a 1 if the property value was changed, or a 0 if the property value was not changed.

**Note**

If the return value is 1, the property sheet interface automatically updates the displayed property value using the value of the property’s USERDEF attribute. If the return value is 0, no update takes place.

## Arguments

### iTool

An object reference to the current iTool object.

### PropertyIdentifier

A string containing the property identifier of the user-defined property.

**Tip**

Since there can only be one EditUserDefProperty method for each class, you can use the *PropertyIdentifier* argument to determine which user-defined property is being edited.

## Keywords

None

## Example

The following is the EditUserDefProperty method of the IDLitOpConvolution operation class. Selecting and editing the Kernel property of this operation displays a dialog that allows the user to edit a convolution kernel.

```
FUNCTION IDLitopConvolution::EditUserDefProperty, oTool, $
   identifier

CASE identifier OF

   'KERNEL': RETURN, oTool -> DoUIService('ConvolKernel', self)

   ELSE:

ENDCASE

RETURN, 0

END
```

This method simply checks the property identifier to determine whether it matches the string `'KERNEL'`. If it does, it returns the value returned by the DoUIService method; otherwise it returns zero. In this case, the DoUIService method actually handles the modification of the property value. See “User Defined Property Types” in Chapter 4 of the *iTool Developer’s Guide* manual for additional discussion.

## Version History

Introduced: 6.0

# IDLitComponent::GetFullIdentifier

The IDLitComponent::GetFullIdentifier function method navigates the iTool object container hierarchy of the object on which it is called and retrieves the fully-qualified object identifier. The full identifier is constructed by recursively retrieving the parent object reference and prepending this to the identifier, separated by / characters. The parent must inherit from the IDLitContainer class. The full identifier string has the following form:

```
/TOPID/GRANDPARENTID/PARENTID/OBJID
```

If the *Objref* argument is specified, the function returns the object identifier path relative to the specified object.

See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for additional discussion of object identifiers.

## Syntax

*Result* = *Obj* -> [IDLitComponent::]GetFullIdentifier([*Objref*])

## Return Value

Returns a string containing the object identifier.

## Arguments

### Objref

An object reference to an iTool component object. If this argument is specified, the returned value is an relative object identifier, beginning with Objref. If this argument is not specified, the returned value is a fully-qualified object identifier.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitComponent::GetProperty

The IDLitComponent::GetProperty procedure method retrieves the value of an IDLitComponent property or properties.

## Syntax

*Obj* -> [IDLitComponent::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitComponent Properties” on page 2745 that contains that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitComponent::GetPropertyAttribute

The IDLitComponent::GetPropertyAttribute procedure method retrieves property attribute values for a registered property.

## Syntax

*Obj* -> [IDLitComponent::]GetPropertyAttribute, *PropertyIdentifier* [, TYPE=*variable*]

## Arguments

### PropertyIdentifier

A string containing the property identifier of the registered property.

## Keywords

Any keywords to the RegisterProperty method followed by the word “Get” can be retrieved. In addition, the following keyword is available:

### TYPE

Set this argument to a named variable that returns the TYPE code as an integer, as specified under the *Type* argument to IDLitComponent::RegisterProperty.

## Version History

Introduced: 6.0

# IDLitComponent::GetPropertyByIdentifier

The IDLitComponent::GetPropertyByIdentifier function method retrieves the value of an IDLitComponent property.

**Tip**

The IDLitComponent::GetPropertyByIdentifier method is similar to the IDLitComponent::GetProperty method, but is useful for cases where the *property identifier* is defined at runtime.

## Syntax

*Result* = *Obj* -> [IDLitComponent::]GetPropertyByIdentifier(*PropertyIdentifier*, *Value*)

## Return Value

Returns 1 if the property value is defined, or 0 if the property value is undefined.

## Arguments

### PropertyIdentifier

A string containing the property identifier of the property. *PropertyIdentifier* does not need to be a registered property, but must be a valid keyword name for the GetProperty method of the component.

### Value

A named variable that will contain the value of the property. If the property value is currently undefined, then the contents of the variable specified by *Value* will not be modified.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitComponent::Init

The IDLitComponent::Init function method initializes the IDLitComponent object, and should be called by the Init method of a subclass.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitComponent'[, *PROPERTY=value*] )

or

*Result* = *Obj* -> [IDLitComponent::]Init([, *PROPERTY=value*])
(*Only in a subclass' Init method.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLitComponent Properties" on page 2745 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitComponent::QueryProperty

The IDLitComponent::QueryProperty function method checks whether a property identifier is registered, or retrieves a list of all registered properties.

## Syntax

*Result* = *Obj* -> [IDLitComponent::]QueryProperty([*PropertyIdentifier*])

## Return Value

Returns a 1 if *PropertyIdentifier* is a scalar string that corresponds to a valid registered property, or a 0 otherwise. If *PropertyIdentifier* is an array, the result is an array of 1s and 0s.

If *PropertyIdentifier* is not specified, *Result* is a string array containing the identifiers of all registered properties.

## Arguments

### PropertyIdentifier

A scalar string or string array containing property identifiers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitComponent::RegisterProperty

The IDLitComponent::RegisterProperty procedure method registers a property as belonging to the component. Only registered properties are displayed in the graphical property sheet interface for the object.

# Syntax

*Obj* -> [IDLitComponent::]RegisterProperty, *PropertyIdentifier*[, *Type*] [, /BOOLEAN] [, /COLOR] [, DESCRIPTION=*string*] [, ENUMLIST=*stringvector*] [, /FLOAT] [, /HIDE] [, /INTEGER] [, /LINESTYLE] [, NAME=*string*] [, /SENSITIVE] [, /STRING] [, /SYMBOL] [, /THICKNESS] [, /UNDEFINED] [, USERDEF=*string*] [, VALID_RANGE=*vector*]

# Arguments

## PropertyIdentifier

A scalar string containing the property identifier. GetProperty and SetProperty methods accept this string as a keyword.

## Type

An optional integer argument representing the property type. Values recognized by Property Sheets are:

- 0 = USERDEF
- 1 = BOOLEAN
- 2 = INTEGER
- 3 = FLOAT
- 4 = STRING
- 5 = COLOR
- 6 = LINESTYLE
- 7 = SYMBOL
- 8 = THICKNESS
- 9 = ENUMLIST

If *Type* is not supplied, then one of the type keywords must be set instead.

# Keywords

Some of the following keywords correspond to *attributes* of the property being registered. Keywords followed by the word “Get” indicate attributes that can be retrieved by the IDLitComponent::GetPropertyAttribute method. Keywords followed by the word “Set” indicate attributes that can be set by the IDLitComponent::SetPropertyAttribute method.

Some of the following keywords correspond to iTool property data types, which can also be specified via the *Type* argument. Note that if both the *Type* argument and one of the corresponding keywords are set, the keyword value will be honored.

## BOOLEAN

Set this keyword to indicate that the property type is BOOLEAN. Properties of type BOOLEAN must accept an integer value of either 0 (“False”) or 1 (“True”). Setting this keyword is equivalent to setting the TYPE argument equal to 1.

## COLOR

Set this keyword to indicate that the property type is COLOR. Properties of type COLOR must accept a three-element integer array containing an RGB triplet. Setting this keyword is equivalent to setting the TYPE argument equal to 5.

## DESCRIPTION (Get, Set)

Set this keyword to a string containing the full name or description of this property. The DESCRIPTION is displayed in the graphical property sheet interface.

**Note**

Do not confuse the DESCRIPTION *property attribute* with the DESCRIPTION *property.*

## ENUMLIST (Get, Set)

Set this keyword equal to an array of strings to be displayed in the dropdown menu displayed by a property of type ENUMLIST. The default is a scalar null string. Properties of type ENUMLIST report their value as an integer between 0 and *n*-1, where *n* is the number of elements in the enumerated list. Setting this keyword implies that the TYPE argument is equal to 9.

## FLOAT

Set this keyword to indicate that the property type is FLOAT. Properties of type FLOAT must accept a scalar double-precision floating-point value. Setting this keyword is equivalent to setting the TYPE argument equal to 3.

## HIDE (Get, Set)

Set this keyword to hide the given property when displaying the graphical property sheet interface. By default, all registered properties are displayed.

## INTEGER

Set this keyword to indicate that the property type is INTEGER. Properties of type INTEGER must accept a scalar integer value. Setting this keyword is equivalent to setting the TYPE argument equal to 2.

## LINESTYLE

Set this keyword to indicate that the property type is LINESTYLE. Properties of type LINESTYLE must accept an integer specifying a pre-defined linestyle, as described under the LINESTYLE property of the IDLgrPolyline class. Setting this keyword is equivalent to setting the TYPE argument equal to 6.

## NAME (Get, Set)

Set this keyword to a string giving the human-readable name for the property. The NAME string will be used when displaying the graphical property sheet interface. If NAME is not set, the value of the *PropertyIdentifier* argument is used.

**Note**

Do not confuse the NAME *property attribute* with the NAME *property.*

## SENSITIVE (Get, Set)

Set this keyword to zero to make the given property insensitive in the graphical property sheet interface. By default, registered properties are sensitive.

## STRING

Set this keyword to indicate that the property type is STRING. Properties of type STRING must accept a scalar string of any length. Setting this keyword is equivalent to setting the TYPE argument equal to 4.

## SYMBOL

Set this keyword to indicate that the property type is SYMBOL. Properties of type SYMBOL must accept an integer specifying one of the pre-defined symbol types described under IDLgrSymbol::Init. Setting this keyword is equivalent to setting the TYPE argument equal to 7.

## THICKNESS

Set this keyword to indicate that the property type is THICKNESS. Properties of type THICKNESS must accept an integer between 1 and 10 specifying the line thickness in points. Setting this keyword is equivalent to setting the TYPE argument equal to 8.

## UNDEFINED (Get, Set)

Set this keyword to indicate that the property should appear as a blank cell when displayed in the graphical property sheet interface. This is useful in situations where properties of multiple objects are displayed in the property sheet (either because multiple objects are selected, or because the objects have been grouped).

**Note**

It is the iTool developer's responsibility to set this property attribute back to zero. Use the SET_DEFINED field of the WIDGET_PROPERTYSHEET event structure to determine when to set the UNDEFINED attribute back to zero.

## USERDEF (Get, Set)

Set this keyword to a string that represents a user-defined property. Properties of type USERDEF can accept and return variables of any type. When the actual property value changes, it is assumed that the string value of the USERDEF attribute will also be modified to reflect the new property value. Setting this keyword implies that the TYPE argument is equal to 0.

## VALID_RANGE (Get, Set)

For INTEGER or FLOAT types, set this keyword to a two- or three-element vector specifying the [*minimum*, *maximum*] or [*minimum*, *maximum*, *increment*] for valid values of the property.

If no *increment* is specified, the property sheet will display an editable text field allowing the user to enter a numerical value. If *increment* is specified, values in the property sheet can only be changed by adjusting a slider, and allowed values are limited to multiples of the increment value plus the minimum value. If *increment* is 0, any value between the minimum and maximum can be selected via the slider.

If this attribute is not set, or is explicitly set equal to zero, the property sheet will use the minimum and maximum values expressible by the data type and an *increment* of 0.

## Version History

Introduced: 6.0

# IDLitComponent::SetProperty

The IDLitComponent::SetProperty procedure method sets the value of an IDLitComponent property or properties.

## Syntax

*Obj* -> [IDLitComponent::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitComponent Properties” on page 2745 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitComponent::SetPropertyAttribute

The IDLitComponent::SetPropertyAttribute procedure method sets one or more property attributes for a registered property.

## Syntax

*Obj* -> [IDLitComponent::]SetPropertyAttribute , *PropertyIdentifier*

## Arguments

### PropertyIdentifier

A string containing the property identifier of the registered property.

## Keywords

Any keywords to the IDLitComponent::RegisterProperty method followed by the word “Set” can be set.

## Version History

Introduced: 6.0

# IDLitComponent::SetPropertyByIdentifier

The IDLitComponent::SetPropertyByIdentifier procedure method sets the value of an IDLitComponent property.

**Tip**

The IDLitComponent::SetPropertyByIdentifier method is similar to the IDLitComponent::SetProperty method, but is useful for cases where the *PropertyIdentifier* is defined at runtime, and avoids the overhead of creating an _EXTRA structure to pass to SetProperty.

## Syntax

*Obj* -> [IDLitComponent::]SetPropertyByIdentifier, *PropertyIdentifier*, *Value*

## Arguments

### PropertyIdentifier

A string containing the property identifier of the property. *PropertyIdentifier* does not need to be a registered property, but must be a valid keyword name for the SetProperty method of the component.

### Value

The new value for the property.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitContainer

The IDLitContainer class is a specialization of the IDL_Container class designed to manage collections of IDLitComponent objects and provide methods to work with the iTools *identifier* system. IDLitContainer object methods allow you to add, retrieve, and remove values from a IDLitContainer-based hierarchy using either object references or iTool identifiers.

This class is written in the IDL language. Its source code can be found in the file `idlitcontainer__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDL_Container

IDLitComponent

## Creation

See "IDLitContainer::Init" on page 2775.

## Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

## Methods

This class has the following methods:

- IDLitContainer::Add
- IDLitContainer::AddByIdentifier
- IDLitContainer::Cleanup
- IDLitContainer::Get
- IDLitContainer::GetByIdentifier
- IDLitContainer::Init

- IDLitContainer::Remove
- IDLitContainer::RemoveByIdentifier

In addition, this class inherits the methods of its superclasses.

## Version History

Introduced: 6.0

# IDLitContainer Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

# IDLitContainer::Add

The IDLitContainer::Add procedure method adds items to the container object.

## Syntax

*Obj* -> [IDLitContainer::]Add, *Components*[, /NO_NOTIFY]

## Arguments

### Components

An object reference (or array of object references) to the IDLitComponent object or objects to be added to the container. When this method is called, the IDENTIFIER properties of objects specified by *Components* are validated, verifying that no items in the container have the same value. If an object with the same identifier already exists in the container, a unique identifier is created by appending a number to the original value.

## Keywords

### NO_NOTIFY

Normally, when an item is added to a container object that inherits from both the IDLitContainer class and the IDLitIMessaging class, an ADDITEMS notification message is broadcast to all iTool components registered as monitoring this container. If this keyword is set, no message is sent.

## Version History

Introduced: 6.0

# IDLitContainer::AddByIdentifier

The IDLitContainer::AddByIdentifier procedure method adds an object to the container hierarchy in the position specified by the *Identifier* argument.

## Syntax

*Obj* -> [IDLitContainer::]AddByIdentifier, *Identifier*, *Item*

## Arguments

### Identifier

An object identifier specifying the location in the container hierarchy where Item should be added. *Identifier* can be either a fully-qualified object identifier (beginning with a "/" character) or a relative to the container on which this method is called. If *Identifier* is a null string (`''`), Item is added to the root of the container object.

See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object identifier strings.

### Item

An object reference to the iTool component object being added to the container.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitContainer::Cleanup

The IDLitContainer::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitContainer::]Cleanup (*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitContainer::Get

The IDLitContainer::Get function method retrieves items from the container.

## Syntax

*Result* = *Obj* -> [IDLitContainer::]Get([, /ALL] [, COUNT=*variable*] [, ISA=*string* or *array of strings*] [, POSITION=*index* or *array of indices*] [, /SKIP_PRIVATE])

## Return Value

Returns an object reference or array of object references to the iTool components stored in the container. Unless either the ALL keyword or the POSITION keyword is specified, the first object in the container is returned. If no objects are found in the container, the return value is -1.

## Arguments

None

## Keywords

### ALL

Set this keyword to return an array of object references to all of the objects in the container.

### COUNT

Set this keyword equal to a named variable that will contain the number of objects selected by the function.

### ISA

Set this keyword equal to a class name or vector of class names. This keyword is used in conjunction with the ALL keyword. The ISA keyword filters the array returned by the ALL keyword, returning only the objects that inherit from the class or classes specified by the ISA keyword.

**Note**

This keyword is ignored if the ALL keyword is not provided.

### POSITION

Set this keyword equal to a scalar or array containing the zero-based indices of the positions of the objects to return.

### SKIP_PRIVATE

Set this keyword to ignore any components for which the PRIVATE property is set to true. This keyword is ignored unless the ALL keyword is also set.

## Version History

Introduced: 6.0

# IDLitContainer::GetByIdentifier

The IDLitContainer::GetByIdentifier function method retrieves an object from a container hierarchy using the specified identifier to locate the object.

## Syntax

*Result* = *Obj* -> [IDLitContainer::]GetByIdentifier(*Identifier*)

## Return Value

Returns an object reference to the object that was requested from the hierarchy, or a null object reference if no object was located.

## Arguments

### Identifier

The object identifier of the object that should be retrieved from the container hierarchy. *Identifier* can be either a fully-qualified object identifier (beginning with a "/" character) or a relative to the container on which this method is called.

See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object identifier strings.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitContainer::Init

The IDLitContainer::Init function method initializes the object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitContainer')

or

*Result* = *Obj* -> [IDLitContainer::]Init() (*Only in subclass' Init method.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitContainer::Remove

The IDLitContainer::Remove procedure method removes items from the container.

## Syntax

*Obj* -> [IDLitContainer::]Remove, *Components*[, /NO_NOTIFY]

## Arguments

### Components

An object reference (or array of object references) to the objects to be removed from the container.

## Keywords

### NO_NOTIFY

Normally, when an item is removed from a container object that inherits from both the IDLitContainer class and the IDLitIMessaging class, a REMOVEITEMS notification message is broadcast to all iTool components registered as monitoring this container. If this keyword is set, no message is sent.

## Version History

Introduced: 6.0

# IDLitContainer::RemoveByIdentifier

The IDLitContainer::RemoveByIdentifier function method removes an object from a container hierarchy using the specified identifier to locate the object.

## Syntax

*Result* = *Obj* -> [IDLitContainer::]RemoveByIdentifier(*Identifier*)

## Return Value

Returns an object reference to the object that was removed from the hierarchy, or a null object reference if no object was removed.

## Arguments

### Identifier

The object identifier of the object that should be removed from the container hierarchy. The *Identifier* argument can be either a fully-qualified object identifier (beginning with a "/" character) or a relative to the container on which this method is called.

See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object identifier strings.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData

The IDLitData class provides a generic data storage object that can hold data items of any IDL data type. The IDLitData class provides typing and data change notification functionality, and when coupled with the IDLitDataContainer object forms the base element for the construction of composite data types.

The IDLitData class implements the iTools *notifier interface*, which provides a mechanism by which observers of a data item can be alerted when the state of the information contained in the data object changes.

This class is written in the IDL language. Its source code can be found in the file `idlitdata__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitComponent

## Creation

See “IDLitData::Init” on page 2789.

## Properties

Objects of this class have the following properties. See “IDLitData Properties” on page 2780 for details on individual properties.

- HIDE
- NO_COPY
- READ_ONLY
- TYPE

In addition, objects of this class inherit the properties of the superclass.

## Methods

This class has the following methods:

- IDLitData::AddDataObserver
- IDLitData::Cleanup
- IDLitData::Copy
- IDLitData::GetByType
- IDLitData::GetData
- IDLitData::GetProperty
- IDLitData::GetSize
- IDLitData::Init
- IDLitData::NotifyDataChange
- IDLitData::NotifyDataComplete
- IDLitData::RemoveDataObserver
- IDLitData::SetData
- IDLitData::SetProperty

In addition, this class inherits the methods of its superclasses.

## Examples

See Chapter 3, “Data Management” in the *iTool Developer’s Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitData Properties

IDLitData objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLitData::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLitData::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLitData::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## HIDE

A Boolean value that controls the visibility of the data with respect to queries performed by the IDLitDataContainer methods GetData, SetData and GetIdentifiers. If the HIDE property has a True value, the data object is not found by these methods and the methods behave as if the data object did not exist.

| | | | |
|---|---|---|---|
| **Property Type** | BOOLEAN | | |
| **Name String** | HIDE | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## NO_COPY

If an initial value of the data is provided, this property will cause the movement of the data into the object without creating an additional copy, leaving the IDL variable named by the Data argument undefined.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## READ_ONLY

A Boolean value that controls the ability to modify the data with the SetData method. If the READ_ONLY property has a True value, an attempt to use SetData on the object fails. IDL prints an informational message in this case.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | READ_ONLY | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TYPE

A scalar string containing the type of the data object. The default value of this property is NULL (`''`) and cannot be changed after the class is instantiated. Subclasses of this class set the value of this property to a value that reflects the type of data that the subclass is implementing.

| **Property Type** | STRING | | |
|---|---|---|---|
| **Name String** | TYPE | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

# IDLitData::AddDataObserver

The IDLitData::AddDataObserver procedure method specifies an object (the *Observer*) that will be notified when the contents of the data object are changed.

The object specified as the *Observer* must implement three methods that form the data observer interface:

- OnDataChange
- OnDataComplete
- OnDataDelete

The OnDataChange method is called when the contents of a data object are changed, and the OnDataComplete method is called when the change messages are completed. This two-part notification process is used to allow observers of data to transact the change event and minimize the required system updates (such as graphic redrawing). The OnDataDelete method is called when the data item is deleted.

## Syntax

*Obj* -> [IDLitData::]AddDataObserver, *Observer*

## Arguments

### Observer

An object reference to an iTool component object that implements the data observer interface methods. When the contained data value changes, the *Observer* is notified of this change.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData::Cleanup

The IDLitData::Cleanup procedure method performs all cleanup operations on the object, and should be called by the Cleanup method of any subclass of this class. This method removes all data stored in the IDLitData object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitData::]Cleanup (*only in subclass' Cleanup method*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData::Copy

The IDLitData::Copy function method returns an exact copy of the data object and its contents, including registered property values.

The following values are *not* copied:

- Values of unregistered properties.
- Values of properties registered after the data object is created.
- Property attribute values.

**Note**

If an object has been added to the data object, only the object reference to the added object is copied.

## Syntax

*Result* = *Obj* -> [IDLitData::]Copy()

## Return Value

Returns a copy of the object on which it is called. If the copy operation fails, a null object is returned.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData::GetByType

The IDLitData::GetByType function method returns all contained objects of the specified iTool data type.

## Syntax

*Result* = *Obj* -> [IDLitData::]GetByType(*Type*[, COUNT=*variable*])

## Return Value

Returns an object array containing references to the contained data objects that are of the iTool data type specified by *Type*. If no objects matching *Type* exist, a null object reference is returned.

## Arguments

### Type

A string containing the iTool data type to search for in the data hierarchy rooted by this data container.

## Keywords

### COUNT

Set this keyword equal to a named variable that will contain the number of valid objects returned by this method.

## Version History

Introduced: 6.0

# IDLitData::GetData

The IDLitData::GetData function method retrieves the data stored in the object.

## Syntax

*Result* = *Obj* -> [IDLitData::]GetData(*Data*[, *Identifier*] [, NAN=*variable*] [, /NO_COPY])

## Return Value

Returns a 1 if the operation succeeds, and 0 if it fails.

## Arguments

### Data

A named variable that will contain the data retrieved from the data object. If the GetData method fails, the variable is not modified.

### Identifier

A string argument that is not used by this method, but is accepted for parameter compatibility with the IDLitDataContainer::GetData method. If a value for this argument is supplied, the method does not retrieve any data and returns the value 0.

## Keywords

### NAN

Set this keyword to a named variable that will contain 1 if *Data* contains any non-finite values (either NaN or Infinity), or 0 otherwise.

### NO_COPY

Set this keyword to move the data from the data object to the variable specified by the *Data* argument, leaving the data value of the data object undefined.

## Version History

Introduced: 6.0

# IDLitData::GetProperty

The IDLitData::GetProperty procedure method retrieves the value of an IDLitData property, and should be called by the GetProperty method of any subclass of this class.

## Syntax

*Obj* -> [IDLitData::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitData Properties” on page 2780 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitData::GetSize

The IDLitData::GetSize function method returns an approximate value for the amount of memory being used by the data object.

## Syntax

*Result* = *Obj* -> [IDLitData::]GetSize()

## Return Value

Returns the number of bytes of memory used by the data object. The returned value is an approximation.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData::Init

The IDLitData::Init function method initializes the IDLitData object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitData'[, *Data*] [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLitData::]Init([*Data*] [, *PROPERTY=value*])
(*Only in subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Data

An IDL variable of any type that is stored in the data object.

## Keywords

Any property listed under “IDLitData Properties” on page 2780 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitData::NotifyDataChange

The IDLitData::NotifyDataChange procedure method is called when a data object has been changed; it is part of the notification process that allows data updates to be reflected by visualizations that use the data. It works in conjunction with the NotifyDataComplete method to provide a two-pass change notification system that minimizes the number of operations performed when a data object changes.

When NotifyDataChange is called, the OnDataChange methods of all observers of the data object (usually visualizations) are automatically called. This causes the observers to perform any necessary updates *without committing those updates*. When the NotifyDataComplete method is called, the observers' OnDataComplete methods are called to commit the updates. This two-pass system allows visualizations to be notified that the data has changed without forcing an immediate redraw of the iTool window; when the NotifyDataComplete method is called, all visualizations can be redrawn at once.

Every call to the NotifyDataChange method must have an accompanying NotifyDataComplete call; without the call to NotifyDataComplete, no updates will take place.

**Note**

If the data object is being changed by an operation based on the IDLitDataOperation class, the call to NotifyDataChange is handled automatically. The only time you will need to call this method directly is if the operation that modifies the data is based on the more generic IDLitOperation class.

## Syntax

*Obj* -> [IDLitData::]NotifyDataChange

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData::NotifyDataComplete

The IDLitData::NotifyDataComplete procedure method is called after a data object has been changed; it is part of the notification process that allows data updates to be reflected by visualizations that use the data. It works in conjunction with the NotifyDataChange method to provide a two-pass change notification system that minimizes the number of operations performed when a data object changes.

When NotifyDataChange is called, the OnDataChange methods of all observers of the data object (usually visualizations) are automatically called. This causes the observers to perform any necessary updates *without committing those updates*. When the NotifyDataComplete method is called, the observers' OnDataComplete methods are called to commit the updates. This two-pass system allows visualizations to be notified that the data has changed without forcing an immediate redraw of the iTool window; when the NotifyDataComplete method is called, all visualizations can be redrawn at once.

Every call to the NotifyDataChange method must have an accompanying NotifyDataComplete call; without the call to NotifyDataComplete, no updates will take place.

**Note**

If the data object is being changed by an operation based on the IDLitDataOperation class, the call to NotifyDataChange is handled automatically. The only time you will need to call this method directly is if the operation that modifies the data is based on the more generic IDLitOperation class.

## Syntax

*Obj* -> [IDLitData::]NotifyDataComplete

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData::RemoveDataObserver

The IDLitData::RemoveDataObserver method unregisters an object that has been registered as an *observer* of this data object. After this method is called, the Observer will no longer be notified when the contents of the data object change. If the specified *Observer* doesn't exist, this method will return quietly.

## Syntax

*Obj* -> [IDLitData::]RemoveDataObserver, *Observer*

## Arguments

### Observer

An object reference to an iTool component object that was previously registered as an observer of this data object.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitData::SetData

The IDLitData::SetData function method copies the data from an IDL variable or expression into the data object, and notifies all its observers that the data has changed.

## Syntax

*Result* = *Obj* -> [IDLitData::]SetData(*Data*[, *Identifier*] [, /NO_COPY] [, /NULL])

## Return Value

Returns a 1 if the operation succeeds, and 0 if it fails.

## Arguments

### Data

An IDL variable or expression whose value is copied into the data object.

### Identifier

A string argument that is not used by this method. It is accepted by this method only for parameter compatibility with IDLitDataContainer::SetData. If a value for this argument is supplied, the method does not retrieve any data and returns the value 0.

## Keywords

### NO_COPY

Set this keyword to move the data into the specified IDLitData object without creating an additional copy. This leaves the original IDL variable named by the *Data* argument undefined.

### NULL

Set this keyword to remove any data stored in the IDLitData object, leaving it empty. If this keyword is set, the *Data* argument is ignored.

## Version History

Introduced: 6.0

# IDLitData::SetProperty

The IDLitData::SetProperty procedure method sets the value of an IDLitData property, and should be called by the SetProperty method of any subclass of this class.

## Syntax

*Obj* -> [IDLitData::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitData Properties” on page 2780 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitDataContainer

The IDLitDataContainer class is used to store collections of IDLitData and IDLitDataContainer objects to form hierarchical data structures. Objects can be added to and removed from an IDLitDataContainer at any time, allowing for the dynamic creation of composite data types.

Objects stored in an IDLitDataContainer hierarchy are referenced using iTool *object identifiers*. Object identifiers are simple scalar strings assigned to the IDENTIFIER property of an object when it is created. For a complete discussion of object identifiers and their role in the iTool system, see "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual.

This class is written in the IDL language. Its source code can be found in the file `idlitdatacontainer__define.pro` in the `lib/itool/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitContainer

IDLitData

## Creation

See "IDLitDataContainer::Init" on page 2803.

## Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

## Methods

This class has the following methods:

- IDLitDataContainer::Cleanup
- IDLitDataContainer::GetData
- IDLitDataContainer::GetIdentifiers
- IDLitDataContainer::GetProperty
- IDLitDataContainer::Init

- IDLitDataContainer::SetData
- IDLitDataContainer::SetProperty

In addition, this class inherits the methods of its superclasses.

## Examples

See Chapter 3, “Data Management” in the *iTool Developer’s Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitDataContainer Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

# IDLitDataContainer::Cleanup

The IDLitDataContainer::Cleanup procedure method performs all cleanup operations on the object, and should be called by the Cleanup method of any subclass of this class. This method destroys all data objects stored in this container.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitDataContainer::]Cleanup (*only in subclass' Cleanup method*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitDataContainer::GetData

The IDLitDataContainer::GetData function method retrieves the data value contained in the data object specified by the *Identifier* argument.

## Syntax

*Result* = *Obj* -> [IDLitDataContainer::]GetData(*Data* [, *Identifier*] [, /NO_COPY])

## Return Value

Returns a 1 if the operation succeeds, and 0 if it fails.

## Arguments

### Data

A named variable that will contain the data value of the specified data object.

### Identifier

A string containing the relative object identifier path to the target data object for this method. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object identifier strings.

If *Identifier* is not set. or is set to a null string, the data contained in the data container itself is returned.

## Keywords

### NO_COPY

Set this keyword to move the data from the data container object to the variable specified by the *Data* argument, leaving the data value of the data object undefined.

## Version History

Introduced: 6.0

# IDLitDataContainer::GetIdentifiers

The IDLitDataContainer::GetIdentifiers function method retrieves the object identifiers for all data and data container objects contained in the data container object.

## Syntax

*Result* = *Obj* -> [IDLitDataContainer::]GetDataIdentifiers([*Pattern*] [, /LEAF])

## Return Value

Returns an array of strings containing the object identifiers for all data and data container objects contained by the data container object. If the container is empty, or if the Pattern argument is supplied and no object identifiers are matched, the function returns a string array containing one empty string ( [''] ).

## Arguments

### Pattern

A string specifying a search pattern to be used for filtering the returned object identifiers. Only object identifiers that match Pattern are returned. See STRMATCH for a description of the rules used when matching patterns.

## Keywords

### LEAF

Set this keyword to return only object identifiers whose final node is *not* a container object.

## Version History

Introduced: 6.0

# IDLitDataContainer::GetProperty

The IDLitDataContainer::GetProperty procedure method retrieves the value of an IDLitDataContainer property, and should be called by the GetProperty method of any subclass of this class.

## Syntax

*Obj* -> [IDLitDataContainer::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitDataContainer Properties” on page 2798 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitDataContainer::Init

The IDLitDataContainer::Init function method initializes the IDLitDataContainer object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitDataContainer'[, *Data*] [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLitDataContainer::]Init([*Data*] [, *PROPERTY=value*])
(*Only in subclass' Init method.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Data

An IDL variable of any type or shape that is stored into the object at initialization.

## Keywords

Any property listed under “IDLitDataContainer Properties” on page 2798 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitDataContainer::SetData

The IDLitDataContainer::SetData function method stores data in the IDLitData object specified by *Identifier*. This method acts in exactly the same way as the IDLitData::SetData method.

## Syntax

*Result* = *Obj* -> [IDLitDataContainer::]SetData(*Data*, *Identifier*[, /NO_COPY] [, /NULL])

## Return Value

Returns a 1 if the operation succeeds, or 0 if it fails.

## Arguments

### Data

An IDL variable of any type that is copied into the specified data object.

### Identifier

A scalar string containing the object identifier of the IDLitData object in which the data specified by *Data* should be stored. This path must specify a valid IDLitData object, or the function fails. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object identifier strings.

## Keywords

### NO_COPY

Set this keyword to move the data into the specified IDLitData object without creating an additional copy. This leaves the original IDL variable named by the *Data* argument undefined.

### NULL

Set this keyword to remove any data stored in the IDLitData object, leaving it empty. If this keyword is set, the *Data* argument is ignored, but must still be present.

## Version History

Introduced: 6.0

# IDLitDataContainer::SetProperty

The IDLitDataContainer::SetProperty procedure method sets the value of an IDLitDataContainer property, and should be called by the SetProperty method of any subclass of this class.

## Syntax

*Obj* -> [IDLitDataContainer::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLitDataContainer Properties” on page 2798 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitDataOperation

The IDLitDataOperation class is a subclass of IDLitOperation that automates data access and automatically records information for the undo-redo system. By automating this functionality, the IDLitDataOperation class eliminates much of the work required to implement a standard subclass of the IDLitOperation class. See IDLitOperation for additional information on iTool operations.

**Note**

The IDLitDataOperation class is designed for use in operations that affect data values. If you are creating an operation that acts on items other than the data that underlies a visualization, you should base your operation class on the IDLitOperation class.

While the implementation of a standard subclass of an IDLitOperation class requires the developer to provide implementations of the DoAction, UndoOperation, and RedoOperation methods, the IDLitDataOperation class provides these methods automatically. The only method the developer of an IDLitDataOperation class is *required* to implement is the Execute method, which contains the logic for the specific operation being performed. Depending on the operation being performed, the developer of an IDLitDataOperation may also implement methods to reverse (or un-execute) the operation, display a user interface before performing the operation, get and set properties specific to the operation, and initialize the IDLitDataOperation object.

When an IDLitDataOperation is requested by a user, the following things occur:

1. As with any operation, execution commences when the DoAction method is called on this object. When called, the IDLitDataOperation retrieves the currently-selected items. If nothing is selected, the operation returns.
2. For each selected item, the data objects of the parameters registered as “operation targets” are retrieved.
3. The data objects are queried for iTool data types that match the types supported by the IDLitDataOperation.

For each data object that includes data of an iTool data type supported by the IDLitDataOperation, the following things occur:

1. The data from the data object is retrieved.
2. If the IDLitDataOperation does not have the REVERSIBLE_OPERATION property set, a copy of the data is created and placed into the undo-redo command set.
3. The Execute method is called, with the retrieved data as its argument.
4. If the Execute method succeeds and the IDLitDataOperation has the EXPENSIVE_OPERATION property set, a copy of the results is placed into the undo-redo command set.
5. The result of the IDLitDataOperation is placed in the data object. This action will cause all visualization items that use the data object to update when the operation is completed.

Once all selected data items have been processed, the undo-redo command set is placed into the system undo-redo buffer for later use.

For a detailed discussion of both the IDLitOperation and IDLitDataOperation classes, see Chapter 7, “Creating an Operation” in the *iTool Developer’s Guide* manual.

This class is written in the IDL language. Its source code can be found in the file `idlitdataoperation__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitOperation

## Creation

See “IDLitDataOperation::Init” on page 2818.

## Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

## Methods

This class has the following methods:

- IDLitDataOperation::Cleanup
- IDLitDataOperation::DoExecuteUI
- IDLitDataOperation::Execute
- IDLitDataOperation::GetProperty
- IDLitDataOperation::Init
- IDLitDataOperation::SetProperty
- IDLitDataOperation::UndoExecute

In addition, this class inherits the methods of its superclasses (if any).

## Examples

See "Creating a New Data-Centric Operation" in Appendix of the *iTool Developer's Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

## See Also

IDLitOperation

# IDLitDataOperation Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

# IDLitDataOperation::Cleanup

The IDLitDataOperation::Cleanup procedure method performs all cleanup on the object.

**Note**

An operation based on the IDLitDataOperation class need not implement this method if the operation does not allocate any pointers or object references of its own.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* `->` [IDLitOperation::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitDataOperation::DoExecuteUI

The IDLitDataOperation::DoExecuteUI function method provides a way for the iTool developer to request user input before performing an operation. If the SHOW_EXECUTION_UI property is set, this method will be called before the operation's Execute method is called.

**Note**

Every operation based directly on the IDLitDataOperation class that requires user interaction before execution must implement its own DoExecuteUI method. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

The DoExecuteUI method itself can present any interface. In practice, most iTool DoExecuteUI methods use the IDLitTool::DoUIService method to display a user interface requesting user input. User interfaces and UI Services are discussed in Chapter 10, "iTool User Interface Architecture" in the *iTool Developer's Guide* manual.

**Warning**

If the DoExecuteUI method does not return success, the Execute method will not be called.

## Syntax

*Result* = *Obj* -> [IDLitDataOperation::]DoExecuteUI()

## Return Value

Returns a 1 if the displayed user interface code executed successfully, and the operation should be executed. If user interface code does not execute successfully, or if the user cancels the operation, this function returns a 0.

## Arguments

None

## Keywords

None

# Example

The following is an example of a DoExecuteUI method, taken from the iTools “Scale Factor” operation:

```
FUNCTION IDLitopScalefactor::DoExecuteUI

oTool = self -> GetTool()
IF (oTool EQ OBJ_NEW()) THEN RETURN, 0

RETURN, oTool -> DoUIService('ScaleFactor', self)

END
```

This implementation of the DoExecuteUI method does the following:

1. Retrieves an object reference to the current iTool using the GetTool method.
2. Checks to make sure the returned object reference is not a null object (which would be the case if the GetTool method failed).
3. Calls the `ScaleFactor` UI Service.

# Version History

Introduced: 6.0

# IDLitDataOperation::Execute

The IDLitDataOperation::Execute function method contains the execution logic for the operation. This method is called automatically when the iTool user requests an operation based on the IDLitDataOperation class.

**Note**

Every operation based directly on the IDLitDataOperation class must implement its own Execute method. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

When the iTool system executes an IDLitDataOperation, it passes the *raw data* (of the appropriate iTools data type) from the selected objects to the Execute method. This means that the Execute method itself does not need to "unpack" a data object before performing the operations, allowing rapid and simple operation execution. For example, if the operation expects data of the iTools data type `IDLARRAY2D`, the iTool system will include the selected two-dimensional array as the *Data* argument.

# Syntax

*Result* = *Obj* `->` [IDLitDataOperation::]Execute(*Data*)

# Return Value

The return value is 1 if the operation executed successfully, or 0 otherwise.

# Arguments

## Data

A single data item on which the operation should be performed. Note that *Data* is *not* an IDLitData object, but actual data.

# Keywords

None

## Version History

Introduced: 6.0

## See Also

IDLitDataOperation::UndoExecute

# IDLitDataOperation::GetProperty

The IDLitDataOperation::GetProperty procedure method retrieves the value of a property or group of properties of an operation object.

**Note**

An operation based on the IDLitDataOperation class *must* implement this method if the operation defines one or more properties not inherited from the superclass. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

## Syntax

*Obj* -> [IDLitDataOperation::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under "IDLitDataOperation Properties" on page 2811 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Example

To retrieve the value of the REVERSIBLE_OPERATION property:

```
Obj -> IDLitDataOperation::GetProperty, REVERSIBLE_OPERATION = rev
```

## Version History

Introduced: 6.0

# IDLitDataOperation::Init

The IDLitDataOperation::Init function method initializes the IDLitDataOperation object and sets properties that define the behavior the operation provides.

**Note**

An operation based on the IDLitDataOperation class *must* implement this method. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

**Note**

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitDataOperation' [, *PROPERTY=variable*] )

or

*Result* = *Obj* -> [IDLitDataOperation::]Init([, *PROPERTY=variable*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under “IDLitDataOperation Properties” on page 2811 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal the appropriate property value.

## Version History

Introduced: 6.0

# IDLitDataOperation::SetProperty

The IDLitDataOperation::SetProperty procedure method sets the value of a property or group of properties for the operation.

**Note**

An operation based on the IDLitDataOperation class *must* implement this method if the operation defines one or more properties not inherited from the superclass. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

## Syntax

*Obj* -> [IDLitDataOperation::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under "IDLitDataOperation Properties" on page 2811 that contains the word "Yes" in the "Set" column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitDataOperation::UndoExecute

The IDLitDataOperation::UndoExecute function method is called when a user selects the Undo operation after executing an IDLitDataOperation that sets the value of the REVERSIBLE_OPERATION property to 1. (If the IDLitDataOperation does not set this property, the UndoExecute method is not called.) If implemented, this method generally applies the inverse of the operation performed by the Execute method.

**Note**

An operation based on the IDLitDataOperation class *must* implement this method if the operation sets the REVERSIBLE_OPERATION property. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

When the iTool system un-executes an IDLitDataOperation, it passes the *raw data* (of the appropriate iTools data type) from the selected objects to the UndoExecute method. This means that the UndoExecute method itself does not need to "unpack" a data object before performing the operations, allowing rapid and simple operation execution. For example, if the operation expects data of the iTools data type `IDLARRAY2D`, the iTool system will include the selected two-dimensional array as the *Data* argument.

## Syntax

*Result* = *Obj* `->` [IDLitDataOperation::]UndoExecute(*Data*)

## Return Value

The return value is 1 if the operation un-executed successfully, or 0 otherwise.

## Arguments

### Data

A single data item on which the operation should be performed. Note that *Data* is *not* an IDLitData object, but actual data.

## Keywords

None

## Version History

Introduced: 6.0

## See Also

IDLitDataOperation::Execute

# IDLitIMessaging

The IDLitIMessaging interface class provides a set of methods used to allow an object that implements the interface to send notification messages and to react appropriately when notification messages are received from other iTool component objects. This class also provides methods that allow the iTool developer to notify the iTool user of error conditions via graphical dialogs, to prompt the user for input, and to retrieve a reference to the current iTool object.

IDLitIMessaging objects are not intended to be created as standalone entities; rather, this class should be included as the superclass of another iTool class.

**Note**

In the iTools system, management of messages is handled by the IDLitVisualization class, of which the IDLitIMessaging class is a superclass. In practice, this means that if you need to override any methods of the IDLitIMessaging class, you will do so in the definition of your visualization class.

This class is written in the IDL language. Its source code can be found in the file `idlitimessaging__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

This class has no superclasses.

## Creation

Objects of this class are not created as standalone objects.

## Properties

Objects of this class have no properties of their own.

## Methods

This class has the following methods:

- IDLitIMessaging::AddOnNotifyObserver
- IDLitIMessaging::DoOnNotify
- IDLitIMessaging::ErrorMessage

- IDLitIMessaging::GetTool
- IDLitIMessaging::ProbeStatusMessage
- IDLitIMessaging::ProgressBar
- IDLitIMessaging::PromptUserText
- IDLitIMessaging::PromptUserYesNo
- IDLitIMessaging::RemoveOnNotifyObserver
- IDLitIMessaging::SignalError
- IDLitIMessaging::StatusMessage

## Version History

Introduced: 6.0

# IDLitIMessaging Properties

Objects of this class have no properties of their own.

# IDLitIMessaging::AddOnNotifyObserver

The IDLitIMessaging::AddOnNotifyObserver procedure method is used to register a specified iTool component object to receive messages generated by the DoOnNotify method of another specified iTool component object.

## Syntax

*Obj* -> [IDLitIMessaging::]AddOnNotifyObserver, *IdObserver, IdSubject*

## Arguments

### IdObserver

The object identifier of an iTool component object that is the *observer* expressing interest in the subject specified by *IdSubject*. Often, *IdObserver* is the object identifier of the object on which this method is being called.

The object specified by *IdObserver* must implement the OnNotify callback method, which is called when a notification message is dispatched to *IdObserver* by the DoOnNotify method of another iTool component object (usually the object specified by *IdSubject*). The OnNotify method has the following signature:

```
PRO ::OnNotify, idOriginator, idMessage, message
```

where

- *idOriginator* is the object identifier of the iTool component that is the source of the message
- *idMessage* is a string that identifies the type of message being sent
- *message* is the message itself.

In general, the *idMessage* string is used by the OnNotify method to determine what type of action to take. See “IDLitIMessaging::DoOnNotify” on page 2828 for additional details.

### IdSubject

A string value identifying the item that *IdObserver* is interested in. This is normally the object identifier of a particular iTool component object, but it can be any string value. When a message sent via IDLitIMessaging::DoOnNotify specifies *IdSubject* as the originator, the *IdObserver* object’s OnNotify method is called.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitIMessaging::DoOnNotify

The IDLitIMessaging::DoOnNotifiy procedure method is used to broadcast a notification message to iTool component objects that are observing the source of the message.

See the "IDLitIMessaging::AddOnNotifyObserver" on page 2826, and "IDLitIMessaging::RemoveOnNotifyObserver" on page 2837 methods for more information on notification messages.

See "iTool Messaging System" in Chapter 2 of the *iTool Developer's Guide* manual for a more in-depth discussion of notification.

## Syntax

*Obj* -> [IDLitIMessaging::]DoOnNotify, *IdOriginator*, *IdMesage*, *Value*

## Arguments

### IdOriginator

A string value identifying the item that is the source of the message. Normally, *IdOriginator* is the object identifier of the object that calls this method, but it can be any string value.

### IdMessage

A string that will uniquely identify the message being sent. The value of *IdMessage* is determined by the iTool developer; it is used by the OnNotify methods of any observer objects to determine what type of message has been received, and to act accordingly. For example, if a property value has changed, this argument might be set to the string `SETPROPERTY`.

### Value

Any value that is associated with the message being sent. For example, if a `SETPROPERTY` message was sent, *Value* might contain the name of the property changed. If no value is associated with the message, set this argument to a null string (`''`).

## Keywords

None

## Version History

Introduced: 6.0

# IDLitIMessaging::ErrorMessage

The IDLitIMessaging::ErrorMessage procedure method is used to display an error message to the user.

The actual method used to display the message to the user depends on the user interface in use. Normally, this method will display a modal dialog.

## Syntax

Obj -> [IDLitIMessaging::]ErrorMessage, *StrMessage*[, SEVERITY=*integer*] [, TITLE=*string*] [, /USE_LAST_ERROR]

## Arguments

### StrMessage

A scalar string or string array containing a description of the error.

## Keywords

### SEVERITY

Set this keyword to the severity code to use for this message. The system recognizes the following values:

- 0 = Informational
- 1 = Warning
- 2 = Error

### TITLE

Set this keyword to the title that should be displayed as part of the prompt. In most cases, this value is placed in the title bar of the modal dialog.

### USE_LAST_ERROR

If this keyword is set, the system will use the information that was part of the last error signaled to the iTool. The last error may have been set either by a previous call to this method or by a call to the IDLitIMessaging::SignalError method.

## Version History

Introduced: 6.0

# IDLitIMessaging::GetTool

The IDLitIMessaging::GetTool function method returns an object reference to the iTool object associated with the object on which it is called.

## Syntax

*Result* = *Obj* -> [IDLitIMessaging::]GetTool()

## Return Value

Returns an object reference to the iTool object associated with the object on which the GetTool is called. If the object is not contained by an iTool, this function returns a null object reference.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitIMessaging::ProbeStatusMessage

The IDLitIMessaging::ProbeStatusMessage procedure method is used to display a status message to the user, which is displayed in a data-specific region of the user interface. Unlike other messages that require immediate acknowledgement by the user, a status message is passive and no response is needed.

The actual method used to display the value to the user depends on the user interface in use. In a standard iTool included with IDL, this status message is displayed in the lower right corner of the iTool window.

## Syntax

*Obj* -> [IDLitIMessaging::]ProbeStatusMessage, *StrMessage*

## Arguments

### StrMessage

A scalar string that is displayed in the data-specific status area.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitIMessaging::ProgressBar

The IDLitIMessaging::ProgressBar function method is used to display a progress bar to the user and update the displayed values.

On the initial call to this method, a dialog is displayed. The dialog remains active until the method is called with the /SHUTDOWN keyword.

The actual method used to display the message to the user depends on the user interface in use. Normally, the progress bar is displayed as a modal dialog.

## Syntax

*Result* = *Obj* -> [IDLitIMessaging::]ProgressBar(*StrMessage*[, PERCENT=*value*] [, /SHUTDOWN])

## Return Value

Returns 1 if the progress bar was displayed successfully, or 0 otherwise.

## Arguments

### StrMessage

A scalar string or string array containing a description of the action taking place.

## Keywords

### PERCENT

Set this keyword to a value between 0 and 100 that represents the “percentage complete” value to be shown on the progress bar.

### SHUTDOWN

If set, any progress bar that is being displayed is removed from the user interface.

## Version History

Introduced: 6.0

# IDLitIMessaging::PromptUserText

The IDLitIMessaging::PromptUserText function method is used to prompt the iTool user with a question and retrieve a text answer. The text answer is returned to the caller of this method via a supplied IDL variable.

The actual method used to prompt the user depends on the user interface in use. Normally, the prompt is displayed as a modal dialog.

## Syntax

*Result* = *Obj* -> [IDLitIMessaging::PromptUserText(*StrPrompt*, *Answer* [, TITLE=*string*])

## Return Value

Returns 1 if the prompt was displayed and the user clicked the **OK** button. If the user clicks the **Cancel** button or dismisses the dialog, the return value is 0.

## Arguments

### StrPrompt

A scalar string or string array containing a prompt for the user to respond to.

### Answer

A named variable that will contain the string value entered by the user.

## Keywords

### TITLE

Set this keyword to a string representing the title of the prompt. This value is placed in the title bar of the modal dialog.

## Version History

Introduced: 6.0

# IDLitIMessaging::PromptUserYesNo

The IDLitIMessaging::PromptUserYesNo function method is used to prompt the user with a yes or no question and return an answer.

The actual method used to prompt the user depends on the user interface in use. Normally, the prompt is displayed as a modal dialog.

## Syntax

*Result* = *Obj* -> [IDLitIMessaging::PromptUserYesNo(*StrPrompt*, *Answer* [, TITLE=*string*])

## Return Value

Returns 1 if the dialog executed properly and returned a value in the variable specified. You must check the value stored in the variable specified as the *Answer* argument to determine which button the user pressed.

## Arguments

### StrPrompt

A scalar string or string array containing a prompt for the user to respond to.

### Answer

A named variable that will contain 1 if the user answered Yes to the prompt and 0 if the user answered No.

## Keywords

### TITLE

Set this keyword to the title that should be displayed as part of the prompt. In most cases, this value is placed in the title bar of the modal dialog.

## Version History

Introduced: 6.0

# IDLitIMessaging::RemoveOnNotifyObserver

The IDLitIMessaging::RemoveOnNotifyObserver procedure method is used to un-register a specified iTool component object as wishing to receive messages generated by the DoOnNotify method of another specified iTool component object. This method reverses the action of calling the IDLitIMessaging::AddOnNotifyObserver method.

## Syntax

*Obj* -> [IDLitIMessaging::]RemoveOnNotifyObserver, *IdObserver*, *IdSubject*

## Arguments

### IdObserver

The object identifier of an iTool component object that is currently registered as an observer of the component specified by *IdSubject*. Often, this is the object identifier of the object on which method is being called.

### IdSubject

The object identifier of the iTool component object that *IdObserver* is currently registered as observing. This is normally the object identifier of a particular iTool component object, but it can be any scalar string.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitIMessaging::SignalError

The IDLitIMessaging::SignalError procedure method is used to signal an error in the system. No user interface is displayed to the user, but the error is registered with the system, made the current error, and recorded by the iTool log service (if enabled).

**Note**

If this method is used to signal an error, the IDLitIMessaging::ErrorMessage method can be called with the /USE_LAST_ERROR keyword to use the information set by this method.

## Syntax

*Obj* -> [IDLitIMessaging::]SignalError, *StrMessage* [, CODE=*integer*] [, SEVERITY=*integer*]

## Arguments

### StrMessage

A scalar string or string array containing a description of the error.

## Keywords

### CODE

Set this keyword to an integer that represents an error code that can be associated with the error. Error codes can be any integer value specified by the iTool developer.

### SEVERITY

Set this keyword to the severity code to use for this message. The system recognizes the following values:

- 0 = Informational
- 1 = Warning
- 2 = Error

## Version History

Introduced: 6.0

# IDLitIMessaging::StatusMessage

The IDLitIMessaging::StatusMessage procedure method is used to display a status message to the user. Unlike other messages that require immediate acknowledgement by the user, a status message is passive and no response is needed.

The actual method used to display the value to the user depends on the user interface in use. In a standard iTool included with IDL, this status message is displayed in the lower left corner of the iTool window.

## Syntax

*Obj* -> [IDLitIMessaging::]StatusMessage, *StrMessage*

## Arguments

### StrMessage

A scalar string that is displayed as a status message to the user.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator

The IDLitManipulator class provides the base functionality of the iTools manipulator system. Most automation and functional capabilities of the manipulator system are provided by this class. Tasks performed by this class include:

- Selection operations and associated selection state management.
- Automated mouse cursor management (changing the cursor as the mouse traverses different items in the current visualization).
- System event settings management.
- Coordination between the manipulator and manipulator visualization system.

This class is written in the IDL language. Its source code can be found in the file `idlitmanipulator__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitContainer

## Creation

See “IDLitManipulator::Init” on page 2854.

## Properties

Objects of this class have the following properties. See “IDLitManipulator Properties” on page 2842 for details on individual properties.

- BUTTON_EVENTS
- DEFAULT_CURSOR
- DESCRIPTION
- DISABLE
- DRAG_QUALITY
- KEYBOARD_EVENTS
- MOTION_EVENTS
- OPERATION_IDENTIFIER

- PARAMETER_IDENTIFIER
- TRANSIENT_DEFAULT
- TRANSIENT_MOTION
- TYPES
- VIEWS_ONLY
- VISUAL_TYPE

In addition, objects of this class inherit the properties of the superclass of this class.

## Methods

This class has the following methods:

- IDLitManipulator::Cleanup
- IDLitManipulator::CommitUndoValues
- IDLitManipulator::GetCursorType
- IDLitManipulator::GetProperty
- IDLitManipulator::Init
- IDLitManipulator::OnKeyboard
- IDLitManipulator::OnLoseCurrentManipulator
- IDLitManipulator::OnMouseDown
- IDLitManipulator::OnMouseMotion
- IDLitManipulator::OnMouseUp
- IDLitManipulator::RecordUndoValues
- IDLitManipulator::SetCurrentManipulator
- IDLitManipulator::SetProperty

In addition, this class inherits the methods of its superclass.

## Version History

Introduced: 6.0

# IDLitManipulator Properties

IDLitManipulator objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLitManipulator::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLitManipulator::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLitManipulator::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## BUTTON_EVENTS

A boolean value controlling whether mouse button events are generated. If set, mouse button up and button down events will be dispatched to this manipulator. These events are enabled by default.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEFAULT_CURSOR

A string containing the name of the default cursor for the manipulator. This is the name of the cursor that is displayed if no items are hit during mouse cursor motion. By default, the default cursor is set to `'ARROW'`.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## DESCRIPTION

A string representing the full name or description of this object.

| | |
|---|---|
| **Property Type** | STRING |

| **Name String** | Description | | |
|---|---|---|---|
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DISABLE

A boolean value indicating that the manipulator should be disabled. Disabling a manipulator prevents it from being chosen by a user or by the iTool system.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DRAG_QUALITY

An integer value representing the drawing quality to be used when the user clicks on a visualization and holds down the mouse button. Choosing a lower quality setting for drag operations may increase performance during the manipulation. When the user releases the mouse button, the visualization is redrawn at the original quality. The property can be set to any of the following values:

- 0 = Low
- 1 = Medium
- 2 = High

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | DRAG_QUALITY | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## KEYBOARD_EVENTS

A boolean value controlling whether keyboard events are generated. If set, keyboard events will be dispatched to the manipulator. These events are enabled by default.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## MOTION_EVENTS

A boolean value controlling whether motion events are generated. If set, motion events will be dispatched to this manipulator. These events are enabled by default.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## OPERATION_IDENTIFIER

A string identifier for the operation that is associated with the manipulator. This identifier specifies the operation that is used by the undo-redo system to transact the actions performed by this manipulator. If not specified, the manipulator actions are not recorded by the undo-redo system.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PARAMETER_IDENTIFIER

A string identifier specifying which parameter the operation should query when transacting the manipulator. If specified, this identifier is used in conjunction with the operation specified by the OPERATION_IDENTIFIER property to transact the operations performed by a manipulator. The parameter is primarily used to specify the property identifier for manipulators that change the values of properties.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TRANSIENT_DEFAULT

An integer value used to indicate that the manipulator is *transient*, which causes the system to automatically switch to the default manipulator when this manipulator's mouse actions are complete (that is, when the OnMouseUp method has been called) or when an end-of-keyboard-entry character (carriage return or escape key) is detected.

This property can be set to any of the following values:

- 0 = No transient behavior
- 1 = Mouse transient behavior is enabled. When a mouse button up is detected, the manipulation system will switch to the default manipulator for the system.
- 2 = Keyboard transient behavior is enabled. When a carriage return or escape key is pressed, the system will switch to the default manipulator for the system.
- 3 = Both keyboard and mouse transient behavior are enabled.

| **Property Type** | Enumerated List | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TRANSIENT_MOTION

A boolean value controlling whether transient motion events are generated. If set, the manipulator will generate motion events beginning when the OnMouseDown method is called and ending when the OnMouseUp method is called.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TYPES

A string array specifying the visualization types that this manipulator can operate on. If not specified, the manipulator will support all registered visualization types.

| **Property Type** | Vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

## VIEWS_ONLY

A boolean value controlling the content of the manipulator hierarchy. If set, the manipulator will only operate on views in the manipulator hierarchy.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## VISUAL_TYPE

A string representing the type of selection visual to use with this manipulator. The VISUAL_TYPE property should match the corresponding property of an IDLitManipulatorVisual object. This high-level abstraction allows similar selection visuals to be assigned across multiple manipulators.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLitManipulator::Cleanup

The IDLitManipulator::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitManipulator::]Cleanup() (*In a subclass' Init method only.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::CommitUndoValues

The IDLitManipulator::CommitUndoValues function method is used to complete a transaction that is occurring as a result of the manipulator interaction. This method works in conjunction with the RecordUndoValues method.

When a manipulator interaction is complete, the manipulator should call this method, which in turn calls the RecordFinalValues method of the operation associated with the manipulator. The RecordFinalValues method records any information needed to undo the operation and places the information in the iTool's undo-redo transaction buffer.

For interactive manipulators, the CommitUndoValues method should be called by the OnMouseUp method.

**Note**

This method must be called on the current manipulator before being called on a superclass to ensure that the current selection state maintained by the manipulator is valid.

## Syntax

*Result* = *Obj* -> [IDLitManipulator::]CommitUndoValues([/UNCOMMENT])

## Return Value

Returns 1 if the commit was successful, or 0 otherwise.

## Arguments

None

## Keywords

### UNCOMMIT

Set this keyword to discard any pending information from a previous call to RecordUndoValues. The interaction is not recorded in the iTool's undo-redo transaction buffer.

## Version History

Introduced: 6.0

# IDLitManipulator::GetCursorType

The IDLitManipulator::GetCursorType function method retrieves the name of the cursor to display for the manipulator. The name of the cursor can be used with the SetCurrentCursor method of the IDLitWindow component.

The system will use this method to automatically change the cursor when the mouse traverses the contents of a visualization window. As the mouse transverses the window, the name for the hit item that is part of the current selection group is retrieved and passed to this routine. This action gives the manipulator the ability to change cursors depending on the area of the visualization the cursor is over.

## Syntax

*Result* = *Obj* -> [IDLitManipulator::]GetCursorType(*TypeIn*, *KeyMods*)

## Return Value

Returns a string containing the name of the cursor. If nothing is matched, an empty string is returned.

## Arguments

### TypeIn

A string variable containing the name of the portion of the selection visual for which the cursor is being requested.

### KeyMods

An integer representing the keyboard modifiers for the button. These can have one of the following values

1 = SHIFT Key

2 = CTRL Key

4 = CAPS LOCK key

8 = ALT key

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::GetProperty

The IDLitManipulator::GetProperty procedure method retrieves the value of an IDLitManipulator property, and should be called by the subclass' GetProperty method. This method also retrieves properties defined in the superclass.

## Syntax

*Obj* -> [IDLitManipulator::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitManipulator Properties” on page 2842 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitManipulator::Init

The IDLitManipulator::Init function method initializes the IDLitManipulator object, and should be called by the subclass' Init method. This method also calls the superclass' Init method.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitManipulator'[, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLitManipulator::]Init([, *PROPERTY*=*value*])
(*In a subclass' Init method only.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under “IDLitManipulator Properties” on page 2842 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitManipulator::OnKeyboard

The IDLitManipulator::OnKeyboard procedure method is used when a keyboard event occurs on the target IDLitWindow.

## Syntax

*Obj* -> [IDLitManipulator::]OnKeyboard, *Win*, *IsASCII*, *Character*, *Key Value*, *X*, *Y*, *Press*, *Release*, *KeyMods*

## Arguments

### Win

An object reference for the IDLitWindow from which the event came.

### IsASCII

A Boolean value to determine if the character is in the ASCII character set. This value is True if the character is in the ASCII character set.

### KeyValue

The numeric value representing the key pressed if the key is non-ASCII. The possible numeric values are:

- 1 = Shift
- 2 = Control
- 3 = Caps Lock
- 4 = Alt
- 5 = Left
- 6 = Right
- 7 = Up
- 8 = Down
- 9 = Page Up
- 10 = Page Down
- 11 = Home
- 12 = End

### Character

A string containing the ASCII character of the key pressed.

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### Press

A Boolean value to determine if the current event is a key press. This value is True if the event is pressing the key

### Release

A Boolean value to determine if the current event is a key release. This value is True if event is releasing the key

### KeyMods

An integer representing the keyboard modifiers for the button. These can have one of the following values:

- 1 = SHIFT key
- 2 = CTRL key
- 4 = CAPS LOCK key
- 8 = ALT key

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::OnLoseCurrentManipulator

The IDLitManipulator::OnLoseCurrentManipulator procedure method is used when this manipulator is no longer the current manipulator in the system.

**Note**

This method is designed to be implemented by a subclass of IDLitManipulator, to perform any cleanup work necessary when a new manipulator is selected.

## Syntax

*Obj* -> [IDLitManipulator::]OnLoseCurrentManipulator

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::OnMouseDown

The IDLitManipulator::OnMouseDown procedure method is used when a mouse down event occurs on the target IDLitWindow. When applied, this method will perform a select operation on the current contents of the target IDLitWindow.

When overriding this method in a sub-class, this method is normally the first task performed so that the instance data of the object is properly setup.

## Syntax

*Obj* -> [IDLitManipulator::]OnMouseDown, *Win*, *X*, *Y*, *IButton*, *KeyMods*, *NClicks*

## Arguments

### Win

An object reference for the IDLitWindow from which the event came.

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### IButton

An integer value representing the mask for the button pressed:

- 1 = Left
- 2 = Middle
- 4 = Right

### KeyMods

An integer representing the keyboard modifiers for the button. These can have one of the following values:

- 1 = SHIFT key
- 2 = CTRL key
- 4 = CAPS LOCK key
- 8 = ALT key

### NClicks

An integer value representing number of clicks

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::OnMouseMotion

The IDLitManipulator::OnMouseMotion procedure method implements the OnMouseMotion method. If no mouse button is down, this method manages the setting of the cursor on the IDLitWindow object.

If the manipulator is in the middle of a mouse-down, mouse-up transaction, the following instance data will be valid:

- ButtonPress — Set to the mouse buttons pressed.
- nSelectionList — The number of items selected.
- pSelectionList — A pointer to the objects current selected in the iTool.

These values can be helpful in performing actions in the manipulator and are automatically managed.

## Syntax

*Obj* -> [IDLitManipulator::]OnMouseMotion, *Win*, *X*, *Y*, *KeyMods*

## Arguments

### Win

An object reference for the IDLitWindow object from which the event came.

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### KeyMods

An integer representing the keyboard modifiers for the button. These can have one of the following values:

- 1 = SHIFT key
- 2 = CTRL key
- 4 = CAPS LOCK key
- 8 = ALT key

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::OnMouseUp

The IDLitManipulator::OnMouseUp procedure method is used when a mouse up event occurs on the target IDLitWindow object.

When overriding this method in a sub-class, this method is normally the last task performed so that the instance data of the object is properly setup.

## Syntax

*Obj* -> [IDLitManipulator::]OnMouseUp, *Win*, *X*, *Y*, *IButton*

## Arguments

### Win

An object reference for the IDLitWindow object from which the event came.

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### IButton

An integer value representing the mask for the button pressed:

- 1 = Left
- 2 = Middle
- 4 = Right

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::RecordUndoValues

The IDLitManipulator::RecordUndoValues function method is used to begin recording the transaction that is occurring as a result of the manipulator interaction. This method works in conjunction with the CommitUndoValues method.

To capture information for the undo-redo system of the tools framework, the initial and final values for the items that the manipulator will adjust must be recorded. This recording process is accomplished with the RecordUndoValues and CommitUndoValues methods.

These two methods make use of the operation that is associated with this manipulator (specified by the OPERATION_IDENTIFIER keyword to the Init method) to capture the needed information. When the RecordUndoValues method is called, the manipulator will retrieve the operation associated with this manipulator and call the RecordInitialValues method on this operation. The RecordInitialValues method is called with a command set, the list of currently selected items (which the manipulator is operating on) and the value that was provided by the PARAMETER_IDENTIFIER keyword to this manipulator. This method will record any information needed to undo the operation and place the values in the provided command set. See IDLitOperation for more information on operations.

For interactive manipulators, the RecordUndoValues method is called as part of the OnMouseDown method.

## Syntax

*Result* = *Obj* -> [IDLitManipulator::]RecordUndoValues()

## Return Value

Returns a 1 if recording was successful, or 0 otherwise.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulator::SetCurrentManipulator

The IDLitManipulator::SetCurrentManipulator procedure method sets the manipulator as the current manipulator in the system.

## Syntax

*Obj* -> [IDLitManipulator::]SetCurrentManipulator [, *Item*]

## Arguments

### Item

If this method is being called on a manipulator container object, *Item* can optionally be set to a string containing the relative object ID of the manipulator that should be set as the current manipulator. If *Item* is not supplied, the manipulator on which the method is called is set as the current manipulator.

## Keyword

None

## Version History

Introduced: 6.0

# IDLitManipulator::SetProperty

The IDLitManipulator::SetProperty procedure method sets the value of an IDLitManipulator property, and should be called by the subclass' SetProperty method. This method also calls the superclass' SetProperty method.

## Syntax

*Obj* -> [IDLitManipulator::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLitManipulator Properties” on page 2842 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitManipulatorContainer

The IDLitManipulatorContainer class allows for the construction of manipulator hierarchies. Building on the functionality provided by the IDLitManipulator class, the manipulator container implements the concept of a *current manipulator* for the items it contains.

This class is written in the IDL language. Its source code can be found in the file `idlitmanipulatorcontainer__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitContainer

IDLitManipulator

## Creation

See "IDLitManipulatorContainer::Init" on page 2875.

## Properties

Objects of this class have the following properties. See "IDLitManipulatorContainer Properties" on page 2870 for details on individual properties.

- AUTO_SWITCH

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLitManipulatorContainer::Add
- IDLitManipulatorContainer::GetCurrent
- IDLitManipulatorContainer::GetCurrentManipulator
- IDLitManipulatorContainer::GetProperty
- IDLitManipulatorContainer::Init
- IDLitManipulatorContainer::OnKeyboard

- IDLitManipulatorContainer::OnMouseDown
- IDLitManipulatorContainer::OnMouseMotion
- IDLitManipulatorContainer::OnMouseUp
- IDLitManipulatorContainer::SetCurrent
- IDLitManipulatorContainer::SetCurrentManipulator
- IDLitManipulatorContainer::SetProperty

In addition, this class inherits the methods of its superclasses.

## Version History

Introduced: 6.0

# IDLitManipulatorContainer Properties

IDLitManipulatorContainer objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the table are retrieved via IDLitManipulatorContainer::GetProperty. Properties with the word “Yes” in the “Init” column of the property table are set via IDLitManipulatorContainer::Init. Properties with the word “Yes” in the “Set” column in the property table are set via IDLitManipulatorContainer::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## AUTO_SWITCH

A boolean that, if set, causes the manipulator container to automatically change the value of its current child manipulator depending on the portion of the selection visual hit during a mouse down operation. This is performed by matching the name of the portion of the selection visual hit during the mouse down operation and the name of the sub-manipulators of this container.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLitManipulatorContainer::Add

The IDLitManipulatorContainer::Add procedure method is used to add a new manipulator to the container.

## Syntax

*Obj* -> [IDLitManipulatorContainer::]Add, *Manipulator*

## Arguments

### Manipulator

The new manipulator to add to this manipulator container. When completed, this manipulator is also set to the current manipulator for this manipulator container.

## Keywords

All keywords are passed to the IDL_Container superclass during the add operation.

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::GetCurrent

The IDLitManipulatorContainer::GetCurrent function method is used to get the object reference of the current manipulator of the container.

## Syntax

*Result* = *Obj* -> [IDLitManipulatorContainer::]GetCurrent()

## Return Value

Returns an object reference to the current manipulator for this container or a null object reference if no manipulators are contained by the container.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::GetCurrentManipulator

The IDLitManipulatorContainer::GetCurrentManipulator function method is used to get the current manipulator of the system. When applied, this function method causes a traversal of the manipulator hierarchy, returning the current leaf manipulator of the system.

## Syntax

*Result* = *Obj* -> [IDLitManipulatorContainer::]GetCurrentManipulator( [, /IDENTIFIER])

## Return Value

Returns an object reference to the current manipulator in the system. If the IDENTIFIER keyword is set, the routine will return the identifier for the current manipulator.

## Arguments

None

## Keywords

### IDENTIFIER

If set, the identifier of the current manipulator is returned. If not set, the current manipulator itself is returned.

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::GetProperty

The IDLitManipulatorContainer::GetProperty procedure method retrieves the value of an IDLitManipulatorContainer property, and should be called by the subclass' GetProperty method. This method also retrieves properties defined in the superclass.

## Syntax

*Obj* -> [IDLitManipulatorContainer::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitManipulatorContainer Properties” on page 2870 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::Init

The IDLitManipulatorContainer::Init function method initializes the IDLitManipulatorContainer object, and should be called by the subclass' Init method. This method also calls the superclass' Init method.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitManipulatorContainer'[, *PROPERTY=value*])

or

*Result = Obj ->* [IDLitManipulatorContainer::]Init([*PROPERTY=value*])
(*In a subclass' Init method only.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under “IDLitManipulatorContainer Properties” on page 2870 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::OnKeyboard

The IDLitManipulatorContainer::OnKeyboard procedure method is used when a keyboard event occurs on the target IDLitWindow object. If the current child manipulator supports keyboard events, the OnKeyboard method for that manipulator is called.

## Syntax

*Obj* -> [IDLitManipulator::]OnKeyboard, *Win*, *IsASCII*, *Character*, *Key Value*, *X*, Y, *Press*, *Release*, *KeyMods*

## Arguments

### Win

An object reference for the IDLitWindow object from which the event came.

### IsASCII

A Boolean value to determine if the character is in the ASCII character set. This value is True if the character is in the ASCII character set.

### KeyValue

The numeric value representing a non-ASCII key pressed. The possible values are:

- 1 = Shift
- 2 = Control
- 3 = Caps Lock
- 4 = Alt
- 5 = Left
- 6 = Right
- 7 = Up
- 8 = Down
- 9 = Page Up
- 10 = Page Down
- 11 = Home

- 12 = End

### Character

A string containing the ASCII character of the key pressed

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### Press

A Boolean value to determine if the current event is a key press. This value is True if the event is pressing the key

### Release

A Boolean value to determine if the current event is a key release. This value is True if event is releasing the key

### KeyMods

An integer representing the keyboard modifiers for the button. These can have one of the following values:

- 1 = SHIFT key
- 2 = CTRL key
- 4 = CAPS LOCK key
- 8 = ALT key

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::OnMouseDown

The IDLitManipulatorContainer::OnMouseDown procedure method is used when a mouse down event occurs on the target IDLitWindow object. When applied and auto-switch mode is enabled in the container, the current child manipulator will be determined by matching the type of the visualization hit with the identifier of the sub-manipulators contained in this container. If no match is made, the default child manipulator is selected. Once complete, normal processing continues.

If the current sub-manipulator supports mouse button events, its OnMouseDown method is called.

## Syntax

*Obj* -> [IDLitManipulatorContainer::]OnMouseDown, *Win*, *X*, *Y*, *IButton*, *KeyMods*, *NClicks*

## Arguments

### Win

An object reference for the IDLitWindow object from which the event came.

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### IButton

An integer value representing the mask for the button pressed:

- 1 = Left
- 2 = Middle
- 4 = Right

### KeyMods

An integer representing the keyboard modifiers for the button. These can have one of the following values:

- 1 = SHIFT key
- 2 = CTRL key
- 4 = CAPS LOCK key
- 8 = ALT key

### NClicks

An integer value representing number of clicks

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::OnMouseMotion

The IDLitManipulatorContainer::OnMouseMotion procedure method implements the OnMouseMotion method. If no mouse button is down and auto-switch mode is enabled, this method manages the setting of the cursor on the IDLitWindow object. Otherwise if the current sub-manipulator supports motion events, its OnMouseMotion method is called.

## Syntax

*Obj* -> [IDLitManipulatorContainer::]OnMouseMotion, *Win, X, Y, KeyMods*

## Arguments

### Win

An object reference for the IDLitWindow object from which the event came.

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### KeyMods

An integer representing the keyboard modifiers for the button. These can have one of the following values:

- 1 = SHIFT key
- 2 = CTRL key
- 4 = CAPS LOCK key
- 8 = ALT key

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::OnMouseUp

The IDLitManipulatorContainer::OnMouseUp procedure method is used when a mouse up event occurs on the target IDLitWindow object. When applied, the container will call the OnMouseUp method of the current child manipulator if that manipulator supports button events.

## Syntax

*Obj* -> [IDLitManipulatorContainer::]OnMouseUp, *Win*, *X*, *Y*, *IButton*

## Arguments

### Win

An object reference for the IDLitWindow object from which the event came.

### X

A floating-point value representing the *x*-coordinate in the window's coordinates.

### Y

A floating-point value representing the *y*-coordinate in the window's coordinates.

### IButton

An integer value representing the mask for the button pressed:

- 1 = Left
- 2 = Middle
- 4 = Right

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::SetCurrent

The IDLitManipulatorContainer::SetCurrent procedure method is used to set a manipulator within the container to be the current manipulator.

## Syntax

*Obj* -> [IDLitManipulatorContainer::]SetCurrent, *Manipulator*

## Arguments

### Manipulator

The object reference of the manipulator to be set as current in the manipulator container. This manipulator must be contained in the container or an error is thrown.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::SetCurrentManipulator

The IDLitManipulatorContainer::SetCurrentManipulator procedure method is used to set the current child manipulator in a manipulator hierarchy. When applied, the manipulator will use the provided identifier to call the SetCurrentManipulator on the target child manipulator. If the provided identifier is null, the default manipulator is set as current.

## Syntax

*Obj* -> [IDLitManipulatorContainer::]SetCurrentManipulator, *Identifier*

## Arguments

### Identifier

Either the identifier for the manipulator that is to be made current in the system or its object reference.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorContainer::SetProperty

The IDLitManipulatorContainer::SetProperty procedure method sets the value of an IDLitManipulatorContainer property, and should be called by the subclass' SetProperty method. This method also calls the superclass' SetProperty method.

## Syntax

*Obj* -> [IDLitManipulator::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitManipulatorContainer Properties” on page 2870 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitManipulatorManager

The IDLitManipulatorManager class is a specialization of a IDLitManipulatorContainer class that acts as the root of a manipulator hierarchy. In addition, this class provides the functionality that allows it to interface with external elements in the iTool system.

This class is written in the IDL language. Its source code can be found in the file `idlitmanipulatormanager__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitManipulatorContainer

## Creation

See "IDLitManipulatorManager::Init" on page 2891.

## Properties

Objects of this class have no properties of their own, but do have properties inherited from any superclasses.

## Methods

This class has the following methods:

- IDLitManipulatorManager::Add
- IDLitManipulatorManager::AddManipulatorObserver
- IDLitManipulatorManager::Init
- IDLitManipulatorManager::RemoveManipulatorObserver

In addition, this class inherits the methods of its superclass.

## Version History

Introduced: 6.0

# IDLitManipulatorManager Properties

Objects of this class have no properties of their own, but do have properties inherited from its superclass.

# IDLitManipulatorManager::Add

The IDLitManipulatorManager::Add procedure method is used to add manipulators to the manipulator manager. This method uses the add functionality of its superclass to add the given manipulator to the hierarchy and checks the default keyword to determine if the given manipulator should be treated as the default for the system.

## Syntax

*Obj* -> [IDLitManipulatorManager::]Add, *Manipulator* [, /DEFAULT]

## Arguments

### Manipulator

A manipulator to add to the manipulator manager

## Keywords

### DEFAULT

If set, the added manipulator is made default for the system. This is primarily used with manipulators that implement transient behavior (mouse or keyboard). When these manipulators complete interaction, the current manipulator of the system is set to the default manipulator.

## Version History

Introduced: 6.0

# IDLitManipulatorManager::AddManipulatorObserver

The IDLitManipulatorManager::AddManipulatorObserver procedure method is used to add an observer to the manipulator system. An observer object is notified when the current manipulator of the manipulator hierarchy changes.

To perform this action, the observer object must implement the method OnManipulatorChange. This method has the following signature:

```
PRO ObjectClass::OnManipulatorChange, Subject
```

Where *Subject* is this class, the manipulator manager.

## Syntax

*Obj* -> [IDLitManipulatorManager::]AddManipulatorObserver, *Observer*

## Arguments

### Observer

A scalar or array of objects that implement the manipulator observer interface.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorManager::Init

The IDLitManipulatorManager::Init function method initializes the IDLitManipulatorManager object, and should be called by the subclass' Init method. This method also calls the superclass' Init method.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitManipulatorManager' [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLitManipulatorManager::]Init([*PROPERTY=value*])
(*In a subclass' Init method only.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under “IDLitManipulatorManager Properties” on page 2888 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitManipulatorManager::RemoveManipulatorObserver

The IDLitManipulatorManager::RemoveManipulatorObserver procedure method is used to remove a manipulator observer from the manipulator object. If the value for the *Observer* argument is not a valid manipulator observer, this method does nothing and no error is reported.

## Syntax

*Obj* -> [IDLitManipulatorManager::]RemoveManipulatorObserver, *Observer*

## Arguments

### Observer

A scalar or array of objects that are to be removed from this container

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorVisual

The IDLitManipulatorVisual class implements methods that allow the iTool developer to create visual elements that are associated with an interactive manipulator. IDLitManipulatorVisual objects are not intended to be created as standalone entities; rather, this class should be included as the superclass of another iTool class.

## Superclasses

This class has no superclasses.

## Creation

See "IDLitManipulatorVisual::Init" on page 2899.

## Properties

Objects of this class have the following properties. See "IDLitManipulatorVisual Properties" on page 2895 for details on individual properties.

- UNIFORM_SCALE
- VISUAL_TYPE

## Methods

This class has the following methods:

- IDLitManipulatorVisual::Cleanup
- IDLitManipulatorVisual::GetProperty
- IDLitManipulatorVisual::Init
- IDLitManipulatorVisual::SetProperty

## Version History

Introduced: 6.0

# IDLitManipulatorVisual Properties

IDLitManipulatorVisual objects have the following properties. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLitManipulatorVisual::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLitManipulatorVisual::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLitManipulatorVisual::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## UNIFORM_SCALE

Set this property to create a manipulator visual which should be scaled equally in all three dimensions when fitting the manipulator visual to the size of its associated visualization. If this property is not set, then the manipulator visual will use a different scale factor in the *x*, *y*, and *z* dimensions, in order to match its associated visualization.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not applicable* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## VISUAL_TYPE

Set this keyword to a string representing the manipulator visual type. The VISUAL_TYPE property should match the corresponding string in its associated IDLitManipulator object. When a new manipulator is selected in an iTool, the VISUAL_TYPE property on the manipulator object is used to search for a corresponding manipulator visual.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not applicable* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLitManipulatorVisual::Cleanup

The IDLitManipulatorVisual::Cleanup procedure method performs all cleanup on the object, and should be called by the Cleanup method of a subclass.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitManipulatorVisual::]Cleanup (*only in subclass' Cleanup method*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitManipulatorVisual::GetProperty

The IDLitManipulatorVisual::GetProperty procedure method retrieves the value of an IDLitManipulatorVisual property.

## Syntax

*Obj* -> [IDLitManipulatorVisual::]GetProperty

## Arguments

None

## Keywords

Any property listed under “IDLitManipulatorVisual Properties” on page 2895 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitManipulatorVisual::Init

The IDLitManipulatorVisual::Init function method initializes the IDLitManipulatorVisual object, and should be called by the Init method of a subclass.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitManipulatorVisual'[, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLitManipulatorVisual::]Init([, *PROPERTY*=*value*])
(*In a subclass' Init method only.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLitManipulatorVisual Properties" on page 2895 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitManipulatorVisual::SetProperty

The IDLitManipulatorVisual::SetProperty procedure method sets the value of an IDLitManipulatorVisual property.

## Syntax

*Obj* -> [IDLitManipulatorVisual::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitManipulatorVisual Properties” on page 2895 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitOperation

The IDLitOperation class is the basis for all iTool operations. It defines how an operation is executed and how information about the operation is recorded for the command transaction (undo-redo) system.

An operation encapsulates a specific set of tasks that perform some atomic action on a target. Between executions of the operation, no state values other than properties of the operation itself are maintained by this object. Two major areas of functionality are provided: automated operation execution and undo-redo capabilities.

Once defined, the operation object exposes a set of properties whose values can affect how the operation executes. The properties that an operation exposes are valid across multiple executions; properties can be set interactively via the Operation browser or programmatically using the operation object's GetProperty and SetProperty methods.

**Note**

For operations that act directly on data items that underlie a visualization, consider basing your operation class on the IDLitDataOperation class. IDLitDataOperation is a subclass of IDLitOperation that automates many of the target-selection and undo-redo mechanisms that must be provided by operation classes based directly on this class.

For a detailed discussion of both the IDLitOperation and IDLitDataOperation classes, see Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual.

This class is written in the IDL language. Its source code can be found in the file `idlitoperation__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitComponent

IDLitIMessaging

## Creation

See "IDLitOperation::Init" on page 2911.

## Properties

Objects of this class have the following properties. See “IDLitOperation Properties” on page 2905 for details on individual properties.

- EXPENSIVE_COMPUTATION
- REVERSIBLE_OPERATION
- SHOW_EXECUTION_UI
- TYPES

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLitOperation::Cleanup
- IDLitOperation::DoAction
- IDLitOperation::GetProperty
- IDLitOperation::Init
- IDLitOperation::RecordFinalValues
- IDLitOperation::RecordInitialValues
- IDLitOperation::RedoOperation
- IDLitOperation::SetProperty
- IDLitOperation::UndoOperation

In addition, this class inherits the methods of its superclasses.

## Examples

See Chapter 7, “Creating an Operation” in the *iTool Developer’s Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

## See Also

IDLitDataOperation

# IDLitOperation Properties

IDLitOperation objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the properties table can be retrieved via IDLitOperation::GetProperty. Properties with the word “Yes” in the “Init” column of the properties table can be initialized via IDLitOperation::Init. Properties with the word “Yes” in the “Set” column of the properties table can be set via IDLitOperation::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## EXPENSIVE_COMPUTATION

Set this property to 1 to indicate that a computation of the operation is *expensive*. Expensive computations are those that require significant memory or processing time to execute. Individual operations should use the value of this property to determine whether the results of the operation should be cached to avoid re-execution when undoing or redoing.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

## REVERSIBLE_OPERATION

Set this property to 1 to indicate that the operation is *reversible*. When an operation is reversible, it can be undone by applying an operation rather than restoring a stored value. Rotation by a specified angle is an example of an operation that is reversible, since applying another rotation by the complementary angle returns the visualization to its original state. Individual operations should use the value of this property to determine how the operation should be undone.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

## SHOW_EXECUTION_UI

Set this property to 1 to indicate that the operation should display a user interface element such as a dialog when the operation is executed. The flag is ignored by the IDLitOperation itself, but can be used by subclasses (notably IDLitDataOperation) to determine when to display user interface elements.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | Show Dialog | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

## TYPES

Set this property to a string or an array of strings indicating the types of data to which the operation can be applied. iTools data types are described in Chapter 3, “Data Management” in the *iTool Developer’s Guide* manual. Set this property to a null string (`''`) to specify that the operation can be applied to all types of data.

| | | | |
|---|---|---|---|
| **Property Type** | User Defined | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLitOperation::Cleanup

The IDLitOperation::Cleanup procedure method performs all cleanup on the object.

**Note**

An operation based on the IDLitOperation class need not implement this method if the operation does not allocate any pointers or object references of its own.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitOperation::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitOperation::DoAction

The IDLitOperation::DoAction function method is called when an operation is requested by the iTools system, either as the result of a user action such as selection of a menu item or toolbar button, or by another operation.

**Note**

Every operation based directly on the IDLitOperation class must implement its own DoAction method. See Chapter 7, “Creating an Operation” in the *iTool Developer’s Guide* manual for details.

A specific operation class’ implementation of this method must create an initialized IDLitCommandSet object, execute the operation, and return the command set object to the caller. DoAction can also call the IDLitOperation::RecordInitialValues and IDLitOperation::RecordFinalValues methods to ensure that the appropriate values are committed to the undo-redo transaction buffer.

If your operation changes the values of its own registered properties (as the result of user interaction with a dialog or other interface element called by DoUIService, for example), be sure to call the RecordInitialValues and RecordFinalValues methods. This ensures that changes made through the dialog are placed in the undo-redo transaction buffer.

**Note**

If you are creating an operation that acts directly on the data that underlies a visualization, consider using the IDLitDataOperation class rather than the IDLitOperation class. IDLitDataOperation provides additional automation of the Undo/Redo mechanism.

# Syntax

*Result* = *Obj* -> [IDLitOperation::]DoAction(*Tool*)

# Return Value

If successful, this method returns an IDLitCommandSet object or array of IDLitCommandSet objects that will be placed in the iTool’s command buffer. The command set object will be passed to the UndoOperation and RedoOperation methods as necessary. If not successful, this method returns a null object reference.

**Note**

The OPERATION_IDENTIFIER property of the command set object returned by the IDLitOperation::DoAction method is set equal to the full identifier of the operation itself. This implies that UndoOperation and RedoOperation methods exist for the operation, and that they implement the necessary undo and redo mechanisms. If you are overriding this method, you must either ensure that the appropriate UndoOperation and RedoOperation methods exist, or manually create an IDLitCommandSet object with the OPERATION_IDENTIFIER set to another operation that is capable of undoing or redoing the changes made by your method.

# Arguments

## Tool

An object reference to the iTool object on which the operation executes.

# Keywords

None

# Version History

Introduced: 6.0

# IDLitOperation::GetProperty

The IDLitOperation::GetProperty procedure method retrieves the value of a property or group of properties of an operation object.

**Note**

An operation based on the IDLitOperation class *must* implement this method if the operation defines one or more properties not inherited from the superclass. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

## Syntax

*Obj* -> [IDLitOperation::]GetProperty [, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under "IDLitOperation Properties" on page 2905 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Example

To retrieve the value of the REVERSIBLE_OPERATION property:

```
Obj -> IDLitOperation::GetProperty, REVERSIBLE_OPERATION = rev
```

## Version History

Introduced: 6.0

# IDLitOperation::Init

The IDLitOperation::Init function method initializes the IDLitOperation object and sets properties that define the behavior the operation provides.

**Note**

An operation based on the IDLitOperation class *must* implement this method. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

**Note**

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitOperation' [, *PROPERTY*=*variable*] )

or

*Result* = *Obj* -> [IDLitOperation::]Init( [, *PROPERTY*=*variable*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under “IDLitOperation Properties” on page 2905 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitOperation::RecordFinalValues

The IDLitOperation::RecordFinalValues function method records the information needed to redo an operation. Information about individual operations is recorded in IDLitCommand objects, which are in turn stored in an IDLitCommandSet object that is passed to the IDLitOperation::UndoOperation and IDLitOperation::RedoOperation methods.

**Note**

If you are creating an operation that acts directly on the data that underlies a visualization, consider using the IDLitDataOperation class rather than the IDLitOperation class. IDLitDataOperation provides additional automation of the Undo and Redo mechanisms.

If this method is implemented for an operation, it should do the following:

- Retrieve the appropriate IDLitCommand object from the IDLitCommandSet object specified as the first parameter,
- Record any information necessary to redo the operation in the IDLitCommand object,
- Return 1 for success.

## Syntax

*Result* = *Obj* `->` [IDLitOperation::]RecordFinalValues(*CommandSet*, *Targets* [, *IdProperty*] )

## Return Value

The return value is 1 if the final values were recorded successfully, or zero otherwise.

## Arguments

### CommandSet

An IDLitCommandSet object that encapsulates all information recorded for this execution of the operation. The command set object is generally created by the IDLitOperation::DoAction method, which then calls the RecordInitialValues method to store the initial state of the target object.

### Targets

An array of objects that are the targets of this operation. In most cases, the target objects are the currently selected objects, as returned by the IDLitTool::GetSelectedItems method.

### IdProperty

A property identifier string specifying the target property or parameter of the operation.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitOperation::RecordInitialValues

The IDLitOperation::RecordInitialValues function method records the information needed to undo an operation. Information about individual operations is recorded in IDLitCommand objects, which are in turn stored in an IDLitCommandSet object that is passed to the IDLitOperation::UndoOperation and IDLitOperation::RedoOperation methods.

**Note**

If you are creating an operation that acts directly on the data that underlies a visualization, consider using the IDLitDataOperation class rather than the IDLitOperation class. IDLitDataOperation provides additional automation of the Undo and Redo mechanisms.

If this method is implemented for an operation, it should do the following:

- Create an IDLitCommand object, setting its TARGET_IDENTIFIER property to the identifier of the target object,
- Record any information necessary to redo the operation in the IDLitCommand object,
- Add the IDLitCommand object to the IDLitCommandSet object specified as the first parameter,
- Return 1 for success.

## Syntax

*Result* = *Obj* `->` [IDLitOperation::]RecordInitialValues(*CommandSet*, *Targets* [, *IdProperty*])

## Return Value

The return value is 1 if the initial values were recorded successfully, or zero otherwise.

# Arguments

## CommandSet

An IDLitCommandSet object that encapsulates all information recorded for this execution of the operation. The command set object is generally created by the IDLitOperation::DoAction method, which then calls the RecordInitialValues method to store the initial state of the target object.

## Targets

An array of objects that are the targets of this operation. In most cases, the target objects are the currently selected objects, as returned by the IDLitTool::GetSelectedItems method.

## IdProperty

A property identifier string specifying the target property or parameter of the operation.

# Keywords

None

# Version History

Introduced: 6.0

# IDLitOperation::RedoOperation

The IDLitOperation::RedoOperation function method is called by the iTool system when the user requests the re-execution of an operation (usually by selecting Redo from the iTool Edit menu or toolbar).

**Note**

An operation based on the IDLitOperation class *must* implement this method. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

**Note**

If you are creating an operation that acts directly on the data that underlies a visualization, consider using the IDLitDataOperation class rather than the IDLitOperation class. IDLitDataOperation provides additional automation of the Undo and Redo mechanisms.

If this method is implemented for an operation, it should do the following:

- Retrieve the IDLitCommand objects from the IDLitCommandSet object passed as the first argument,
- For each IDLitCommand object, retrieve the target of the operation, using the TARGET_IDENTIFIER property,
- Retrieve the stored information and use it to redo the operation,
- Return 1 for success.

# Syntax

*Result* = *Obj* -> [IDLitOperation::]RedoOperation(*CommandSet*)

# Return Value

The return value is 1 if the operation was redone successfully, or zero otherwise.

# Arguments

## CommandSet

An IDLitCommandSet object that contains all the IDLitCommand objects that were stored during the original execution of the operation.

## Keywords

None

## Version History

Introduced: 6.0

## See Also

IDLitOperation::RecordFinalValues, IDLitOperation::RecordInitialValues, IDLitOperation::UndoOperation

# IDLitOperation::SetProperty

The IDLitOperation::SetProperty procedure method sets the value of a property or group of properties for the operation.

**Note**

An operation based on the IDLitOperation class *must* implement this method if the operation defines one or more properties not inherited from the superclass. See Chapter 7, “Creating an Operation” in the *iTool Developer’s Guide* manual for details.

## Syntax

*Obj* -> [IDLitOperation::]SetProperty [, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitOperation Properties” on page 2905 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitOperation::UndoOperation

The IDLitOperation::UndoOperation function method is called by the iTool system when the user requests the un-execution of an operation (usually by selecting Undo from the iTool Edit menu or toolbar).

**Note**

An operation based on the IDLitOperation class *must* implement this method. See Chapter 7, "Creating an Operation" in the *iTool Developer's Guide* manual for details.

**Note**

If you are creating an operation that acts directly on the data that underlies a visualization, consider using the IDLitDataOperation class rather than the IDLitOperation class. IDLitDataOperation provides additional automation of the Undo and Redo mechanisms.

If this method is implemented for an operation, it should do the following:

- Retrieve the IDLitCommand objects from the IDLitCommandSet object passed as the first argument,
- For each IDLitCommand object, retrieve the target of the operation, using the TARGET_IDENTIFIER property,
- Retrieve the stored information and use it to undo the operation,
- Return 1 for success.

# Syntax

*Result* = *Obj* -> [IDLitOperation::]UndoOperation(*CommandSet*)

# Return Value

The return value is 1 if the operation was undone successfully, or zero otherwise.

# Arguments

## CommandSet

An IDLitCommandSet object that contains all the IDLitCommand objects that were stored during the original execution of the operation.

## Keywords

None

## Version History

Introduced: 6.0

## See Also

IDLitOperation::RecordFinalValues, IDLitOperation::RecordInitialValues, IDLitOperation::RedoOperation

# IDLitParameter

The IDLitParameter class implements parameter management methods that allow parameter names to be associated with IDLitData objects. IDLitParameter objects are not intended to be created as standalone entities; rather, this class should be included as the superclass of another iTool class.

**Note**

In the iTools system, management of data parameters is handled by the IDLitVisualization class, of which the IDLitParameter class is a superclass. In practice, this means that if you need to override any methods of the IDLitParameter class, you will do so in the definition of your visualization class. In most cases, the only method you will need to implement is the OnDataChangeUpdate method.

When an object that inherits from the IDLitParameter class is created, the following are created as part of the new object's instance data:

- An IDL_Container object, which will contain parameter names for all parameters registered with the object. Parameter names are discussed in "Parameters" in Chapter 3 of the *iTool Developer's Guide* manual,
- A pointer to a string array containing the parameter names for all parameters registered with the object,
- An IDLitParameterSet object, which will contain the actual IDLitData objects associated with the object's parameters. Parameter sets are discussed in "Parameter Sets" in Chapter 3 of the *iTool Developer's Guide* manual, and in "IDLitParameterSet" on page 2939.

This class is written in the IDL language. Its source code can be found in the file `idlitparameter__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

This class has no superclasses.

## Creation

The objects of this class are not created as standalone objects.

## Properties

Objects of this class have no properties of their own.

## Methods

This class has the following methods:

- IDLitParameter::Cleanup
- IDLitParameter::GetParameter
- IDLitParameter::GetParameterSet
- IDLitParameter::Init
- IDLitParameter::OnDataChangeUpdate
- IDLitParameter::OnDataDisconnect
- IDLitParameter::RegisterParameter
- IDLitParameter::SetData
- IDLitParameter::SetParameterSet

## Version History

Introduced: 6.0

# IDLitParameter Properties

Objects of this class have no properties of their own.

# IDLitParameter::Cleanup

The IDLitParameter::Cleanup procedure method removes the *data observer* from each data object in the visualization object's parameter set, and cleans up the objects and pointers defined to hold parameter data when the visualization object was created.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitParameter::]Cleanup() (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitParameter::GetParameter

The IDLitParameter::GetParameter function method retrieves the IDLitData object associated with a registered parameter.

## Syntax

*Result* = *Obj* -> [IDLitParameter::]GetParameter(*Name* [, /ALL] [, COUNT=*variable*] )

## Return Value

Returns an object reference to the IDLitData object associated with the specified parameter name, or a null object reference if no data objects are associated with the specified parameter name.

## Arguments

### Name

A scalar string containing the parameter name associated with the IDLitData object to be retrieved.

## Keywords

### ALL

Set this keyword to retrieve all of the IDLitData objects contained in the visualization object's IDLitParameterSet object.

### COUNT

Set this keyword equal to a named variable that will contain the number of items returned by this function.

## Version History

Introduced: 6.0

# IDLitParameter::GetParameterSet

The IDLitParameter::GetParameterSet function method returns a reference to the IDLitParameterSet object associated with the visualization object.

## Syntax

*Result* = *Obj* -> [IDLitParameter::]GetParameterSet([, /DEEP_COPY)

## Return Value

Returns an IDLitParameterSet object that contains the IDLitData objects and associated parameter names for the visualization object.

## Arguments

None

## Keywords

### DEEP_COPY

Set this keyword to cause GetParameterSet to return a parameter set that contains *copies* of the IDLitData objects used by the visualization object's registered parameters. If this keyword is not set, the parameter set returned by this function will contain *references* to the IDLitData objects that are being used by the visualization object's registered parameters.

## Version History

Introduced: 6.0

# IDLitParameter::Init

The IDLitParameter::Init function method initializes object instance fields that contain parameter data. Since the IDLitParameter class is always used as a superclass of another class (IDLitVisualization, in the context of the iTool system), initializing this class simply initializes the objects and pointers used to store parameter information in the IDLitVisualization object.

**Note**

Init methods are special lifecycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Result* = *Obj* -> [IDLitParameter::]Init() (*Only in subclass' Init method.*)

## Return Value

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitParameter::OnDataChangeUpdate

The IDLitParameter::OnDataChangeUpdate method is called when a data value has been updated or a new data object has been associated with the visualization object.

**Note**

A visualization class based on the IDLitVisualization class *must* implement this method in order for changes or additions to the data parameters to be updated automatically in the resulting visualizations.

## Syntax

*Obj* `->` [IDLitParameter::]OnDataChangeUpdate, *Data*, *ParameterName*

## Arguments

### Data

An object reference to the IDLitData object or the IDLitParameterSet object containing the changed parameter data. If *Data* is an IDLitParameterSet object, the *ParameterName* argument must be set to the string `'<PARAMETER SET>'`.

### ParameterName

An upper-case scalar string containing the name of the parameter that has changed. The parameter specified via this argument must be registered with the visualization object. If *oData* is an IDLitParameterSet object, this argument must be set to the string `'<PARAMETER SET>'`.

## Keywords

None

# Example

Normally, an implementation of this method will contain a CASE statement that switches based on the value of the *ParameterName* argument. For example, the following code handles a parameter named Z:

```
PRO MyVis::OnDataChangeUpdate, oData, ParameterName

CASE ParameterName OF
   'Z': BEGIN
      ;; do something with the z data
   END
   '<PARAMETER SET>': BEGIN
      oZ = oData -> GetByName('Z')
      ;; do something with the z data.
   END
ENDCASE

END
```

**Note**

The Z parameter is handled twice — once if supplied as an individual IDLitData object and once if supplied via the IDLitParameterSet object.

See "Creating an OnDataChangeUpdate Method" in the section "Creating a New Visualization Type" in Chapter 6 of the *iTool Developer's Guide* manual for more discussion of the OnDataChangeUpdate method.

# Version History

Introduced: 6.0

# IDLitParameter::OnDataDisconnect

The IDLitParameter::OnDataDisconnect procedure method is called when a data value has been disconnected from a parameter. The general idea is that when a data item is disassociated from a visualization parameter, one or more properties of the visualization may need to be reset to reasonable default values.

**Note**

A visualization class based on the IDLitVisualization class *must* implement this method in order for changes or additions to the data parameters to be updated automatically in the resulting visualizations.

## Syntax

*Obj* `->` [IDLitParameter::]OnDataDisconnect, *ParameterName*

## Arguments

### ParameterName

An upper-case string containing the name of the parameter that was disconnected. The parameter must have been previously registered with the visualization.

## Keywords

None

## Example

Normally, an implementation of this method will contain a CASE statement that switches based on the value of the *ParameterName* argument. For example, the following sample code performs some action when the parameter name is `TEXTURE`:

```
PRO MyVis::OnDataDisconnect, ParameterName

CASE ParameterName OF
   'TEXTURE': BEGIN
   ;; do something to remove the ref. of the texture
   END
ENDCASE

END
```

## Version History

Introduced: 6.0

# IDLitParameter::RegisterParameter

The IDLitParameter::RegisterParameter procedure method registers a parameter with the visualization object. Registered parameters are displayed in the iTool parameter editor dialog, allowing users to interactively assign data values to individual visualization parameters.

## Syntax

*Obj* -> [IDLitParameter::]RegisterParameter, *Name* [, /BY_VALUE] [, DESCRIPTION=*string*] [, /INPUT] [, /OPTARGET] [, /OPTIONAL] [, /OUTPUT] [, TYPES=*string*]

## Arguments

### Name

Set this argument to a string specifying the name of the parameter.

## Keywords

### BY_VALUE

Set this keyword to indicate that this parameter is a by-value parameter. If a parameter is marked as by value, when data is associated with it a copy of the data is made and managed by this class.

### DESCRIPTION

Set this keyword to a string giving the full name or description of this object.

### INPUT

Set this keyword to indicate that this is an input parameter.

### OPTARGET

Set this keyword to indicate that this parameter may be the target of any operations.

### OPTIONAL

If this keyword is set, then this parameter is an optional parameter, and it is not required to be set. The default is OPTIONAL=0, indicating that it is required to be set.

### OUTPUT

Set this keyword to indicate that this is an output parameter.

### TYPES

Set this keyword to a scalar string or string array giving the data types that correspond to this parameter. See "iTool Data Types" in Chapter 3 of the *iTool Developer's Guide* manual for more on parameter data types.

## Version History

Introduced: 6.0

# IDLitParameter::SetData

The IDLitParameter::SetData function method is used to set data in this interface, associating a data object with a given parameter. This method can automatically perform type matching to determine which parameter to associate with a particular parameter or the user can specify a parameter name.

If a parameter name is provided by the user via the PARAMETER_NAME keyword, this method will query the given data object for a data item that is of one of the types supported by this parameter and associate the found data item with the parameter. This could be the data object provided or if the data object contains other data objects, one of its children. If a type match doesn't occur, the method will return 0.

If no parameter name is provided, this method will start with the first available parameter (non-associated parameters, starting with op-targets first) and attempt to perform a data type match. When a data type match between the parameter and the provided data item (or one of its contained items) the association between the two are made.

When a data match has been made, this object is made an observer of the data object and if the NO_UPDATE keyword is not set, the OnDataChangeUpdate() method is called on this object.

If a type match is found, but the given parameter already has a data object associated with it, the type match will continue.

If a match cannot be found, a value of 0 is returned.

## Syntax

*Result* = *Obj* -> [IDLitParameter::]SetData(*Data* [, /BY_VALUE] [, PARAMETER_NAME=*string*] [, /NO_UPDATE]

## Return Value

Returns 1 if the IDLitData object was successfully matched with a parameter registered with the visualization object, or 0 otherwise.

## Arguments

### Data

An IDLitData object to be matched with a parameter registered with the visualization object.

# Keywords

## BY_VALUE

Set this keyword to cause *Data* to be copied and managed by the visualization's parameter interface. If this keyword is not set, the data object is managed by the iTool system, and can be altered by other iTools.

## NO_UPDATE

Set this keyword to prevent the OnDataChangeUpdate method from being called when *Data* is associated with one of the visualization object's registered parameters. If this keyword is not set, the OnDataChangeUpdate method is called, providing the opportunity for subclasses of the visualization object to be notified that data associated with the parameter interface has changed.

## PARAMETER_NAME

Set this keyword to a scalar string containing the name of the registered parameter with which *Data* should be associated. If the iTool data type of the data contained in *Data* does not match one of the data types supported by the specified registered parameter, *Data* will not be associated with the registered parameter and this function will return zero.

# Version History

Introduced: 6.0

# IDLitParameter::SetParameterSet

The IDLitParameter::SetParameterSet function method is used to associate an IDLitParameterSet object with the visualization object's parameter interface. IDLitData objects contained in the parameter set object will be associated with the registered parameters of the visualization object, either based on the parameter names included in the parameter set object or on the iTool data types of the data objects. When the association of the parameter set's data objects with the visualization object's registered parameters is complete, the OnDataChangeUpdate method is called with the IDLitParameterSet object and the string `'<PARAMETER SET>'` as the arguments.

**Note**

When this method is called, the IDLitParameterSet object created when the visualization object was initialized will be disassociated from the object's parameter interface. This means that any individual data objects or parameter names previously added to the initial parameter set object will also be disassociated from the visualization object's parameter interface.

This method will not destroy or delete the information contained in the specified IDLitParameterSet object.

# Syntax

*Result* = *Obj* `->` [IDLitParameter::]SetParameterSet(*ParamSet*)

# Return Value

Returns 1 if the IDLitParameterSet object was successfully associated with the visualization object's parameter interface, or 0 otherwise.

# Arguments

## ParamSet

An IDLitParameterSet object to be associated with the visualization object's parameter interface.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitParameterSet

The IDLitParameterSet class is a specialized subclass of the IDLitDataContainer class that provides the ability to associate names with the contained IDLitData objects. This association allows the iTool developer to package a set of data parameters in a single container, which is then provided to the iTools system for processing a display.

In addition to providing a mechanism for associating IDLitData objects with parameter names, the IDLitParameterSet class allows you to incorporate an IDLitData object for which no parameter name is provided. These *auxiliary data* items are treated as parameters for which the parameter name is a null string (`''`). The auxiliary data mechanism allows you to associate any amount of data with a parameter set without the need to define parameter names.

This class is written in the IDL language. Its source code can be found in the file `idlitparameterset__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitDataContainer

## Creation

See “IDLitParameterSet::Init” on page 2951.

## Properties

Objects of this class have no properties of their own, but do have properties inherited from the superclass.

## Methods

This class has the following methods:

- IDLitParameterSet::Add
- IDLitParameterSet::Cleanup
- IDLitParameterSet::Copy
- IDLitParameterSet::Get

- IDLitParameterSet::GetByName
- IDLitParameterSet::GetParameterName
- IDLitParameterSet::Init
- IDLitParameterSet::Remove

In addition, this class inherits the methods of its superclass.

## Examples

See Chapter 3, “Data Management” in the *iTool Developer’s Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitParameterSet Properties

Objects of this class have no properties of their own, but do have properties inherited from the superclass.

# IDLitParameterSet::Add

The IDLitParameterSet::Add procedure method is used to add a data object to the parameter set.

# Syntax

*Obj* `->` [IDLitParameterSet::]Add, *Data* [, PARAMETER_NAME=*string*] [, /PRESERVE_LOCATION]

# Arguments

## Data

An object reference or array of object references to IDLitData objects to be added to the parameter set.

# Keywords

## PARAMETER_NAME

Set this keyword to a string or array of strings containing the names of parameters to be associated with the data objects. If this value is not provided, a null string (`''`) is associated with the data object. If the value of this keyword is an array with fewer elements than the array specified as the *Data* argument, null strings are associated with data objects for which no parameter name is specified.

## PRESERVE_LOCATION

Set this keyword to leave the PARENT property (of all data items specified by the *Data* argument) unchanged. Normally, when an item is added to a parameter set (or any data container), the item's PARENT property is changed to be the parameter set or data container object. This, in turn, changes the data item's identifier string, since the item's location in the iTools hierarchy has changed. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for details.) In many cases, it is desirable to leave the PARENT property unchanged when adding items to a parameter set.

## Version History

Introduced: 6.0

## See Also

IDLitParameterSet::Remove

# IDLitParameterSet::Cleanup

The IDLitParameterSet::Cleanup procedure method performs all cleanup on the parameter set object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitParameterSet::]Cleanup() (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitParameterSet::Copy

The IDLitParameterSet::Copy function method will return a copy of the parameter set and its contents. All items contained in the parameter set are copied when this method is called.

For individual data objects contained in the parameter set, the following values are *not* copied:

- Values of unregistered properties.
- Values of properties registered after the data object is created.
- Property attribute values.

**Note**

If an object has been added to a contained data object, only the object reference to the added object is copied.

## Syntax

*Result* = *Obj* -> [IDLitParameterSet::]Copy()

## Return Value

Returns an IDLitParameterSet object that is a copy of the parameter set object on which the method was called.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitParameterSet::Get

The IDLitParameterSet::Get function method is used to retrieve one or more IDLitData objects from the parameter set.

## Syntax

*Result* = *Obj* -> [IDLitParameterSet::]Get( [, /ALL] [, COUNT=*variable*] [, NAME=*variable*] [, POSITION=*integer*]

## Return Values

Returns an object reference or array of object references to the IDLitData objects specified, or returns -1 if the method fails.

## Arguments

None

## Keywords

### ALL

Set this keyword to return an array containing object references to all IDLitData items in the parameter set.

### COUNT

Set this keyword equal to a named variable that will contain the number of items returned by this function.

### NAME

Set this keyword equal to a named variable that will contain a string or string array of the parameter names associated with the returned IDLitData objects. If a returned data object has no parameter name, a null string ( '' ) is returned.

### POSITION

Set this keyword equal to a scalar or array containing the zero-based indices of the positions of the desired IDLitData objects within the parameter set.

## Version History

Introduced: 6.0

# IDLitParameterSet::GetByName

The IDLitParameterSet::GetByName function method returns the IDLitData object associated with a specified named parameter.

## Syntax

*Result* = *Obj* -> [IDLitParameterSet::]GetByName( *Names* [, COUNT=*variable*] [, NAME=*variable*] )

## Return Value

An object reference or array of object references to the IDLitData objects specified by the *Names* argument. If no matching parameter names are found, a null object is returned.

**Note**

If multiple parameter names are specified, the IDLitData objects are returned in the order in which they are stored in the IDLitParameterSet object, which is not necessarily the same as the order specified in the *Names* argument. Use the value returned by the NAME keyword to associate the parameter names with IDLitData objects in the returned array.

## Arguments

### Names

A scalar string or string array that contains the parameter names of the IDLitData objects to be retrieved from the parameter set.

**Note**

Parameter names can be supplied in any case; the search is case insensitive.

# Keywords

## NAME

Set this keyword equal to a named variable that will contain a scalar string or string array of the parameter names of the IDLitData objects returned by this method. When multiple parameter names are specified via the *Names* argument, the array returned in the NAME variable can be used to sort through the returned IDLitData objects by matching the indices of the two returned arrays.

## COUNT

Set this keyword equal to a named variable that will contain the number of items returned by this function.

# Version History

Introduced: 6.0

# IDLitParameterSet::GetParameterName

The IDLitParameterSet::GetParameterName function method retrieves the name of a specified parameter using a provided data object.

## Syntax

*Result* = *Obj* -> [IDLitParameterSet::]GetParameterName(*Data*, *Name*)

## Return Value

Returns an integer 1 if a parameter name was found for the specified IDLitData object, or 0 if no parameter name was found.

## Arguments

### Data

An IDLitData object for which the parameter name is being requested.

### Name

A named variable that will contain the parameter name associated with the object specified by the *oData* argument. If no parameter name is associated with the object specified by the *oData* argument, a null string (`''`) is returned.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitParameterSet::Init

The IDLitParameterSet::Init function method initializes the IDLitParameter object.

**Note**

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitParameterSet')

or

*Result* = *Obj* -> [IDLitParameterSet::]Init() (*Only in subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or 0 otherwise.

## Arguments

None

## Keywords

The IDLitParameterSet object has no properties of its own, but inherits the properties of its superclass, IDLitDataContainer. Any property listed under "IDLitDataContainer Properties" on page 2798 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitParameterSet::Remove

The IDLitParameterSet::Remove procedure method is used to remove a data item from the parameter set.

## Syntax

*Obj* -> [IDLitParameterSet::]Remove [, *Items*] [, /ALL] [, POSITION=*integer*]

## Arguments

### Items

An object reference or array of object references to IDLitData objects to be removed from the parameter set.

## Keywords

### ALL

Set this keyword to remove all items from the parameter set. If this keyword is set, the *Items* parameter is not required.

### POSITION

Set this keyword equal to a scalar or array containing the zero-based indices within the parameter set of the specified IDLitData objects to be removed. If this keyword is set, the *Items* parameter is not required

## Version History

Introduced: 6.0

## See Also

IDLitParameterSet::Add

# IDLitReader

The IDLitReader class defines the interface used to construct file readers for the iTools framework. Objects of this class are not intended to be created as standalone entities; rather, this class should be included as the superclass of an iTool file reader class.

This class is written in the IDL language. Its source code can be found in the file `idlitreader__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitComponent

IDLitIMessaging

## Creation

See “IDLitReader::Init” on page 2962.

## Properties

Objects of this class do not have any properties of their own, but do have properties inherited from any superclasses.

## Methods

This class has the following methods:

- IDLitReader::Cleanup
- IDLitReader::GetData
- IDLitReader::GetFileExtensions
- IDLitReader::GetFilename
- IDLitReader::GetProperty
- IDLitReader::Init
- IDLitReader::IsA

- IDLitReader::SetFilename
- IDLitReader::SetProperty

In addition, this class inherits the methods of its superclasses.

## Examples

See Chapter 8, “Creating a File Reader” in the *iTool Developer’s Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitReader Properties

Objects of this class do not have any properties of their own, but do have properties inherited from any superclasses.

# IDLitReader::Cleanup

The IDLitReader::Cleanup procedure method performs all cleanup on the object, and should be called by the subclass' Cleanup method.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitReader::]Cleanup (*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitReader::GetData

The IDLitReader::GetData function method is called by the system to retrieve the data from the current file. When called, the reader should access the current filename and read the desired data. Once the information is loaded, the reader should place the obtained data in a data object, which is then passed back to the system.

This method will contain a majority of the implementation for a new reader class.

## Syntax

*Result* = *Obj* -> [IDLitReader::]GetData(*Data*)

## Return Value

Returns a 1 if successful, or a 0 if the initialization failed.

## Arguments

### Data

A data object that contains the read information. The reader determines the exact type and format of this data object, which keys off the type of information being read and what the format supports.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitReader::GetFileExtensions

The IDLitReader::GetFileExtensions function method is called by the system to retrieve the file extensions supported by this particular reader.

## Syntax

*Result* = *Obj* -> [IDLitReader::]GetFileExtensions([COUNT=*variable*])

## Return Value

Returns a scalar or string array that contains the file extensions associated with this reader.

## Arguments

None

## Keywords

### COUNT

Set this keyword equal to a named variable that will contain the number of items returned by this function.

## Version History

Introduced: 6.0

# IDLitReader::GetFilename

The IDLitReader::GetFilename function method is called by the system to retrieve the current filename associated with this reader. Due to the automated nature of the file reader system, filenames can be associated with a file reader and then read at a later time. This method allows direct access to the file currently associated with the reader.

In addition, this methodology is helpful when multiple reads are performed from a given file.

## Syntax

*Result* = *Obj* -> [IDLitReader::]GetFilename()

## Return Value

Returns a string containing the current file name associated with this reader, or an empty string if no filename has been associated.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitReader::GetProperty

The IDLitReader::GetProperty procedure method retrieves the value of an IDLitReader property, and should be called by the subclass' GetProperty method. This method also retrieves properties defined in the superclasses.

## Syntax

*Obj* -> [IDLitReader::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under "IDLitReader Properties" on page 2956 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitReader::Init

The IDLitReader::Init function method initializes the IDLitReader object, and should be called by the subclass' Init method. This method also calls the superclass' Init method.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

# Syntax

*Obj* = OBJ_NEW('IDLitReader', *Extensions* [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLitReader::]Init(*Extensions* [, *PROPERTY=value*])

(*Only in subclass' Init method.*)

# Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

# Arguments

## Extensions

A scalar or string array containing the file extensions that are common for this file type. These values should not include the period that is often associated with file extensions (a correct value is "jpeg" not ".jpeg").

## Keywords

Any property listed under “IDLitReader Properties” on page 2956 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitReader::IsA

The IDLitReader::IsA function method is called by the system to determine if the given file is of the type supported by this file reader. Often this is used to determine what file reader to use when opening a new file.

The default behavior provided by this method is to check the file extension on the provided file name with the extensions provided to this object during initialization.

When a new reader is implemented, the default behavior can be used, or the developer can provide further logic to determine if the provided file is the correct type.

## Syntax

*Result* = *Obj* -> [IDLitReader::]IsA(*Filename*)

## Return Value

Returns a 1 if the reader supports this type of file, or a 0 if the reader does not support this type of file.

## Arguments

### Filename

A string representing of the filename, which is used to check and determine if the reader supports its format.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitReader::SetFilename

The IDLitReader::SetFilename procedure method is called by the system to set the current filename associated with this reader. Due to the automated nature of the file reader system, filenames can be associated with a file reader and then the read at a later time.

## Syntax

*Obj* -> [IDLitReader::]SetFilename, *Filename*

## Arguments

### Filename

A string that contains the filename associated with this reader.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitReader::SetProperty

The IDLitReader::SetProperty procedure method sets the value of an IDLitReader property, and should be called by the subclass' SetProperty method. This method also calls the superclass' SetProperty method.

## Syntax

*Obj* -> [IDLitReader::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under "IDLitReader Properties" on page 2956 that contains the word "Yes" in the "Set" column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitTool

The IDLitTool class represents all the functionality provided by a particular instance of an IDL Intelligent Tool. It provides the management systems for the underlying iTool functionality and implements the desired interfaces for external parties to interact with this functionality in a known manner.

This class is written in the IDL language. Its source code can be found in the file `idlittool__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Note on the IDLitToolbase Class

All iTools included with the IDL release are based on a subclass of the IDLitTool class named IDLitToolbase. If your aim is to create a new iTool that shares the common features of the iTools included with IDL, you should base your new iTool on the IDLitToolbase class. Since IDLitToolbase is a subclass of IDLitTool, it inherits all of IDLitTool's methods and properties. Additional features included in the IDLitToolbase class are described in "Subclassing from the IDLitToolbase Class" in Chapter 5 of the *iTool Developer's Guide* manual.

## Superclasses

IDLitContainer

IDLitIMessaging

## Creation

See "IDLitTool::Init" on page 2993.

## Properties

Objects of this class have the following properties. See "IDLitTool Properties" on page 2970 for details on individual properties.

- DESCRIPTION
- ICON
- NAME
- TYPE

- UPDATE_BYTYPE
- VERBOSE
- VERSION

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLitTool::Add
- IDLitTool::AddService
- IDLitTool::Cleanup
- IDLitTool::CommitActions
- IDLitTool::DisableUpdates
- IDLitTool::DoAction
- IDLitTool::DoSetProperty
- IDLitTool::DoUIService
- IDLitTool::EnableUpdates
- IDLitTool::GetCurrentManipulator
- IDLitTool::GetFileReader
- IDLitTool::GetFileWriter
- IDLitTool::GetManipulators
- IDLitTool::GetOperations
- IDLitTool::GetProperty
- IDLitTool::GetSelectedItems
- IDLitTool::GetService
- IDLitTool::GetVisualization
- IDLitTool::Init
- IDLitTool::RefreshCurrentWindow
- IDLitTool::Register
- IDLitTool::RegisterFileReader

- IDLitTool::RegisterFileWriter
- IDLitTool::RegisterManipulator
- IDLitTool::RegisterOperation
- IDLitTool::RegisterVisualization
- IDLitTool::SetProperty
- IDLitTool::UnRegister
- IDLitTool::UnRegisterFileReader
- IDLitTool::UnRegisterFileWriter
- IDLitTool::UnRegisterManipulator
- IDLitTool::UnRegisterOperation
- IDLitTool::UnRegisterVisualization

In addition, this class inherits the methods of its superclasses.

## Examples

See "Example: Simple iTool" in Chapter 5 of the *iTool Developer's Guide* manual.

## Version History

Introduced: 6.0

## See Also

Chapter 5, "Creating an iTool" in the *iTool Developer's Guide* manual

# IDLitTool Properties

IDLitTool objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLitTool::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLitTool::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLitTool::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## DESCRIPTION

This property contains a string representing the full name or description of this object.

| | | | |
|---|---|---|---|
| **Property Type** | STRING | | |
| **Name String** | Description | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ICON

A string identifying the icon that should be used when displaying the iTool object. See “System Resources” in Chapter 2 of the *iTool Developer’s Guide* manual for additional details.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## NAME

A string representing the name of this object.

| | |
|---|---|
| **Property Type** | STRING |
| **Name String** | Name |

| | | | |
|---|---|---|---|
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TYPE

A string or vector of strings that identify the type(s) that this iTool represents.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## UPDATE_BYTYPE

A Boolean value controlling whether the given iTool will add new functionality to it as new visualization types are added. By default, when a new visualization is added to the iTool, any functionality associated with that visualization type is added to the iTool. If this property is set to zero (False), this updating is disabled.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## VERBOSE

A named variable that will control the verbose logging of the iTool. If set to a non-zero value, the iTool will log more information than normal. If this keyword is set to 0, minimal logging (error conditions only) will be sent to the logging system.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## VERSION

A named variable that will be set to the version of the iTool system.

| | |
|---|---|
| **Property Type** | String |
| **Name String** | *not displayed* |

| | | | |
|---|---|---|---|
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLitTool::Add

The IDLitTool::Add procedure method adds any item to the iTool. If called with a Visualization, that visualization is added to the current IDLitWindow object. If called with a data object, that data object is placed in the systems data manager. All other items are added to the iTool container.

## Syntax

*Obj* -> [IDLitTool::]Add, *Item*

## Arguments

### Item

The item to add to the iTool.

## Keywords

This method passes keywords to the Add method of the appropriate object. If the target destination is a data object, no keywords are passed. If the target destination is a visualization object, the keywords are passed to the IDLitWindow::Add method; otherwise, the keywords are passed to the IDLitContainer::Add method.

## Version History

Introduced: 6.0

# IDLitTool::AddService

The IDLitTool::AddService procedure method adds a service to the iTool. Unlike registration methodologies provided by the iTool, the method takes an existing object and adds it to the service repository in the iTool.

When a service is added to the system, a description of this service class is placed in the tools service folder. If it is desired to retrieve this descriptor at a later time, the iTool relative identifier would be `SERVICES/identifier`, where `identifier` is the identifier provided to this method.

## Syntax

*Obj* -> [IDLitTool::]AddService, *Service*

## Arguments

### Service

Set this variable to the service to add to the tools service repository. This service can be retrieved at a later point in time using its identifier (specified when creating the service object via the identifier keyword).

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::Cleanup

The IDLitTool::Cleanup procedure method performs all cleanup on the object, and should be called by the Cleanup method of a subclass.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitTool::]Cleanup (*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::CommitActions

The IDLitTool::CommitActions procedure method commits all pending transactions to the undo-redo buffer and causes a refresh of the current window.

This method is designed to be used in conjunction with the IDLitTool::DoSetProperty method.

## Syntax

*Obj* -> [IDLitTool::]CommitActions

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

## See Also

IDLitTool::DoSetProperty

# IDLitTool::DisableUpdates

The IDLitTool::DisableUpdates procedure method disables all drawing updates to the current window and UI updates (menu sensitivity) being passed to the user interface. After this method is called, updates are re-enabled by calling the EnableUpdates method.

## Syntax

*Obj* -> [IDLitTool::]DisableUpdates

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::DoAction

The IDLitTool::DoAction function method initiates an operation or action in the iTool object. The identifier that is passed in as the argument to this method specifies the action that executes.

## Syntax

*Result* = *Obj* -> [IDLitTool::]DoAction(*Identifier*)

## Return Value

Returns 1 if the action succeeds, or 0 if the action fails.

## Arguments

### Identifier

This argument is set to a string identifier that specifies the object in the iTool that performs the operation that it implements.

## Keywords

All keywords are passed to the DoAction function of the object in the iTool that performs the operation.

## Version History

Introduced: 6.0

# IDLitTool::DoSetProperty

The IDLitTool::DoSetProperty function method sets a property on a target component object, and places the change in the undo/redo transaction buffer.

**Note**

In order to commit the change to the undo/redo transaction buffer, you must call the IDLitTool::CommitActions method. The property change is not actually undoable until it has been committed.

The separation of addition of the change to the buffer and commit of the change allows you to "package" several property changes into a single undo/redo transaction. The call to the CommitActions method will commit any changes that have been performed but not committed. For example, the following statements change two properties on an iTool component (`oTarget`) and commit them together:

```
targetID = oTarget -> GetFullIdentifier()
status = oTool -> DoSetProperty(targetID, 'Property1', 'Value 1')
status = oTool -> DoSetProperty(targetID, 'Property2', 'Value 2')
oTool -> CommitActions
```

If the user later undoes the action, both property value changes will be reversed in one step.

## Syntax

*Result* = *Obj* -> [IDLitTool::]DoSetProperty(*TargetIdentifier*, *PropertyIdentifier*, *Value*)

## Return Value

Returns 1 if the SetProperty was successful, or 0 otherwise.

**Note**

If successful, you are responsible for calling IDLitTool::CommitActions to complete the transaction.

# Arguments

## TargetIdentifier

A scalar string or a string array containing the full object identifiers of the objects on which the property is being set.

## PropertyIdentifier

A scalar string containing the property identifier to change. *PropertyIdentifier* must be a registered property of the target objects.

## Value

The new property value.

# Keywords

None

# Version History

Introduced: 6.0

# See Also

IDLitTool::CommitActions

# IDLitTool::DoUIService

The IDLitTool::DoUIService function method initiates a request for a UI service to execute. This method allows underlying iTool functionality to perform user-interface interactions without having a direct connection to the user interface portion of the iTool.

An example of an iTool UI service would be the **File → Open** command, which will prompt the user to select a file using the standard file open dialog. This command is identified by setting the *ServiceIdentifier* argument to `FileOpen`. See Chapter 12, "Creating a User Interface Service" in the *iTool Developer's Guide* manual for more information about UI services.

## Syntax

*Result* = *Obj* -> [IDLitTool::]DoUIService(*ServiceIdentifier*, *Requestor*)

## Return Value

Returns 1 if the action succeeds, or 0 if the action fails.

## Arguments

### ServiceIdentifier

A string identifier that specifies the UI service being requested. This identifier is passed to the tools user interface for control dispatching purposes.

### Requestor

An object reference to the object that is requesting the UI service. The UI service uses this object to obtain any information particular to the interaction taking place.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::EnableUpdates

The IDLitTool::EnableUpdates procedure method re-enables all drawing updates to the current window and UI updates (menu sensitivity) being passed to the user interface. After this method is called, updates can be disabled by calling the DisableUpdates method.

## Syntax

*Obj* -> [IDLitTool]::EnableUpdates

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::GetCurrentManipulator

The IDLitTool::GetCurrentManipulator function method returns the current manipulator in the system.

## Syntax

*Result* = *Obj* -> [IDLitTool]::GetCurrentManipulator()

## Return Value

Returns an object reference to the current manipulator.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::GetFileReader

The IDLitTool::GetFileReader function method retrieves a file reader registered with the iTool object. If the requested item does not exist in the given iTool, the system will be queried to see if it supports an object of the given identifier.

## Syntax

*Result* = *Obj* -> [IDLitTool::]GetFileReaders(*Identifier* [, /ALL] [, COUNT=*variable*])

## Return Value

Returns the object descriptors constructed for the registered file reader.

If the ALL keyword is set, the *Identifier* argument is ignored and the resulting list of object descriptors will be both those registered with the specific iTool and those file readers registered with the system.

## Arguments

### Idenitifer

A string representing the single level identifier of the item that is being requested. This identifier is the value provided during object registration and is either supplied using the IDENTIFIER keyword during registration, or constructed automatically by the name that is provided during the registration call.

## Keywords

### ALL

Set this keyword to return all file readers registered with the iTool and the system.

### COUNT

Set this keyword to a named variable that will contain the number of object descriptors returned by this method.

## Version History

Introduced: 6.0

# IDLitTool::GetFileWriter

The IDLitTool::GetFileWriter function method retrieves a file writer registered with the iTool object. If the requested item does not exist in the given iTool, the system will be queried to see if it supports an object of the given identifier.

## Syntax

*Result* = *Obj* -> [IDLitTool::]GetFileWriters(*Identifier* [, /ALL] [, COUNT=*variable*])

## Return Value

Returns the object descriptors constructed for the registered file writer.

If the ALL keyword is set, the *Identifier* argument is ignored and the resulting list of object descriptors will be both those registered with the specific iTool and those file writers registered with the system.

## Arguments

### Identifier

A string representing the identifier of the item that is being requested. This identifier is the value provided during object registration and is either supplied using the IDENTIFIER keyword during registration, or constructed automatically by the name that is provided during the registration call.

## Keywords

### ALL

Set this keyword to return all file writers registered with the iTool and the system.

### COUNT

Set this keyword to a named variable that will contain the number of object descriptors returned by this method.

## Version History

Introduced: 6.0

# IDLitTool::GetManipulators

The IDLitTool::GetManipulators function method retrieves the manipulators registered with the iTool object. Unlike other items in the iTool and due to the active nature of the subsystem, manipulators are instantiated when registered.

## Syntax

*Result* = *Obj* -> [IDLitTool::]GetManipulators([COUNT=*variable*])

## Return Value

Returns the object references to the manipulators that were instantiated when items were registered with the iTool.

## Arguments

None

## Keywords

### COUNT

Set this keyword to a named variable that will contain the number of object descriptors returned by this method.

## Version History

Introduced: 6.0

# IDLitTool::GetOperations

The IDLitTool::GetOperations function method retrieves the operations registered with the iTool object.

**Note**

This routine returns a set of object descriptor classes that reference the items registered with the iTool. In addition, if the operation folder in the registry contains sub-folders, the returned list will contain IDLitContainer classes, each containing sub-operations.

## Syntax

*Result* = *Obj* -> [IDLitTool::]GetOperations([, IDENTIFIER=*string*] [, COUNT=*variable*])

## Return Value

Returns the object descriptors constructed for the registered operations.

## Arguments

None

## Keywords

### IDENTIFIER

Set this keyword to an optional identifier that identifies the location in the operation hierarchy to retrieve the operation object descriptors from.

### COUNT

Set this keyword to a named variable that will contain the number of object descriptors returned by this method.

## Version History

Introduced: 6.0

# IDLitTool::GetProperty

The IDLitTool::GetProperty procedure method retrieves the value of an IDLitTool property, and should be called by the subclass' GetProperty method. This method also retrieves properties defined in the superclasses.

## Syntax

*Obj* -> [IDLitTool::]GetProperty, [*PROPERTY=variable]*

## Arguments

None

## Keywords

Any property listed under "IDLitTool Properties" on page 2970 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitTool::GetSelectedItems

The IDLitTool::GetSelectedItems function method returns a vector of references to the objects currently selected within the current window in the iTool. If no objects are currently selected, this function returns `-1`.

## Syntax

*Result* = *Obj* -> [IDLitTool::]GetSelectedItems([COUNT=*variable*])

## Return Value

Returns a vector of references to the currently selected objects. If no objects are currently selected, this function returns `-1`.

## Arguments

None

## Keywords

### COUNT

Set this keyword to a named variable that will contain the number of valid items returned by this function.

## Version History

Introduced: 6.0

# IDLitTool::GetService

The IDLitTool::GetService method retrieves a service that has been registered with the iTool.

## Syntax

*Result* = *Obj* -> [IDLitTool::]GetService(*IdService*)

## Return Value

Returns an object reference to the service.

## Arguments

### IdService

The identifier of the desired service.

**Note**

*IdService* should specify only the relative identifier, not the fully-qualified identifier. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for details.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::GetVisualization

The IDLitTool::GetVisualization function method retrieves a visualization registered with the iTool object. If the requested item does not exist in the given iTool, the system will be queried to see if it supports an object of the given identifier.

## Syntax

*Result* = *Obj* -> [IDLitTool::]GetVisualizations(*Identifier* [, /ALL] [, COUNT=*variable*])

## Return Value

Returns the object descriptors constructed for the registered visualizations. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object descriptors.)

If the ALL keyword is set, the *Identifier* argument is ignored and the resulting list of object descriptors will be both those registered with the specific iTool as well as those visualizations registered with the system.

## Arguments

### Identifier

A string containing the relative identifier of the item that is being requested. This identifier is the value provided during object registration and is either supplied using the IDENTIFIER keyword during registration, or constructed automatically by the name that is provided during the registration call. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of relative vs. fully-qualified identifiers.)

## Keywords

### ALL

Set this keyword to return all visualizations registered with the iTool and the system.

### COUNT

Set this keyword to a variable that will contain the number of object descriptors returned by this method. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object descriptors.)

## Version History

Introduced: 6.0

# IDLitTool::Init

The IDLitTool::Init function method initializes the IDLitTool object, and should be called by the Init method of a subclass.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitTool'[, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLitTool::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLitTool Properties" on page 2970 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitTool::RefreshCurrentWindow

The IDLitTool::RefreshCurrentWindow procedure method redraws the current window of the iTool. The redraw will occur only if updates are enabled in the iTool.

## Syntax

*Obj* -> [IDLitTool]::RefreshCurrentWindow

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::Register

The IDLitTool::Register procedure method registers a generic object subclassed from the IDLitComponent class with the iTool. Once registered, the iTool has the ability to instantiate this type of component when needed. Unlike the other provided methods to register components, this method is generic.

This method allows items to be registered in the standard registry folders of the IDLitTool object, and can be used as well for the creation of new folders. If the provided identifier specifies a folder that does not currently exist in the iTool, it is created.

This method performs none of the validation performed by the specific registration functions. As such, it can cause issues with iTool operation, if used incorrectly. You should use the following related methods for registering certain, specific components to insure validation:

- File readers — “IDLitTool::RegisterFileReader” on page 2999.
- File writers — “IDLitTool::RegisterFileWriter” on page 3001.
- Manipulators — “IDLitTool::RegisterManipulator” on page 3003.
- Operations — “IDLitTool::RegisterOperation” on page 3005.
- Visualizations — “IDLitTool::RegisterVisualization” on page 3007

# Syntax

*Obj* -> [IDLitTool::]Register, *Name*, *ClassName* [, DESCRIPTION=*string*] [, ICON=*string*] [, IDENTIFIER=*string*] [, PROXY=*string*]

# Arguments

## Name

A string containing the human readable name of the component type being registered with the iTool.

## ClassName

A string containing the class name of the component being registered. This class name is used by the iTool object to instantiate a component of this type when requested by the system.

# Keywords

**Note**

Any keywords provided to this routine but not listed here are treated as property defaults for the registered item and applied to the registered object when it is created.

## DESCRIPTION

Set this keyword to a string that provides a brief description of the component being registered.

## ICON

Set this keyword to the icon that should be used when displaying the iTool object. See "System Resources" in Chapter 2 of the *iTool Developer's Guide* manual for additional details.

## IDENTIFIER

Set this keyword to the identifier that should be used by the system for this visualization type. If not provided, an identifier is constructed from the provided *Name* value.

To use one of the iTool-provided registration locations, the value of this keyword should contain the destination for the new component that is being registered. Valid destinations in the iTool are:

- Visualizations
- Operations
- Manipulators
- File Writers
- File Readers

## PROXY

Set this keyword to the identifier of the object that this registered item should utilize instead of providing a new object descriptor. If a proxy is registered, all requests and actions performed to this item are routed to the item specified by the identifier provide to this keyword. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object descriptors.)

## Version History

Introduced: 6.0

# IDLitTool::RegisterFileReader

The IDLitTool::RegisterFileReader procedure method registers a file reader component with the iTool. Once registered, the iTool has the ability to instantiate this type of component when needed.

When a reader class is registered with the system, an object descriptor for this operation class is placed in the iTool's file reader folder. To retrieve this descriptor at a later time, the iTool relative identifier would be `FILE READERS/identifier`, where `identifier` is the identifier provided to this method.

## Syntax

*Obj* -> [IDLitTool::]RegisterFileReader, *Name*, *ClassName*
[, DESCRIPTION=*string*] [, ICON=*string*] [, IDENTIFIER=*string*]
[, PROXY=*string*]

## Arguments

### Name

The human readable name of the component type being registered with the iTool.

### ClassName

A string containing the class name of the component being registered. This class name is used by the iTool object to instantiate a component of this type when requested by the system.

## Keywords

**Note**

Any keywords provided to this routine but not listed here are treated as property defaults for the registered item and applied to the registered object when it is created.

### DESCRIPTION

Set this keyword to a string that provides a brief description of the component being registered.

### ICON

Set this keyword to the icon that should be used when displaying the file reader in an iTool browser. See "System Resources" in Chapter 2 of the *iTool Developer's Guide* manual for additional details.

### IDENTIFIER

Set this keyword to the identifier that should be used by the system for this visualization type. If not provided, an identifier is constructed from the provided *Name* value.

While some items registered with an iTool can contain sub-folders that are specified by identifiers, the file reader registration cannot. As such, any nested identifiers that are registered are not visible to the iTool system.

### PROXY

Set this keyword to the identifier of the object that this registered item should utilize instead of providing a new object descriptor. If a proxy is registered, all requests and actions performed on this item are routed to the item specified by the identifier provided for this keyword. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object descriptors.)

## Version History

Introduced: 6.0

# IDLitTool::RegisterFileWriter

The IDLitTool::RegisterFileWriter procedure method registers a file writer component with the iTool. Once registered, the iTool has the ability to instantiate this type of component when needed.

When a writer class is registered with the system, an object descriptor for this operation class is placed in the iTool's file writer folder. To retrieve this descriptor at a later time, the iTool relative identifier would be `FILE WRITERS/identifier`, where `identifier` is the identifier provided to this method.

# Syntax

*Obj* -> [IDLitTool::]RegisterFileWriter, *Name*, *ClassName*
[, DESCRIPTION=*string*] [, ICON=*string*] [, IDENTIFIER=*string*]
[, PROXY=*string*]

# Arguments

## Name

A string containing the human readable name of the component type being registered with the iTool.

## ClassName

A string containing the class name of the component being registered. The iTool object uses this class name to instantiate a component of this type when requested by the system.

# Keywords

**Note**

Any keywords provided to this routine but not listed here are treated as property defaults for the registered item and applied to the registered object when it is created.

## DESCRIPTION

Set this keyword to a string that provides a brief description of the component being registered.

### ICON

Set this keyword to the icon that should be used when displaying the file writer in an iTool browser. See "System Resources" in Chapter 2 of the *iTool Developer's Guide* manual for additional details.

### IDENTIFIER

Set this keyword to the identifier that should be used by the system for this visualization type. If not provided, an identifier is constructed from the provided *Name* value.

While some items registered with an iTool can contain sub-folders that are specified by identifiers, the file writer registration cannot. As such, any nested identifiers that are registered are not visible to the iTool system.

### PROXY

Set this keyword to the identifier of the object that this registered item should utilize instead of providing a new object descriptor. If a proxy is registered, all requests and actions performed on this item are routed to the item specified by the identifier provided for this keyword. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object descriptors.)

## Version History

Introduced: 6.0

# IDLitTool::RegisterManipulator

The IDLitTool::RegisterManipulator procedure method registers a manipulator component with the iTool. Once registered, the iTool has the ability to instantiate this type of component when needed.

When a manipulator class is registered with the system, an object of the given class is created and added to the tools manipulator manager (an instance of IDLitManipulatorManager). To reference the new manipulator, the identifier that is provided should be prepended with the MANIPULATORS identifier level.

## Syntax

*Obj* -> [IDLitTool::]Manipulator, *Name*, *ClassName* [, /DEFAULT] [, DESCRIPTION=*string*] [, ICON=*string*] [, IDENTIFIER=*string*]

## Arguments

### Name

A string containing the human readable name of the component type being registered with the iTool.

### ClassName

A string containing the class name of the component being registered. This class name is used by the iTool object to instantiate a component of this type when requested by the system.

## Keywords

**Note**

Any keywords provided to this routine but not listed here are treated as property defaults for the registered item and applied to the registered object when it is created.

### DEFAULT

If set, this registered item will be treated as the default manipulator for this iTool. Only one default manipulator can exist at anytime.

### DESCRIPTION

Set this keyword to a string that provides a brief description of the component being registered.

### ICON

Set this keyword to the icon that should be used when displaying the manipulator in an iTool menubar. See "System Resources" in Chapter 2 of the *iTool Developer's Guide* manual for additional details.

### IDENTIFIER

Set this keyword to the identifier that should be used by the system for this visualization type. If not provided, an identifier is constructed from the provided name value.

## Version History

Introduced: 6.0

# IDLitTool::RegisterOperation

The IDLitTool::RegisterOperation procedure method registers an operation component with the iTool. Once registered, the iTool has the ability to instantiate this type of operation when needed.

When an operation class is registered with the system, an object descriptor for this operation class is placed in the tools operations folder. To retrieve this descriptor at a later time, the iTool relative identifier would be `OPERATIONS/identifier,` where `identifier` is the identifier provided to this method.

# Syntax

*Obj* -> [IDLitTool::]RegisterOperation, *Name*, *ClassName* [, DESCRIPTION=*string*] [, ICON=*string*] [, IDENTIFIER=*string*] [, PROXY=*string*]

# Arguments

## Name

A string containing the human readable name of the operation type being registered with the iTool. If the name includes leading identifier values that indicates a location in the operation hierarchy of the iTool, the new operation shall be placed in the target location.

If the target location specified by the name does not exist in the tools operation hierarchy, it is created.

## ClassName

A string containing the class name of the operation component being registered. This class name is used by the iTool object to instantiate an operation component of this type when requested.

# Keywords

**Note**

Any keywords provided to this routine but not listed here are treated as property defaults for the registered item and applied to the registered object when it is created.

### DESCRIPTION

Set this keyword to a string that provides a brief description of the component being registered.

### ICON

Set this keyword to the icon that should be used when displaying the operation in an iTool browser. See "System Resources" in Chapter 2 of the *iTool Developer's Guide* manual for additional details.

### IDENTIFIER

Set this keyword to the identifier that should be used by the system for this component type. If not provided, an identifier is constructed from the provided name value.

If a multiple level identifier is provided (indicated by the presence of a "/"), the registered item is placed in a subfolder of the tools operation folder. If the specified folder is not present in the iTool at registration time, it is created. It is this functionality that allows operations to be classified in logical groupings and results in sub-menu items in the operations menus of the iTool interface.

### PROXY

Set this keyword to the identifier of the object that this registered item should utilize instead of providing a new object descriptor. If a proxy is registered, all requests and actions performed on this item are routed to the item specified by the identifier provided for this keyword. (See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of object descriptors.)

## Version History

Introduced: 6.0

# IDLitTool::RegisterVisualization

The IDLitTool::RegisterVisualization procedure method registers a visualization component with the iTool. Once registered, the iTool has the ability to instantiate this type of visualization when needed.

When a visualization class is registered with the system, an object descriptor for this visualization class is placed in the iTool's visualization folder. To retrieve this descriptor at a later time, the iTool relative identifier would be: `VISUALIZATIONS/identifier` where identifier is the identifier provided to this method.

## Syntax

*Obj* -> [IDLitTool::]RegisterVisualization, *Name*, *ClassName* [, /DEFAULT] [, DESCRIPTION=*string*] [, ICON=*string*] [, IDENTIFIER=*string*] [, PROXY=*string*]

## Arguments

### Name

A string containing the human readable name of the visualization type being registered with the iTool.

### ClassName

A string containing the class name of the visualization component being registered. The iTool object uses this class name to instantiate a visualization component of this type when requested.

## Keywords

**Note**

Any keywords provided to this routine but not listed here are treated as property defaults for the registered item and applied to the registered object when it is created.

### DEFAULT

If set, this registered item will be treated as the default visualization for this iTool. Only one default visualization can exist at a time.

### DESCRIPTION

Set this keyword to a string that provides a brief description of the component being registered.

### ICON

Set this keyword to the icon that should be used when displaying the visualization in an iTool browser. See "System Resources" in Chapter 2 of the *iTool Developer's Guide* manual for additional details.

### IDENTIFIER

Set this keyword to the identifier that should be used by the system for this visualization type. If not provided, an identifier is constructed from the provided name value.

While some items registered with an iTool can contain sub-folders that are specified by identifiers, the visualization registration cannot. As such, any nested identifiers that are registered are not visible to the iTool system.

### PROXY

Set this keyword to the identifier of the object that this registered item should utilize instead of providing a new object descriptor. If a proxy is registered, all requests and actions performed on this item are routed to the item specified by the identifier provided for this keyword.

## Version History

Introduced: 6.0

# IDLitTool::SetProperty

The IDLitTool::SetProperty procedure method sets the value of an IDLitTool property, and should be called by the subclass' SetProperty method. This method also calls the superclass' SetProperty method.

## Syntax

*Obj* -> [IDLitTool::]SetProperty[, *PROPERTY=value]*

## Arguments

None

## Keywords

Any property listed under "IDLitTool Properties" on page 2970 that contains the word "Yes" in the "Set" column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

## See Also

IDLitTool::DoSetProperty

# IDLitTool::UnRegister

The IDLitTool::UnRegister procedure method unregisters a component with the iTool. When a component is unregistered, it is no longer available to perform whatever function it performs, and it is removed from iTool menus and toolbars.

# Syntax

*Obj* -> [IDLitTool::]UnRegister, *Identifier*

# Arguments

## Identifier

Set this to the relative identifier of the component to be removed from the iTool. To remove a component from the standard folders in the iTool's content registry, this identifier should contain the location of the component as well as the component identifier itself. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of iTool identifiers.

Valid destinations in the iTool are:

- Visualizations
- Operations
- Manipulators
- File Writers
- File Readers

# Keywords

None

# Version History

Introduced: 6.0

# IDLitTool::UnRegisterFileReader

The IDLitTool::UnRegisterFileReader procedure method unregisters a file reader component with the iTool. When a file reader is unregistered, it is no longer available to import files into the iTool, and it is removed from iTool menus and toolbars.

## Syntax

*Obj* -> [IDLitTool::]UnRegisterFileReader, *Identifier*

## Arguments

### Identifier

Set this to the relative identifier of the file reader to be removed from the iTool. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of iTool identifiers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::UnRegisterFileWriter

The IDLitTool::UnRegisterFileWriter procedure method unregisters a component with the iTool. When a file writer is unregistered, it is no longer available to export files from the iTool, and it is removed from iTool menus and toolbars.

## Syntax

*Obj* -> [IDLitTool::]UnRegisterFileWriter, *Identifier*

## Arguments

### Identifier

Set this to the relative identifier of the file writer to be removed from the iTool. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of iTool identifiers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::UnRegisterManipulator

The IDLitTool::UnRegisterManipulator procedure method unregisters a manipulator component with the iTool. When a manipulator is unregistered, it is removed from iTool menus and toolbars.

## Syntax

*Obj* -> [IDLitTool::]UnRegisterManipulator, *Identifier*

## Arguments

### Identifier

Set this to the relative identifier of the manipulator to be removed from the iTool. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of iTool identifiers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::UnRegisterOperation

The IDLitTool::UnRegisterOperation procedure method unregisters an operation component with the iTool. When an operation is unregistered, it is no longer available to perform actions within the iTool, and it is removed from iTool menus and toolbars.

## Syntax

*Obj* -> [IDLitTool::]UnRegisterOperation, *Identifier*

## Arguments

### Identifier

Set this to the relative identifier of the component to be removed from the iTool. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of iTool identifiers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitTool::UnRegisterVisualization

The IDLitTool::UnRegisterVisualization procedure method unregisters a visualization component with the iTool. When a visualization is unregistered, visualizations of its type can no longer be created by the iTool, and it is removed from iTool menus and toolbars.

## Syntax

*Obj* -> [IDLitTool::]UnRegisterVisualization, *Identifier*

## Arguments

### Identifier

Set this to the relative identifier of the visualization to remove from the iTool. See "iTool Object Identifiers" in Chapter 2 of the *iTool Developer's Guide* manual for a discussion of iTool identifiers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI

The IDLitUI class serves as the link between the underlying functionality of an iTool and the IDL Widget interface that is displayed to the user. The user interface object provides the following functionality:

- Access to and communication with the underlying iTool object.
- Registration of various user interface elements that are part of the iTool.
- Registration and management of dialog sub-elements that are used by the iTool to perform specific tasks.

For additional information on the IDLitUI class, and user interface issues in general, see Chapter 10, "iTool User Interface Architecture" in the *iTool Developer's Guide* manual.

This class is written in the IDL language. Its source code can be found in the file `idlitui__define.pro` in the `lib/itools/ui_widgets` subdirectory of the IDL distribution.

## Superclasses

IDLitContainer

## Creation

See "IDLitUI::Init" on page 3026.

## Properties

Objects of this class have the following properties. See "IDLitUI Properties" on page 3018 for details on individual properties.

- GROUP_LEADER

## Methods

This class has the following methods:

- IDLitUI::AddOnNotifyObserver
- IDLitUI::Cleanup
- IDLitUI::DoAction

- IDLitUI::GetProperty
- IDLitUI::GetTool
- IDLitUI::GetWidgetByName
- IDLitUI::Init
- IDLitUI::RegisterUIService
- IDLitUI::RegisterWidget
- IDLitUI::RemoveOnNotifyObserver
- IDLitUI::SetProperty
- IDLitUI::UnRegisterUIService
- IDLitUI::UnRegisterWidget

In addition, this class inherits the methods of its superclasses (if any).

## Examples

See "Example: A Simple UI Panel" in Chapter 13 of the *iTool Developer's Guide* manual.

## Version History

Introduced: 6.0

## See Also

Chapter 10, "iTool User Interface Architecture" in the *iTool Developer's Guide* manual

# IDLitUI Properties

IDLitUI objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLitUI::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLitUI::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLitUI::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## GROUP_LEADER

A long integer containing the IDL Widget ID of the group leader widget for the user interface.

| | | | |
|---|---|---|---|
| **Property Type** | Long Integer (Widget ID) | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLitUI::AddOnNotifyObserver

The IDLitUI::AddOnNotifyObserver procedure method is used to register a specified iTool component object as wishing to receive messages generated by the DoOnNotify method of another specified iTool component object.

## Syntax

*Obj* -> [IDLitUI::]AddOnNotifyObserver, *IdObserver*, *IdSubject*

## Arguments

### IdObserver

The object identifier of an iTool component object that is the *observer* expressing interest in the subject specified by *IdSubject*. Often, *IdObserver* is the object identifier of the object on which this method is being called.

The object specified by *IdObserver* must implement the OnNotify callback method, which is called when a notification message is dispatched to *IdObserver* by the DoOnNotify method of another iTool component object (usually the object specified by *IdSubject*). The OnNotify method has the following signature:

```
PRO ::OnNotify, idObject, idMessage, message
```

where

- *idObject* is the object identifier of the iTool component that is the source of the message.
- *idMessage* is a string that identifies the type of message being sent.
- *message* is the message data itself.

In general, the *idMessage* string is used by the OnNotify method to determine what type of action to take. See “IDLitIMessaging::DoOnNotify” on page 2828 for additional details.

### IdSubject

A string identifying the item that *IdObserver* is interested in. This is normally the object identifier of a particular iTool component object, but it can be any string value. When a message sent via IDLitIMessaging::DoOnNotify specifies *IdSubject* as the originator, the *IdObserver* object’s OnNotify method is called.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::Cleanup

The IDLitUI::Cleanup procedure method performs all cleanup on the object, and should be called by the Cleanup method of a subclass.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitUI::]Cleanup (only in subclass' *Cleanup* method)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::DoAction

The IDLitUI::DoAction function method initiates an operation or action in the iTool object associated with this user interface. The identifier that is passed in as the argument to this method specifies the action that executes.

## Syntax

*Result* = *Obj* -> [IDLitUI::]doAction(*Identifier*)

## Return Value

Returns 1 if the action succeeds, or 0 if the action fails.

## Arguments

### Identifier

This argument is set to a string identifier that specifies the object in the iTool that performs the operation or action that it implements.

## Keywords

All keywords are passed to the DoAction function of the object in the iTool that performs the operation or action.

## Version History

Introduced: 6.0

# IDLitUI::GetProperty

The IDLitUI::GetProperty procedure method retrieves the value of an IDLitUI property, and should be called by the subclass' GetProperty method. This method also retrieves properties defined in the superclass.

## Syntax

*Obj* -> [IDLitUI::]GetProperty, [*PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under "IDLitUI Properties" on page 3018 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitUI::GetTool

The IDLitUI::GetTool function method returns an object reference to the iTool with which the user interface is associated.

## Syntax

*Result* = *Obj* -> [IDLitUI::]GetTool()

## Return Value

Returns an object reference to the iTool associated with the current user interface, or a null object if there is no associated iTool.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::GetWidgetByName

The IDLitUI::GetWidgetByName function method returns the IDL Widget ID of a widget that has been registered with the user interface object via a call to the IDLitUI::RegisterWidget method.

## Syntax

*Result* = *Obj* -> [IDLitUI::]GetWidgetByName(*Name*)

## Return Value

Returns the widget identifier (a long integer) of the widget specified by the Name argument, or 0 if the widget was not registered with the iTool system.

## Arguments

### Name

Set this argument to the name that the desired widget was registered with.

## Keywords

None

## Example

This method can be used to determine whether a given widget already exists and act accordingly. For example, the following code checks to determine whether a widget registered as `myWidget` exists; if it does, that widget is mapped and un-iconified:

```
wID = oUI -> GetWidgetByName(myWidget)
IF(wID NE 0) THEN BEGIN
   WIDGET_CONTROL, wID, /MAP, ICONIFY=0 ;; show the widget
   RETURN
ENDIF
```

Similar code is used in many of the widget interface elements used by the standard iTools included with IDL.

## Version History

Introduced: 6.0

# IDLitUI::Init

The IDLitUI::Init function method initializes the IDLitUI object, and should be called by the Init method of a subclass.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitUI')

or

*Result* = *Obj* -> [IDLitUI::]Init() (*Only in subclass' Init method.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::RegisterUIService

The IDLitUI::RegisterUIService function method registers a *user interface service* with the user interface. Once the user interface service has been registered, the iTool with which the user interface is associated can call the UI service to display dialogs or other UI elements.

**Note**

Every UI service must implement a callback function that displays the requested user interface. See Chapter 12, "Creating a User Interface Service" in the *iTool Developer's Guide* manual for details.

## Syntax

*Restult* = *Obj* -> [IDLitUI::]RegisterUIService(*Name, Callback*)

## Return Value

Returns an iTool object identifier for the UI service specified by *Name*.

## Arguments

### Name

A string containing the human readable name of the user interface being registered.

### Callback

A string containing the name of the callback function for this UI service. The callback function is called when execution of the UI service is requested. The callback should have the following calling signature:

```
FUNCTION NAME, oUI, oTarget
```

where:

- *NAME* is the name of the callback function,
- *oUI* is an object reference to the user interface object of which the UI service is a part
- *oTarget* is an object reference to the object that is the target of the operation or action with which the UI service is associated.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::RegisterWidget

The IDLitUI::RegisterWidget function method registers an IDL widget hierarchy with the user interface object. Once a widget has been registered with the UI object, the UI can route messages to that widget and manage visibility if the widget is registered with the FLOATING property set.

## Syntax

*Result* = *Obj* -> [IDLitUI::]RegisterWidget(*wID*, *Name*, *Callback*[, /FLOATING])

## Return Value

The iTool object identifier of the user interface adaptor that links the widget specified by *wID* with the iTool.

## Arguments

### wID

A long integer containing the widget ID of the widget being registered. This value is provided to the routine specified by the *Callback* argument when it is called.

### Name

A string containing the human readable name for the widget being registered.

### Callback

A string containing the name of a *callback procedure* for the widget. Any notification messages sent by the iTool to this widget are sent to this callback procedure. The callback procedure should have the following calling signature:

```
PRO NAME, wID, strID, message, messageData
```

where:

- *NAME* is the name of the callback procedure,
- *wID* is the widget ID provided to the IDLitUI:;RegisterWidget method,
- *strID* is a string containing the object identifier of the iTool object that triggered the message,

- *message* is the message being sent to the callback procedure,
- *messageData* is any data associated with the message.

**Note**

If this argument is set to an empty string, no callbacks will be made to this widget.

# Keywords

## FLOATING

Set this keyword to treat the widget as a floating element of the specified iTool user interface, to be managed by the user interface object. If this keyword is set, the widget will only be visible if the associated iTool is “current,” and the widget will be destroyed when the iTool is destroyed.

# Version History

Introduced: 6.0

# IDLitUI::RemoveOnNotifyObserver

The IDLitUI::RemoveOnNotifyObserver procedure method is used to un-register a specified iTool component object as wishing to receive messages generated by the DoOnNotify method of another specified iTool component object. This method reverses the action of calling the IDLitUI::AddOnNotifyObserver method.

## Syntax

*Obj* -> [IDLitUI::]RemoveOnNotifyObserver, *IdObserver*, *IdSubject*

## Arguments

### IdObserver

The object identifier of an iTool component object that is currently registered as an observer of the component specified by *IdSubject*. Often, this is the object identifier of the object on which method is being called.

### IdSubject

The object identifier of the iTool component object that *IdObserver* is currently registered as observing. This is normally the object identifier of a particular iTool component object, but it can also be a string that references a global system service.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::SetProperty

The IDLitUI::SetProperty procedure method sets the value of an IDLitUI property, and should be called by the subclass' SetProperty method. This method also calls the superclass' SetProperty method.

## Syntax

*Obj* -> [IDLitUI::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::UnRegisterUIService

The IDLitUI::UnRegisterUIService procedure method unregisters a user interface service with the user interface object.

## Syntax

*Obj* -> [IDLitUI::]UnRegisterUIService, *Name*

## Arguments

### Name

A string containing the name of the UI service to be unregistered.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitUI::UnRegisterWidget

The IDLitUI::UnRegisterWidget procedure method unregisters a widget with the user interface object.

## Syntax

*Obj* -> [IDLitUI::]UnRegisterWidget, *Name*

## Arguments

### Name

A string containing the name of the widget to be unregistered.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization

The IDLitVisualization class represents the base visualization component, from which all iTool visualization classes should subclass. IDLitVisualization acts as a container and provides methods for adding, removing, and grouping visualization components.

This class is written in the IDL language. Its source code can be found in the file `idlitvisualization__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLgrModel

IDLitIMessaging

IDLitParameter

## Creation

See "IDLitVisualization::Init" on page 3059.

## Properties

Objects of this class have the following properties. See "IDLitVisualization Properties" on page 3038 for details on individual properties.

- CENTER_OF_ROTATION
- GROUP_PARENT
- IMPACTS_RANGE
- ISOTROPIC
- MANIPULATOR_TARGET
- TYPE

In addition, objects of this class inherit the properties of all superclasses of this class.

# Methods

This class has all the methods associated with the superclasses, plus the following methods:

- IDLitVisualization::Add
- IDLitVisualization::Aggregate
- IDLitVisualization::Cleanup
- IDLitVisualization::Get
- IDLitVisualization::GetCenterRotation
- IDLitVisualization::GetCurrentSelectionVisual
- IDLitVisualization::GetDataSpace
- IDLitVisualization::GetDataString
- IDLitVisualization::GetDefaultSelectionVisual
- IDLitVisualization::GetManipulatorTarget
- IDLitVisualization::GetProperty
- IDLitVisualization::GetSelectionVisual
- IDLitVisualization::GetTypes
- IDLitVisualization::GetXYZRange
- IDLitVisualization::Init
- IDLitVisualization::Is3D
- IDLitVisualization::IsIsotropic
- IDLitVisualization::IsManipulatorTarget
- IDLitVisualization::IsSelected
- IDLitVisualization::OnDataChange
- IDLitVisualization::OnDataComplete
- IDLitVisualization::OnDataRangeChange
- IDLitVisualization::Remove
- IDLitVisualization::Scale
- IDLitVisualization::Select

- IDLitVisualization::Set3D
- IDLitVisualization::SetCurrentSelectionVisual
- IDLitVisualization::SetData
- IDLitVisualization::SetDefaultSelectionVisual
- IDLitVisualization::SetParameterSet
- IDLitVisualization::SetProperty
- IDLitVisualization::UpdateSelectionVisual
- IDLitVisualization::VisToWindow
- IDLitVisualization::WindowToVis

In addition, this class inherits the methods of its superclasses.

## Examples

See Chapter 6, “Creating a Visualization” in the *iTool Developer’s Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitVisualization Properties

IDLitVisualization objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLitVisualization::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be initialized via IDLitVisualization::Init. Properties with the word “Yes” in the “Set” column of the property table can be set via IDLitVisualization::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## CENTER_OF_ROTATION

A two- or three-element vector, [*x*, *y*] or [*x*, *y*, *z*] indicating the center (in data coordinates) of rotation for this visualization. If a two-element vector is supplied, the *z* value remains unchanged. When retrieving the value of this property, the center of rotation is always returned as a three-element vector.

| **Property Type** | Vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GROUP_PARENT

A reference to the IDLitVisualization object that serves as the group parent for this visualization.

| **Property Type** | Object Reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## IMPACTS_RANGE

A boolean that, when set to 0, indicates that the *x*, *y*, and *z* range of the contents of this visualization should not impact the *x*, *y*, and *z* range of any visualization that contains it. By default, IMPACTS_RANGE is 1.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | Init: Yes | **Registered:** No |

## ISOTROPIC

A boolean that, when set to a non-zero value, indicates that this object should have isotropic scaling applied to it. By default, ISOTROPIC is 0 (isotropic scaling is not enforced).

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## MANIPULATOR_TARGET

A boolean that, when set to a non-zero value, indicates that this object should be treated as a target for manipulations. By default, MANIPULATOR_TARGET is 0 (this object is not a target for manipulations).

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PROPERTY_INTERSECTION

A boolean value that indicates whether the visualization should display the intersection or the union of the properties of any aggregated objects. Visualizations that display the union of their aggregated objects' properties appear in iTool browsers as a single visualization with one set of properties. Visualizations that display the intersection of their aggregated objects' properties appear in iTool browsers as a container for the aggregated objects, allowing access to the contained objects'

properties as well as to those of the container. See "Working with Aggregated Properties" in Chapter 4 of the *iTool Developer's Guide* manual for additional discussion of aggregated properties.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *no default value* | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** No |

## TYPE

A string or vector of strings that identify the type(s) that this visualization represents. See "Predefined iTool Visualization Classes" in Chapter 6 of the *iTool Developer's Guide* manual for a list of predefined types.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLitVisualization::Add

The IDLitVisualization::Add procedure method adds objects to the visualization container.

## Syntax

*Obj* -> [IDLitVisualization::]Add, *Objects* [, /AGGREGATE] [, /GROUP] [, /NO_UPDATE] [, POSITION=*index*]

## Arguments

### Objects

An object reference (or array of object references), each referring to an atomic graphic object, an IDLgrModel, or another IDLitVisualization object to be added to the visualization container.

## Keywords

### AGGREGATE

Set this keyword to indicate that the object(s) being added should become part of this visualization's property aggregate. The properties of all aggregated objects are exposed as properties of this visualization (accessible via the GetProperty and SetProperty methods).

### GROUP

Set this keyword to indicate that the added object is to be considered part of the group that is rooted at this visualization. By default, the added objects are not considered to be part of the group.

### NO_UPDATE

Set this keyword to indicate that the overall scene should not be updated after the addition of the object(s). By default, the overall scene is updated.

### POSITION

Set this keyword equal to a scalar or vector of zero-based index values. The number of elements specified must be equal to the number of object references specified by the *Objects* argument. Each index value specifies the position within this visualization container at which the corresponding object should be placed. The default is to add new objects at the end of the list of contained items.

## Version History

Introduced: 6.0

# IDLitVisualization::Aggregate

The IDLitVisualization::Aggregate procedure method adds the given object(s) to this visualization's property aggregate. The properties of all aggregated objects are exposed as properties of this visualization (via ::GetProperty and ::SetProperty).

## Syntax

*Obj* -> [IDLitVisualization::]Aggregate, *Objects*

## Arguments

### Objects

An object reference (or array of object references), each of which refers to an atomic graphic object, an IDLgrModel, or another IDLitVisualization object to be aggregated within this visualization container.

## Keywords

None.

## Version History

Introduced: 6.0

# IDLitVisualization::Cleanup

The IDLitVisualization::Cleanup procedure method performs all cleanup on the object, and should be called by the subclass' Cleanup method.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitVisualization::]Cleanup (*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::Get

The IDLitVisualization::Get function method retrieves object(s) from the visualization.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]Get([, /ALL] [, COUNT=*variable*] [, ISA=*string* or *array of strings*] [, POSITION=*index* or *array of indices*] [, /SKIP_PRIVATE])

## Return Value

Returns the reference of the object retrieved from the visualization. If the object is not contained by this visualization, a NULL object reference is returned.

## Arguments

None

## Keywords

### ALL

Set this keyword to return an array of object references to all of the objects in the container.

### COUNT

Set this keyword equal to a named variable that will contain the number of objects selected by the function.

### ISA

Set this keyword equal to a class name or vector of class names. This keyword is used in conjunction with the ALL keyword. The ISA keyword filters the array returned by the ALL keyword, returning only the objects that inherit from the class or classes specified by the ISA keyword.

**Note**

This keyword is ignored if the ALL keyword is not provided.

### POSITION

Set this keyword equal to a scalar or array containing the zero-based indices of the positions of the objects to return.

### SKIP_PRIVATE

Set this keyword to indicate that this method should return only those objects that do not have the PRIVATE property set.

## Version History

Introduced: 6.0

# IDLitVisualization::GetCenterRotation

The IDLitVisualization::GetCenterRotation function method returns the center of rotation for this visualization.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetCenterRotation([, /DATA] [, /NO_TRANSFORM] [, XRANGE=[*xmin*, *xmax*]] [, YRANGE=[*ymin*, *ymax*]] [, ZRANGE=[*zmin*, *zmax*]])

## Return Value

Returns a two- or three-element vector, [*x*, *y*] or [*x*, *y*, *z*] indicating the center (in data coordinates) of the bounding box for this visualization if the center of rotation was not explicitly specified with the CENTER_OF_ROTATION property of this visualization. See the CENTER_OF_ROTATION property for more details.

## Arguments

None

## Keywords

### DATA

Set this keyword to indicate that the ranges should be computed for the full data sets of the contents of this visualization. By default (if the keyword is not set), the ranges are computed for the displayed portions of the data sets.

### NO_TRANSFORM

Set this keyword to indicate that this visualization's transform should not be applied when computing the *x*, *y*, and *z* ranges. By default, the transform is applied.

### XRANGE

Set this keyword to a named variable that will contain a 2-element vector, [*xmin*, *xmax*], representing the *x* range of the bounding box for this visualization.

### YRANGE

Set this keyword to a named variable that will contain a 2-element vector, [*ymin*, *ymax*], representing the *y* range of the bounding box for this visualization.

### ZRANGE

Set this keyword to a named variable that will contain a 2-element vector, [*zmin*, *zmax*], representing the *z* range of the bounding box for this visualization.

## Version History

Introduced: 6.0

# IDLitVisualization::GetCurrentSelectionVisual

The IDLitVisualization::GetCurrentSelectionVisual function method returns the currently active selection visual object for this visualization.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetCurrentSelectionVisual()

## Return Value

Returns a reference to an IDLitManipulatorVisual object. If no selection visual is currently active, the NULL object reference is returned.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::GetDataSpace

The IDLitVisualization::GetDataSpace function method returns a reference to the parent data space object within the graphics hierarchy that contains the visualization.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetDataSpace([, /UNNORMALIZED])

## Return Value

Returns a reference to the nearest data space object in the graphics hierarchy. If no data space objects are found by walking up the hierarchy, then a null object reference is returned.

## Arguments

None

## Keywords

### UNNORMALIZED

Set this keyword to indicate that the returned data space should be the parent data space that subclasses from the IDLitVisDataSpace class (which is not normalized) rather than the IDLitVisNormDataSpace class (which is normalized).

## Version History

Introduced: 6.0

# IDLitVisualization::GetDataString

The IDLitVisualization::GetDataString function method retrieves a description of this visualization's data at the given *x*, *y*, and *z* location.

**Note**

This method is designed to be implemented as needed by subclasses. The IDLitVisualization::GetDataString method simply always returns an empty string

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetDataString(*XYZLocation*)

## Return Value

Returns a string describing the visualization's data at the given location.

## Arguments

### XYZLocation

A three-element vector representing the *x*, *y*, and *z* location of the data for which a string description is to be returned.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::GetDefaultSelectionVisual

The IDLitVisualization::GetDefaultSelectionVisual function method returns an object that serves as the default selection visual for this visualization.

**Note**

If the visualization on which this method is called is not a manipulator target (see "MANIPULATOR_TARGET" on page 3039), the default selection visual returned by this method will be used as the current selection visual whenever the visualization is selected.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetDefaultSelectionVisual()

## Return Value

Returns a reference to an IDLitManipulatorVisual object.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::GetManipulatorTarget

The IDLitVisualization::GetManipulatorTarget function method retrieves the manipulator target associated with this visualization. The manipulator target may be this visualization itself.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetManipulatorTarget()

## Return Value

Returns an object reference to the manipulator target, or a NULL object reference if none is found.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::GetProperty

The IDLitVisualization::GetProperty procedure method retrieves the value of a property or group of properties for the object.

## Syntax

*Obj* -> [IDLitVisualization::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitVisualization Properties” on page 3038 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitVisualization::GetSelectionVisual

The IDLitVisualization::GetSelectionVisual function method retrieves the selection visual for this visualization that corresponds to the given manipulator.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetSelectionVisual(*Manipulator*)

## Return Value

Returns a reference to an IDLitManipulatorVisual object that corresponds to the given manipulator. If this visualization already has a selection visual for the given manipulator, a reference to that selection visual is returned. Otherwise, a default selection visual will be requested from the manipulator, added to the visualization, and returned.

## Arguments

### Manipulator

Set this argument to a reference to an IDLitManipulator object that identifies the manipulator for which a selection visual is to be retrieved.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::GetTypes

The IDLitVisualization::GetTypes function method identifies the types that this visualization represents, including base types and any specializations.

**Note**

This method is designed to be implemented as needed by subclasses of the IDLitVisualization class. Calling this method on the IDLitVisualization class itself returns the following string array: [`'VISUALIZATION', '_VISUALIZATION',` *`AnySpecifiedTypes`*] where *`AnySpecifiedTypes`* are provided by any value set for the TYPE property of the IDLitVisualization class.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetTypes()

## Return Value

Returns a vector of strings identifying the types that this visualization represents. See "Predefined iTool Visualization Classes" in Chapter 6 of the *iTool Developer's Guide* manual for a list of predefined types

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::GetXYZRange

The IDLitVisualization::GetXYZRange function method computes the *x*, *y*, and *z* ranges of the overall contents of the visualization, taking into account the IMPACTS_RANGE property setting for itself and its contents.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]GetXYZRange(*XRange*,*YRange*, *ZRange* [, /DATA] [, /NO_TRANSFORM])

## Return Value

Returns a 1 if the *x*, *y*, and *z* ranges were successfully computed, or 0 otherwise.

## Arguments

### XRange

A named variable that, upon return, will contain a two-element vector, [*xmin*, *xmax*], representing the *x*-range of the contents of this visualization that impact ranges.

### YRange

A named variable that, upon return, will contain a two-element vector, [*ymin*, *ymax*], representing the *y*-range of the contents of this visualization that impact ranges.

### ZRange

A named variable that, upon return, will contain a two-element vector, [*zmin*, *zmax*], representing the *z*-range of the contents of this visualization that impact ranges.

## Keywords

### DATA

Set this keyword to indicate that the ranges should be computed for the full data sets of the contents of this visualization. By default, if the keyword is not set, the ranges are computed for the displayed portions of the data sets.

### NO_TRANSFORM

Set this keyword to indicate that this visualization's transform matrix should not be applied when computing the *x*, *y*, and *z* ranges. By default, the transform matrix is applied.

## Version History

Introduced: 6.0

# IDLitVisualization::Init

The IDLitVisualization::Init function method initializes the visualization object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitVisualization' [, *PROPERTY*=*value*] )

or

*Result* = *Obj* -> [IDLitVisualization::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLitVisualization Properties" on page 3038 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitVisualization::Is3D

The IDLitVisualization::Is3D function method determines whether or not this visualization (or any of its contents) is marked as being three-dimensional.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]Is3D()

## Return Value

Returns 1 if this visualization is marked as being three-dimensional, or 0 if it is not three-dimensional.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::IsIsotropic

The IDLitVisualization::IsIsotropic function method indicates whether or not this visualization (or any of its contents) is marked as being isotropic. See the ISOTROPIC property for more information.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]IsIsotropic()

## Return Value

Returns 1 if the visualization or any of the items it contains has the ISOTROPIC property set, or 0 otherwise.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::IsManipulatorTarget

The IDLitVisualization::IsManipulatorTarget function method determines whether or not this visualization is a manipulator target.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]IsManipulatorTarget()

## Return Value

Returns 1 if this visualization is a manipulator target, or 0 if it is not.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::IsSelected

The IDLitVisualization::IsSelected function method determines if this visualization is currently selected or not.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]IsSelected()

## Return Value

Returns 1 if this visualization is currently selected, or 0 if it is not selected.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::OnDataChange

The IDLitVisualization::OnDataChange procedure method ensures that objects that use the visualization's data are notified when the visualization's data changes.

**Note**

This method is generally not called explicitly.

## Syntax

*Obj* -> [IDLitVisualization::]OnDataChange, *Notifier*

## Arguments

### Notifier

A reference to the object that is sending notification when the data changes.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::OnDataComplete

The IDLitVisualization::OnDataComplete procedure method ensures that objects that use the visualization's data are notified when changes to the visualization's data are complete.

**Note**

This method is generally not called explicitly.

## Syntax

*Obj* -> [IDLitVisualization::]OnDataComplete, *Notifier*

## Arguments

### Notifier

A reference to the object that is sending notification when the data changes are complete.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::OnDataRangeChange

The IDLitVisualization::OnDataRangeChange procedure method ensures that objects that use the visualization's data are notified when the range of the visualization's data changes.

**Note**

This method is generally not called explicitly.

## Syntax

*Obj* -> [IDLitVisualization::]OnDataRangeChange, *Notifier*, *XRange*, *YRange*, *Zrange*

## Arguments

### Notifier

A reference to the object that is sending notification when the data range changes.

### XRange

A two-element vector, [*xmin*, *xmax*], representing the new *x*-range.

### YRange

A two-element vector, [*ymin*, *ymax*], representing the new *y*-range.

### ZRange

A two-element vector, [*zmin*, *zmax*], representing the new *z*-range.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::Remove

The IDLitVisualization::Remove procedure method removes the given object(s) from the visualization.

## Syntax

*Obj* -> [IDLitVisualization::]Remove, *Object*

## Arguments

### Object

A reference (or vector of references) to the object(s) to be removed from this visualization.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::Scale

The IDLitVisualization::Scale procedure method scales the visualization by the given scale factors.

## Syntax

*Obj* -> [IDLitVisualization::]Scale, *SX*, *SY*, *SZ* [, CENTER_OF_ROTATION=[*x*, *y*] | [*x*, *y*, *z*]] [, /PREMULTIPLY]

## Arguments

### SX

The factor in the *x*-dimension by which the visualization is to be scaled.

### SY

The factor in the *y*-dimension by which the visualization is to be scaled.

### SZ

The factor in the *z*-dimension by which the visualization is to be scaled.

## Keywords

**Note**

This method accepts all keywords accepted by the Scale method of the visualization's current selection visual. In addition, the following keywords are accepted:

### CENTER_OF_ROTATION

Set this keyword to a 3-element vector, [*x*,*y*,*z*], representing the center of rotation (in data coordinates) to be used as the center for scaling. By default, if PREMULTIPLY is set, then this visualization’s own center of rotation will be used as the center for scaling; if PREMULTIPLY is not set, the result of transforming this visualization’s center of rotation by its own transformation matrix will be used as the center for scaling.

### PREMULTIPLY

Set this keyword to cause the scaling matrix specified by *Sx*, *Sy*, and *Sz* to be pre-multiplied to this visualization's transformation matrix. By default, the scaling matrix is post-multiplied.

## Version History

Introduced: 6.0

# IDLitVisualization::Select

The IDLitVisualization::Select procedure method handles notification of mechanisms that key off the current selection (such as the visualization browser) when this visualization has been selected.

## Syntax

*Obj* -> [IDLitVisualization::]Select[, *Mode*]
[, /ADDITIVE | /SELECT | /TOGGLE | /UNSELECT] [, /NO_NOTIFY]

## Arguments

### Mode

A scalar that indicates the selection mode. Valid values include:

- 0 - Unselect (deselect this visualization).
- 1 - Select (set this visualization as the current selection). This mode is the default.
- 2 - Toggle (toggle the selection of this visualization). Use the **CRTL** key to toggle.
- 3 - Additive (add this visualization to the current selection list). Use the **SHIFT** key to add.

## Keywords

### ADDITIVE

Set this keyword to indicate that the selection mode is additive. This is equivalent to setting *Mode* to 3.

### NO_NOTIFY

Set this keyword to indicate that this visualization's parent should not be notified of this selection. By default, the parent is notified.

### SELECT

Set this keyword to indicate that the selection mode is select. This is equivalent to setting *Mode* to 1.

### TOGGLE

Set this keyword to indicate that the selection mode is toggle. This is equivalent to setting *Mode* to 2.

### UNSELECT

Set this keyword to indicate that the selection mode is unselect. This is equivalent to setting *Mode* to 0.

## Version History

Introduced: 6.0

# IDLitVisualization::Set3D

The IDLitVisualization::Set3D procedure method sets a flag indicating this visualization is three-dimensional.

## Syntax

*Obj* -> [IDLitVisualization::]Set3D, *Is3D* [, /ALWAYS] [, /AUTO_COMPUTE]

## Arguments

### Is3D

A non-zero value indicates that the visualization is three-dimensional; 0 indicates that it is two-dimensional.

## Keywords

### ALWAYS

Set this keyword to indicate that the given 3D setting always applies.

### AUTO_COMPUTE

Set this keyword to indicate that the 3D setting for this visualization should be auto-computed based upon the dimensionality of its contents. This keyword is mutually exclusive of the ALWAYS keyword, and the *Is3D* argument is ignored if AUTO_COMPUTE is set.

## Version History

Introduced: 6.0

# IDLitVisualization::SetCurrentSelectionVisual

The IDLitVisualization::SetCurrentSelectionVisual procedure method sets the current selection visual for the given manipulator.

## Syntax

*Obj* -> [IDLitVisualization::]SetCurrentSelectionVisual, *Manipulator*

## Arguments

### Manipulator

An object reference (that subclasses from IDLitManipulator) identifying the manipulator that corresponds to the selection visual to be set as current.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::SetData

The IDLitVisualization::SetData function method sets the data parameter of the visualization.

**Note**

If the SetData method returns successfully, notification of a data change is issued to all observers of the data object.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]SetData(*Data*)

## Return Value

Returns a 1 if successful, or 0 if it fails.

## Arguments

### Data

A reference to the data object to be associated with the visualization parameter.

## Keywords

This method accepts all keywords accepted by the IDLitParameter::SetData method.

## Version History

Introduced: 6.0

# IDLitVisualization::SetDefaultSelectionVisual

The IDLitVisualization::SetDefaultSelectionVisual procedure method sets the default selection visual to be associated with this visualization.

**Note**

If the visualization on which this method is called is not a manipulator target (see "MANIPULATOR_TARGET" on page 3039) the default selection visual set by this method will be used as the current selection visual whenever the visualization is selected.

## Syntax

*Obj* -> [IDLitVisualization::]SetDefaultSelectionVisual, *SelectionVisual* [, POSITION=*value*]

## Arguments

### SelectionVisual

A reference to the IDLitManipulatorVisual object that is added to the visualization object and serves as the default selection visual for this visualization.

## Keywords

### POSITION

Set this keyword equal to the zero-based position at which the selection visual should be inserted within the container. The default is to add the object to the end of the container (the visualization object).

## Version History

Introduced: 6.0

# IDLitVisualization::SetParameterSet

The IDLitVisualization::SetParameterSet function method associates a parameter set with this visualization.

**Note**

If the SetParameterSet method returns successfully, notification of a data change is issued to all observers of the visualization's data.

## Syntax

*Result* = *Obj* -> [IDLitVisualization::]SetParameterSet(*ParameterSet*)

## Return Value

Returns a 1 if successful, or a 0 otherwise.

## Arguments

### ParameterSet

A reference to the IDLitParameterSet object to be associated with the visualization.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::SetProperty

The IDLitVisualization::SetProperty procedure method sets the value of a property or group of properties for the object.

## Syntax

*Obj* -> [IDLitVisualization::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitVisualization Properties” on page 3038 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitVisualization::UpdateSelectionVisual

The IDLitVisualization::UpdateSelectionVisual procedure method transforms this visualization's selection visual to match the visualization's geometry.

## Syntax

*Obj* -> [IDLitVisualization::]UpdateSelectionVisual

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitVisualization::VisToWindow

The IDLitVisualization::VisToWindow procedure method transforms given points from visualization data space to window device coordinates.

## Syntax

*Obj* -> [IDLitVisualization::]VisToWindow, *InX*, *InY, InZ, OutX*, *OutY, OutZ* [, /NO_TRANSFORM]

or

*Obj* -> [IDLitVisualization::]VisToWindow, *InX*, *InY, OutX*, *OutY* [, /NO_TRANSFORM]

or

*Obj* -> [IDLitVisualization::]VisToWindow, *InVerts*, *OutVerts* [, /NO_TRANSFORM]

## Arguments

### InX

A vector of input X values (in visualization data space).

### InY

A vector of input Y values (in visualization data space). The number of elements of this vector must match the number of elements in *InX*.

### InZ

A vector of input Z values (in visualization data space). The number of elements of this vector must match the number of elements in *InX*.

### InVerts

A [2, *n*] or [3, *n*] array of input vertices (in visualization data space).

### OutX

A named variable that will contain a vector of output X values (in window device coordinates).

### OutY

A named variable that will contain a vector of output Y values (in window device coordinates).

### OutZ

A named variable that will contain a vector of output Z values (in window device coordinates).

### OutVerts

A named variable that will contain a vector of output vertices (in window device coordinates).

## Keywords

### NO_TRANSFORM

If this keyword is set, the current transformation matrix is not included in the computation. Setting this keyword is useful when computing selection visual scaling.

## Version History

Introduced: 6.0

# IDLitVisualization::WindowToVis

The IDLitVisualization::WindowToVis procedure method transforms given points from window device coordinates to visualization data space.

## Syntax

*Obj* -> [IDLitVisualization::]WindowToVis, *InX*, *InY*, *InZ*, *OutX*, *OutY*, *OutZ*

or

*Obj* -> [IDLitVisualization::]WindowToVis, *InX*, *InY*, *OutX*, *OutY*

or

*Obj* -> [IDLitVisualization::]WindowToVis, *InVerts*, *OutVerts*

## Arguments

### InX

A vector representing the input x values (in window device coordinates).

### InY

A vector representing the input y values (in window device coordinates). The number of elements of this vector must match the number of elements in *InX*.

### InZ

A vector representing the input z values (in window device coordinates). The number of elements of this vector must match the number of elements in *InX*.

### InVerts

A [2, *n*] or [3, *n*] array representing the input vertices (in window device coordinates).

### OutX

A named variable that upon return will contain a vector representing the output x values (in visualization data space).

### OutY

A named variable that upon return will contain a vector representing the output y values (in visualization data space).

### OutZ

A named variable that upon return will contain a vector representing the output z values (in visualization data space).

### OutVerts

A named variable that upon return will contain a vector representing the output vertices (in visualization data space).

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow

The IDLitWindow class serves as the base class for all windows within the iTools framework.

## Superclasses

IDLgrWindow

## Creation

See "IDLitWindow::Init" on page 3105.

## Properties

Objects of this class have the following properties. See "IDLitWindow Properties" on page 3086 for details on individual properties.

- COLOR_MODEL
- CURRENT_ZOOM
- DESCRIPTION
- DIMENSIONS
- DISPLAY_NAME (X Only)
- GRAPHICS_TREE
- LOCATION
- MINIMUM_VIRTUAL_DIMENSIONS
- NAME
- N_COLORS
- PALETTE
- QUALITY
- RENDERER
- RETAIN
- TITLE
- UNITS

- UVALUE
- VIRTUAL_DIMENSIONS
- VISIBLE_LOCATION
- ZOOM_BASE
- ZOOM_NSTEP

In addition, objects of this class inherit the properties of its superclass.

## Methods

This class has the following methods:

- IDLitWindow::Add
- IDLitWindow::AddWindowEventObserver
- IDLitWindow::Cleanup
- IDLitWindow::ClearSelections
- IDLitWindow::DoHitTest
- IDLitWindow::GetEventMask
- IDLitWindow::GetProperty
- IDLitWindow::GetSelectedItems
- IDLitWindow::Init
- IDLitWindow::OnKeyboard
- IDLitWindow::OnMouseDown
- IDLitWindow::OnMouseMotion
- IDLitWindow::OnMouseUp
- IDLitWindow::OnScroll
- IDLitWindow::Remove
- IDLitWindow::RemoveWindowEventObserver
- IDLitWindow::SetCurrentZoom
- IDLitWindow::SetEventMask
- IDLitWindow::SetManipulatorManager
- IDLitWindow::SetProperty

- IDLitWindow::ZoomIn
- IDLitWindow::ZoomOut

In addition, this class inherits the methods of its superclass.

## Version History

Introduced: 6.0

# IDLitWindow Properties

IDLitWindow objects have the following properties. Properties with the word “Yes” in the “Get” column of the table can be retrieved via IDLitWindow::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be set via IDLitWindow::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLitWindow::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## COLOR_MODEL

An integer value representing the color model to be used for the window:

- 0 = RGB (default)
- 1 = Color Index

**Note**

For some X11 display situations, IDL may not be able to support a color index model destination object in Object Graphics. We do, however, guarantee that an RGB color model destination will be available for all display situations.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Color model | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## CURRENT_ZOOM

A named variable that upon return will contain a floating point value representing the current zoom factor associated with this window.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Zoom Factor | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** Yes |

## DESCRIPTION

A string representing the full name or description of this object.

| **Property Type** | STRING | | |
|---|---|---|---|
| **Name String** | Description | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DIMENSIONS

A two-element vector of the form [*width, height*] to specify the dimensions of the window in units specified by the UNITS property. By default, if no value is specified for DIMENSIONS, IDL uses the value of the “Default Window Width” and “Default Window Height” preferences set in the IDL Development Environment’s (IDLDE) Preferences dialog. If there is no preference file for the IDLDE, the DIMENSIONS property is set equal to one quarter of the screen size. There are limits on the maximum size of an IDLgrWindow object.

**Note**

Changing DIMENSIONS properties is merely a request and may be ignored for various reasons.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Zoom Factor | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DISPLAY_NAME (X Only)

A string containing the name of the X Windows display on which the window is to appear.

| **Property Type** | STRING | | |
|---|---|---|---|
| **Name String** | Display Name | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## GRAPHICS_TREE

An object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView describing the graphics tree of this window object. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

| | | | |
|---|---|---|---|
| **Property Type** | Object Reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LOCATION

A two-element vector of the form [*x*, *y*] to specify the location of the upper left corner of the window relative to the display screen, in units specified by the UNITS property. By default, the window is positioned at one of four quadrants on the display screen, and the location is measured in device units.

**Note**

Changing LOCATION properties is merely a request and may be ignored for various reasons. LOCATION may be adjusted to take into account window decorations.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Location | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MINIMUM_VIRTUAL_DIMENSIONS

A two-element vector, [*width*, *height*], specifying the minimum dimensions allowed for the virtual canvas of this window. In a scrolling window, the virtual canvas represents the full canvas, of which only a smaller visible portion is displayed at any given time. The default value of this property is [0, 0], a value indicating that the minimum virtual dimensions should match the current virtual dimensions.

| | |
|---|---|
| **Property Type** | Vector |

| **Name String** | *not displayed* | | |
|---|---|---|---|
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## NAME

A string representing the human-readable name of this object.

| **Property Type** | STRING | | |
|---|---|---|---|
| **Name String** | Name | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## N_COLORS

An integer value representing the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to Indexed (1). This property is ignored if COLOR_MODEL is set to RGB (0).

**Note**

If COLOR_MODEL is set to color index (1), setting N_COLORS is treated as a request to your operating system. You should always check the actual number of available colors for any Color Indexed destination with the IDLgrWindow::GetProperty method. The actual number of available colors depends on your system and also on how you have used IDL.

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Number of colors | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## PALETTE

The object reference of a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the graphics destination’s color lookup table, applicable if the Indexed color model is used.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## QUALITY

An integer value indicating the rendering quality at which graphics are to be drawn to this destination. Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default).

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Draw quality | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## RENDERER

An integer value indicating which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation

By default, your platform's native OpenGL implementation is used. If your platform does not have a native OpenGL implementation, IDL's software implementation is used regardless of the value of this property. See "Hardware vs. Software Rendering" in Using IDL for details. Your choice of renderer may also affect the maximum size of an IDLitWindow object.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Draw quality | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## RETAIN

An integer value to specify how backing store should be handled for the window. By default, if no value is specified for RETAIN, IDL uses the value of the "Backing Store" preference set in the IDL Development Environment's (IDLDE) Preferences dialog. If there is no preference file for the IDLDE (that is, if you always use IDL in plain tty mode), the RETAIN property is set equal to 0 by default.

- 0 = No backing store

- 1 = The server or window system is requested to provide the backing store. Note that requesting backing store from the server is only a request; backing store may not be provided in all situations
- 2 = Requests that IDL provide the backing store directly. In some situations, IDL can not provide this backing store in Object Graphics. To see if IDL provided backing store, query the RETAIN property of IDLitWindow::GetProperty. IDL may also alter the RENDERER property while attempting to provide backing store

**Note**

If you are using software rendering (that is, the RENDERER property is set equal to one), IDL will refresh the window automatically regardless of the setting of the RETAIN property.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Retain | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## TITLE

A string representing the title of the window.

| | | | |
|---|---|---|---|
| **Property Type** | STRING | | |
| **Name String** | Title | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## UNITS

An integer value indicating the units of measure for the LOCATION and DIMENSIONS properties. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of the screen

**Note**

If you set the value of the UNITS property (using the SetProperty method) without also setting the value of the LOCATION and DIMENSIONS properties, IDL will convert the current size and location values into the new units.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Units | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## UVALUE

A value of any type containing any information you wish. If you set this user value equal to a pointer or object reference that does not belong to a container, you should explicitly destroy that pointer or object reference when destroying the object of which this property is a user value.

| **Property Type** | User Defined | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## VIRTUAL_DIMENSIONS

A two-element vector, [*width*, *height*], specifying the dimensions of the *virtual canvas* for this window. In a scrolling window, the virtual canvas represents the full canvas, of which only a smaller visible portion is displayed at any given time. The default value of this property is [0, 0], a value indicating that the virtual canvas dimensions should match the visible dimensions (as specified via the DIMENSIONS property).

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Virtual dimensions | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VISIBLE_LOCATION

A two-element vector, [*x*, *y*], specifying the lower left coordinate of the visible portion of the canvas (relative to the virtual canvas). In a scrolling window, the virtual canvas represents the full canvas, of which only a smaller visible portion is displayed at any given time.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Visible Location | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ZOOM_BASE

A floating point value representing the base value by which the window's current zoom factor will be multiplied or divided for zooming in or zooming out. The default is 2.0.

| **Property Type** | Float | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZOOM_NSTEP

A named variable that, upon return, will contain an integer that indicates the number of times this window's ZOOM_BASE property has been applied to achieve the current zoom factor. A positive value indicates that the current zoom factor represents the result of zooming in ZOOM_NSTEP times. A negative value indicates that the current zoom factor represents the result of zooming out -ZOOM_NSTEP times.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLitWindow::Add

The IDLitWindow::Add procedure method adds the given object(s) to the window.

## Syntax

*Obj* -> [IDLitWindow::]Add, *Objects* [, POSITION=*value*]

## Arguments

### Objects

A reference (or array of references) to the object(s) to be added to the window. Any of the objects that inherit from IDLgrViewGroup are added directly to the window's scene, which represents a container for all of the views (and their corresponding visualization hierarchies) that appear within a window. The remaining objects are added to the current view within the window's scene.

## Keywords

### POSITION

Set this keyword equal to a scalar or array containing the zero-based indices of the position within the container at which the new object should be placed.

## Version History

Introduced: 6.0

# IDLitWindow::AddWindowEventObserver

The IDLitWindow::AddWindowEventObserver procedure method adds the given object(s) to the list of observers that are to be notified of events that occur within this window. Each observer must support the following methods:

- OnKeyboard
- OnMouseDown
- OnMouseMotion
- OnMouseUp

When an event occurs within this window, the corresponding method (from the list above) will be called for each observer in the window's list.

## Syntax

*Obj* -> [IDLitWindow::]AddWindowEventObserver, *Objects*

## Arguments

### Objects

A reference (or vector of references) to the object(s) to be added as window event observers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::Cleanup

The IDLitWindow::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitWindow::]Cleanup (only in subclass' *Cleanup* method)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::ClearSelections

The IDLitWindow::ClearSelections procedure method clears the window's list of currently selected items (within its current view). The items within the current view that had been selected are deselected.

## Syntax

*Obj* -> [IDLitWindow::]ClearSelections

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::DoHitTest

The IDLitWindow::DoHitTest function method performs a hit test to determine which visualizations within the destination are displayed at a given pixel location.

**Note**

The objects returned in *Result* are the “top-level” objects (usually IDLgrModel or IDLitVisualization objects). Objects *contained* by he returned objects can be returned using the SUB_HIT keyword.

## Syntax

*Result* = *Obj* -> DoHitTest(*X*, *Y* [, DIMENSIONS=[*width*, *height*]] [, SUB_HIT=*variable*] [, UNITS={0 | 1 | 2 | 3}])

## Return Value

Returns a vector of references to the IDLitVisualizations that appear at the given location. If no visualizations are displayed at that location, a null reference is returned.

## Arguments

### X

A floating-point value representing the *x*-location at which the hit test is to be performed

### Y

A floating-point value representing the *y*-location at which the hit test is to be performed.

## Keywords

### DIMENSIONS

Set this keyword to a two-element integer vector, [*w*, *h*], to specify the dimensions (width and height) of the hit test box. The hit test box is centered at the location specified by the *X* and *Y* arguments. Any object that falls within this hit test box will be included in the return vector. By default, the hit test box is 3 pixels by 3 pixels.

### SUB_HIT

Set this keyword to a named variable that will contain references to all *contained* visualization objects that satisfy all of the following conditions:

- the objects are contained by the nearest hit visualization (the first object in the return value),
- the objects are SELECT_TARGETs (see "IDLgrModel" on page 3343), and
- the objects are actively displayed at the given *X* and *Y* coordinates.

### UNITS

Set this keyword to a scalar value to indicate the units of measure for the *X*, *Y* arguments and the DIMENSIONS keyword. Valid values include:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of this window

## Version History

Introduced: 6.0

# IDLitWindow::GetEventMask

The IDLitWindow::GetEventMask function method returns a bitwise mask representing the events that are enabled for this window.

## Syntax

*Result* = *Obj* -> [IDLitWindow::]GetEventMask([, BUTTON_EVENTS=*variable*] [, KEYBOARD_EVENTS=*variable*] [, /MOTION_EVENTS=*variable*] [, /TRACKING_EVENTS=*variable*])

## Return Value

Returns the bitwise mask as an unsigned long integer. The bits in the mask are as follows:

| Bit | Value | Event |
|---|---|---|
| 0 | 1 | Button Events |
| 1 | 2 | Motion Events |
| 2 | 4 | Keyboard Events |
| 3 | 8 | Tracking Events |

*Table 115: Bits of the Event Mask*

## Arguments

None

## Keywords

### BUTTON_EVENTS

Set this keyword to a named variable that upon return will contain a 1 if mouse button events are currently enabled for this window, or a 0 otherwise.

### KEYBOARD_EVENTS

Set this keyword to a named variable that upon return will contain a 1 if keyboard events are currently enabled for this window, or a 0 otherwise.

### MOTION_EVENTS

Set this keyword to a named variable that upon return will contain a 1 if mouse motion events are currently enabled for this window, or a 0 otherwise.

### TRACKING_EVENTS

Set this keyword to a named variable that upon return will contain a 1 if tracking events are currently enabled for this window, or a 0 otherwise.

## Version History

Introduced: 6.0

# IDLitWindow::GetProperty

The IDLitWindow::GetProperty procedure method retrieves the value of an IDLitWindow property, and should be called by the subclass' GetProperty method. This method also retrieves properties defined in the superclass.

## Syntax

*Obj* -> [IDLitData::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLitWindow Properties” on page 3086 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitWindow::GetSelectedItems

The IDLitWindow::GetSelectedItems function method returns the currently selected objects within this window's scene, which represents a container for all of the views (and their corresponding visualization hierarchies) that appear within a window.

## Syntax

*Result* = *Obj*->[IDLitWindow::]GetSelectedItems([, /COUNT])

## Return Value

Returns a vector of references to the objects currently selected within this window's scene. If no objects are currently selected, this function returns a –1.

## Arguments

None

## Keywords

### COUNT

Set this keyword to a named variable that will contain the number of items returned by this method.

## Version History

Introduced: 6.0

# IDLitWindow::Init

The IDLitWindow::Init function method initializes the window object.

This function method initializes the IDLitWindow object, and should be called by the subclass' Init method. This method also calls the superclass' Init method.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitWindow'[, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLitWindow::]Init([, *PROPERTY=value*])
(*Only in subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or 0 otherwise.

## Arguments

None

## Keywords

Any property listed under “IDLitWindow Properties” on page 3086 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitWindow::OnKeyboard

The IDLitWindow::OnKeyboard procedure method handles notification (from the native window device) that a keyboard event has occurred, and passes along that notification to all observers in the list of window event observers.

# Syntax

*Obj* -> [IDLitWindow::]OnKeyboard, *IsAlphaNumeric*, *Character*, *KeySymbol*

# Arguments

## IsAlphaNumeric

A byte that is non-zero if the keyboard event corresponds to an alphanumeric character, in which case the ASCII character will be placed in the *Character* argument. If the keyboard event does not correspond to an alphanumeric character, then *IsAlphaNumeric* will be zero, and the symbol for the key that was pressed will be placed in the *KeySymbol* argument.

## Character

A string that is set to the ASCII character that corresponds to the key that was pressed if *IsAlphaNumeric* is non-zero. Otherwise, this argument is set to zero.

## KeySymbol

A string that is set to an unsigned long integer that indicates the key that was pressed if *IsAlphaNumeric* is zero. Otherwise, this argument is set to zero. Valid values for key symbols include:

- 1 = Backspace
- 2 = Tab
- 3 = Return

# Keywords

None

# Version History

Introduced: 6.0

# IDLitWindow::OnMouseDown

The IDLitWindow::OnMouseDown procedure method handles notification (from the native window device) that a mouse down event has occurred, and passes along that notification to all observers in the list of window event observers.

## Syntax

*Obj* -> [IDLitWindow::]OnMouseDown, *X, Y, ButtonMask, Modifiers, NumClicks*

## Arguments

### X

A floating-point value representing the *x*-location (in device coordinates) of the mouse event.

### Y

A floating-point value representing the *y*-location (in device coordinates) of the mouse event.

### ButtonMask

An integer value of a bitwise mask indicating which of the left, center, or right mouse button was pressed:

| Bitmask | Mouse Button |
|---|---|
| 1 | Left |
| 2 | Middle |
| 4 | Right |

*Table 116: Bitmask for Button Events*

### Modifiers

An integer value of a bitwise mask indicating which modifier keys are active at the time the mouse button is pressed. If a bit is zero, the key is up; if the bit is set, the key is pressed. The following table describes the bits in this bitmask:

| Bit | Value | Modifier Key |
|---|---|---|
| 0 | 1 | Shift |
| 1 | 2 | Control |
| 2 | 4 | Caps Lock |
| 3 | 8 | Alt |

*Table 117: Bits of the Modifier Key Mask*

### NumClicks

An integer value indicating the number of times the mouse button was clicked.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::OnMouseMotion

The IDLitWindow::OnMouseMotion procedure method handles notification (from the native window device) that a mouse motion event has occurred, and passes along that notification to all observers in the list of window event observers.

## Syntax

*Obj* -> [IDLitWindow::]OnMouseMotion, *X*, *Y*, *Modifiers*

## Arguments

### X

A floating-point value representing the *x*-location (in device coordinates) of the mouse event.

### Y

A floating-point value representing the *y*-location (in device coordinates) of the mouse event.

### Modifiers

An integer value of a bitwise mask indicating which modifier keys are active at the time the mouse button is pressed. If a bit is zero, the key is up; if the bit is set, the key is pressed. The following table describes the bits in this bitmask:

| Bit | Value | Modifier Key |
|---|---|---|
| 0 | 1 | Shift |
| 1 | 2 | Control |
| 2 | 4 | Caps Lock |
| 3 | 8 | Alt |

*Table 118: Bits of the Modifier Key Mask*

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::OnMouseUp

The IDLitWindow::OnMouseUp procedure method handles notification (from the native window device) that a mouse up event has occurred, and passes along that notification to all observers in the list of window event observers.

# Syntax

*Obj* -> [IDLitWindow::]OnMouseUp, *X*, *Y*, *ButtonMask*

# Arguments

## X

A floating-point value representing the *x*-location (in device coordinates) of the mouse event.

## Y

A floating-point value representing the *y*-location (in device coordinates) of the mouse event.

## ButtonMask

An integer value of a bitwise mask indicating which of the left, center, or right mouse button was pressed:

| Bitmask | Mouse Button |
|---|---|
| 1 | Left |
| 2 | Middle |
| 4 | Right |

*Table 119: Bitmask for Button Events*

# Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::OnScroll

The IDLitWindow::OnScroll procedure method handles notification (from the native window device) that a scrolling event has occurred. This notification is passed on to the window's scene, which handles the cropping of each of its contained views. A scene represents a container for all of the views (and their corresponding visualization hierarchies) that appear within a window.

## Syntax

*Obj* -> [IDLitWindow::]OnScroll, *X*, *Y*

## Arguments

### X

A floating-point value representing the *x*-coordinate of the lower left corner of the visible portion of the canvas (in device coordinates) after the scroll.

### Y

A floating-point value representing the *y*-coordinate of the lower left corner of the visible portion of the canvas (in device coordinates) after the scroll.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::Remove

The IDLitWindow::Remove procedure method removes the given object(s) from the window.

## Syntax

*Obj* -> [IDLitWindow::]Remove, *Object* [, /ALL] [, POSITION=index]

## Arguments

### Object

A reference (or vector of references) to the object(s) to be removed from this window.

## Keywords

### ALL

Set this keyword to remove all objects from the container. If this keyword is set, the *Object* argument is not required.

### POSITION

Set this keyword equal to the zero-based index of the object to be removed. If the *Object* argument is supplied, this keyword is ignored.

## Version History

Introduced: 6.0

# IDLitWindow::RemoveWindowEventObserver

The IDLitWindow::RemoveWindowEventObserver procedure method removes the given object(s) from the list of observers that are notified of events that occur within this window.

## Syntax

*Obj* -> [IDLitWindow::]RemoveWindowEventObserver, *Objects*

## Arguments

### Objects

A reference (or vector of references) to the object(s) to be removed from the list of window event observers.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::SetCurrentZoom

The IDLitWindow::SetCurrentZoom procedure method sets the current zoom factor for this window by changing its virtual dimensions. The contents of the window are updated to reflect the new zoom factor.

## Syntax

*Obj* -> [IDLitWindow::]SetCurrentZoom, *ZoomFactor* [, /RESET]

## Arguments

### ZoomFactor

A positive floating point value indicating the zoom factor to be applied to the window. Values less than 1.0 result in a zooming out; values greater than 1.0 result in a zooming in on the contents of the window.

## Keywords

### RESET

Set this keyword to indicate that the zoom factor should be reset to 1.0. If this keyword is present, the *ZoomFactor* argument is ignored.

## Version History

Introduced: 6.0

# IDLitWindow::SetEventMask

The IDLitWindow::SetEventMask procedure method enables the given events within this window.

When an event occurs within this window, if the corresponding event type is enabled, then the list of its window event observers will be notified of the event. See “IDLitWindow::AddWindowEventObserver” on page 3096 for more details.

## Syntax

*Obj* -> [IDLitWindow::]SetEventMask([*EventMask*] [, /BUTTON_EVENTS] [, /KEYBOARD_EVENTS] [, /MOTION_EVENTS] [, /TRACKING_EVENTS])

## Arguments

### EventMask

An unsigned long integer representing the bitwise mask for the events that are to be enabled for this window. The bits in the mask are as follows:

| Bit | Value | Event |
|---|---|---|
| 0 | 1 | Button Events |
| 1 | 2 | Motion Events |
| 2 | 4 | Keyboard Events |
| 3 | 8 | Tracking Events |

*Table 120: Bits of the Event Mask*

This argument is optional; the keywords described below may be used instead.

## Keywords

### BUTTON_EVENTS

Set this keyword to indicate that mouse button events are to be enabled for this window.

### KEYBOARD_EVENTS

Set this keyword to indicate the keyboard events are to be enabled for this window.

### MOTION_EVENTS

Set this keyword to indicate that mouse motion events are to be enabled for this window.

### TRACKING_EVENTS

Set this keyword to indicate that tracking events are to be enabled for this window.

## Version History

Introduced: 6.0

# IDLitWindow::SetManipulatorManager

The IDLitWindow::SetManipulatorManager procedure method sets the given IDLitManipulatorManager object as the current manager of this window's manipulators.

## Syntax

*Obj* -> [IDLitWindow::]SetManipulatorManager, *Manager*

## Arguments

### Manager

A reference to the IDLitManipulatorManager object that is to serve as the manager for this window's manipulators.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::SetProperty

The IDLitWindow::SetProperty procedure method sets the value of an IDLitWindow property, and should be called by the subclass' SetProperty method. This method also calls the superclass' SetProperty method.

## Syntax

*Obj* -> [IDLitWindow::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLitWindow Properties” on page 3086 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitWindow::ZoomIn

The IDLitWindow::ZoomIn procedure method causes the current zoom factor for this window to be increased (that is, multiplied by the factor given by the window's ZOOM_BASE property). The contents of the window are updated to reflect the new zoom factor. See "IDLitWindow::SetCurrentZoom" on page 3117 for additional details.

## Syntax

*Obj* -> [IDLitWindow::]ZoomIn

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWindow::ZoomOut

The IDLitWindow::ZoomOut procedure method causes the current zoom factor for this window to be decreased (that is, divided by the factor given by the window's ZOOM_BASE property). The contents of the window are updated to reflect the new zoom factor. See "IDLitWindow::SetCurrentZoom" on page 3117 for additional details.

## Syntax

*Obj* -> [IDLitWindow::]ZoomOut

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWriter

The IDLitWriter class defines the interface used to construct file writers for the iTools framework. Objects of this class are not intended to be created as standalone entities; rather, this class should be included as the superclass of an iTool file writer class.

This class is written in the IDL language. Its source code can be found in the file `idlitwriter__define.pro` in the `lib/itools/framework` subdirectory of the IDL distribution.

## Superclasses

IDLitComponent

IDLitIMessaging

## Creation

See "IDLitWriter::Init" on page 3131.

## Properties

Objects of this class do not have any properties of their own, but do have properties inherited from any superclasses.

## Methods

This class has the following methods:

- IDLitWriter::Cleanup
- IDLitWriter::GetFileExtensions
- IDLitWriter::GetFilename
- IDLitWriter::GetProperty
- IDLitWriter::Init
- IDLitWriter::IsA
- IDLitWriter::SetData

- IDLitWriter::SetFilename
- IDLitWriter::SetProperty

In addition, this class inherits the methods of its superclasses.

## Examples

See Chapter 9, “Creating a File Writer” in the *iTool Developer’s Guide* manual for examples using this class and its methods.

## Version History

Introduced: 6.0

# IDLitWriter Properties

Objects of this class do not have any properties of their own, but do have properties inherited from any superclasses.

# IDLitWriter::Cleanup

The IDLitWriter::Cleanup procedure method performs all cleanup on the object, and should be called by the subclass' Cleanup method.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLitWriter::]Cleanup (*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWriter::GetFileExtensions

The IDLitWriter::GetFileExtensions method is called by the system to retrieve the file extensions supported by this particular writer.

## Syntax

*Result* = *Obj* -> [IDLitWriter::]GetFileExtensions([COUNT=*count*])

## Return Value

Returns a scalar or string array that contains the file extensions associated with this writer.

## Arguments

None

## Keywords

### COUNT

Set this keyword to a named variable that will contain the number of file extensions returned by this method.

## Version History

Introduced: 6.0

# IDLitWriter::GetFilename

The IDLitWriter::GetFilename function method is called by the system to retrieve the current filename associated with this writer. Due to the automated nature of the file writer system, filenames can be associated with a file writer and then the file can be written at a later time. This method allows direct access to the file currently associated with the writer.

In addition, this methodology is helpful when multiple writes are performed from a given file.

## Syntax

*Result* = *Obj* -> [IDLitWriter::]GetFilename()

## Return Value

Returns a string containing the current file name associated with this writer, or an empty string if no filename has been associated.

## Arguments

None

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWriter::GetProperty

The IDLitWriter::GetProperty procedure method retrieves the value of an IDLitWriter property, and should be called by the subclass' GetProperty method. This method also retrieves properties defined in the superclasses.

## Syntax

*Obj* -> [IDLitWriter::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under "IDLitReader Properties" on page 2956 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 6.0

# IDLitWriter::Init

The IDLitWriter::Init function method initializes the IDLitWriter object, and should be called by the subclass' Init method. This method also calls the superclass' Init method.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: if you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLitWriter', *Extensions* [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLitWriter::]Init(*Extensions* [, *PROPERTY=value*])
(*Only in subclass' Init method.*)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or 0 otherwise.

## Arguments

### Extensions

A scalar or string array that contains the file extensions that are common for this file type. These values should not include the period that is often associated with file extensions (a correct value is "jpeg" not ".jpeg").

## Keywords

Any property listed under “IDLitReader Properties” on page 2956 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0

# IDLitWriter::IsA

The IDLitWriter::IsA function method is called by the system to determine if the given file is of the type supported by this file writer. Often this is used to determine what file writer to use when opening a new file.

The default behavior provided by this method is to check the file extension on the provided file name with the extensions provided to this object during initialization.

When a new writer is implemented, the default behavior can be used, or the developer can provide further logic to determine if the provided file is the correct type.

## Syntax

*Result* = *Obj* -> [IDLitWriter::]IsA(*Filename*)

## Return Value

Returns a 1 if the writer supports this type of file, or a 0 if the writer does not support this type of file.

## Arguments

### Filename

A string scalar representing of the filename, which is used to check and determine if the writer supports its format.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWriter::SetData

The IDLitWriter::SetData function method is called by the system to set the data for the current file. When called, the writer should access the current filename and write the desired data.

This method will contain a majority of the implementation for a new writer class.

## Syntax

*Result* = *Obj* -> [IDLitWriter::]SetData(*Data*)

## Return Value

Returns a 1 if successful, or a 0 if the initialization failed.

## Arguments

### Data

A data object that contains the information to be written.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWriter::SetFilename

The IDLitWriter::SetFilename procedure method is called by the system to set the current filename associated with this writer. Due to the automated nature of the file writer system, filenames can be associated with a file writer and then the file can be written at a later time.

## Syntax

*Obj* -> [IDLitWriter::]SetFilename, *Filename*

## Arguments

### Filename

A string that contains the filename associated with this writer.

## Keywords

None

## Version History

Introduced: 6.0

# IDLitWriter::SetProperty

The IDLitWriter::SetProperty procedure method sets the value of an IDLitWriter property, and should be called by the subclass' SetProperty method. This method also calls the superclass' SetProperty method.

## Syntax

*Obj* -> [IDLitWriter::]SetProperty[, *PROPERTY*=*value*]

## Arguments

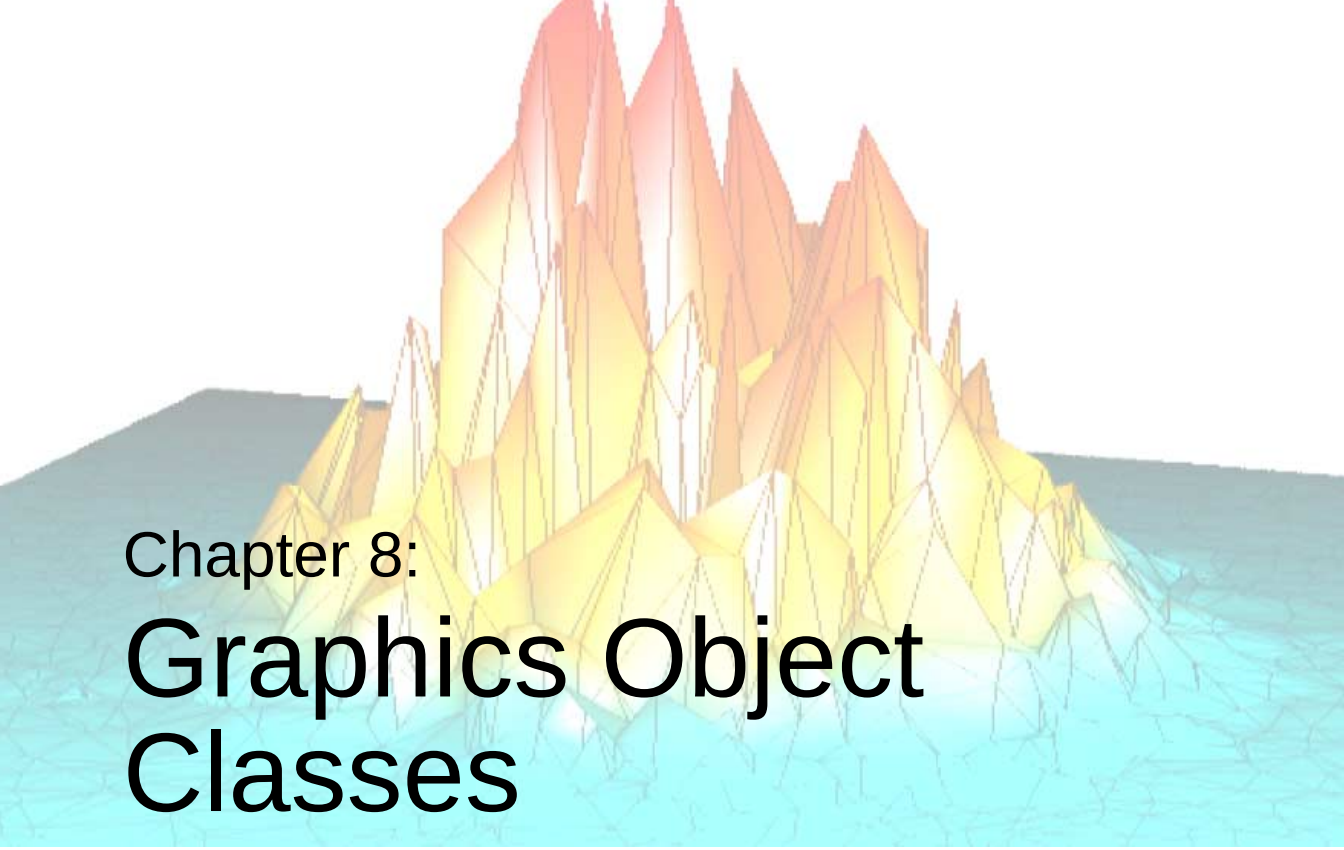
None

## Keywords

Any property listed under "IDLitReader Properties" on page 2956 that contains the word "Yes" in the "Set" column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 6.0



# Chapter 8: Graphics Object Classes

This chapter describes IDL's built-in graphics class library.

# IDLgrAxis

An axis object represents a single vector that may include a set of tick marks, tick labels, and a title.

An IDLgrAxis object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrAxis::Init" on page 3165.

## Properties

Objects of this class have the following properties. See "IDLgrAxis Properties" on page 3140 for details on individual properties.

- ALL
- AM_PM
- CLIP_PLANES
- COLOR
- CRANGE
- DAYS_OF_WEEK
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- DIRECTION
- EXACT
- EXTEND
- GRIDSTYLE
- HIDE
- LOCATION
- LOG
- MAJOR
- MINOR
- MONTHS
- NOTEXT
- PALETTE
- PARENT
- RANGE
- REGISTER_PROPERTIES
- SUBTICKLEN
- TEXTALIGNMENTS

- TEXTBASELINE
- TEXTUPDIR
- TICKDIR
- TICKFRMTDATA
- TICKLAYOUT
- TICKTEXT
- TICKVALUES
- USE_TEXT_COLOR
- XRANGE
- YRANGE
- ZRANGE
- TEXTPOS
- THICK
- TICKFORMAT
- TICKINTERVAL
- TICKLEN
- TICKUNITS
- TITLE
- XCOORD_CONV
- YCOORD_CONV
- ZCOORD_CONV

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrAxis::Cleanup
- IDLgrAxis::GetCTM
- IDLgrAxis::GetProperty
- IDLgrAxis::Init
- IDLgrAxis::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrAxis Properties

IDLgrAxis objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrAxis::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrAxis::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrAxis::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## AM_PM

A string array of 2 names to be used for the names of the AM and PM string when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the TICKFORMAT property.

| | | | |
|---|---|---|---|
| **Property Type** | String array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## CLIP_PLANES

A 4 by *n* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

The color to be used as the foreground color for this axis. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

| **Property Type** | Color | | |
|---|---|---|---|
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CRANGE

A double-precision floating-point vector of the form [minval, maxval] that will contain the actual full range of the axis. This range may not exactly match the requested range provided via the RANGE property in the Init and SetProperty

methods. Adjustments may have been made to round to the nearest even tick interval or to accommodate the EXTEND property.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DAYS_OF_WEEK

A string array of 7 names to be used for the names of the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the TICKFORMAT property.

| **Property Type** | String array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DIRECTION

An integer value that specifies which axis is being created. Specify 0 (zero) to create an X axis, 1 (one) to create a Y axis, or 2 to create a Z axis. Specifying this property is the same as specifying the optional *Direction* argument.

This property is registered as an enumerated list, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Direction | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## EXACT

A Boolean value that determines whether to force the axis range to be exactly as specified. If this property is not set, the range may be lengthened or shortened slightly to allow for evenly spaced tick marks.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | Use exact axis range | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## EXTEND

A Boolean value that determines whether to extend the axis slightly beyond the specified range. This can be useful when you specify the axis range based on the minimum and maximum data values, but do not want the graphic to extend all the way to the end of the axis.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | Extend axis | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## GRIDSTYLE

An integer or two-element vector that indicates the line style that should be used to draw the axis' tick marks. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the GRIDSTYLE property equal to one of the following integer values:

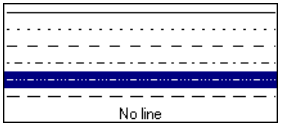
- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `GRIDSTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

In a property sheet, this property appears as a Linestyle drop-down list, with the following options:




| **Property Type** | Linestyle | | |
|---|---|---|---|
| **Name String** | Line style | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value indicating whether this object should be drawn. Options:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In property sheets, this property appears as an enumerated list, with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LOCATION

A two- or three-element floating-point vector of the form [*x*, *y*] or [*x*, *y*, *z*] to specify the coordinate through which the axis should pass. The default is [0, 0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LOG

A Boolean value that indicates whether the axis is logarithmic.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | Use logarithmic axis | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MAJOR

An integer representing the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | Number of major ticks | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MINOR

An integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | Number of minor ticks | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MONTHS

A string array of 12 names to be used for the names of the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the TICKFORMAT property.

| | | | |
|---|---|---|---|
| **Property Type** | String array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## NOTEXT

A Boolean value indicating whether the tick labels and the axis title should be drawn.

- 0 = Draw tick labels and axis title (the default).
- 1 = Do not draw tick labels and axis title.

In a property sheet, this property appears as an enumerated list. Options:

- True = Draw tick labels and axis title (the default).
- False = Do not draw the tick labels and axis title.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Text show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

The object reference of a palette object (an instance of the IDLgrPalette object class) that defines the color palette of this object. This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## RANGE

A two-element floating-point vector containing the minimum and maximum data values covered by the axis. The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## SUBTICKLEN

A floating-point scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Minor tick length | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TEXTALIGNMENTS

A two-element floating-point vector, [*horizontal*, *vertical*], specifying the horizontal and vertical alignments for the tick text. Each alignment value should be a value between 0.0 and 1.0. For horizontal alignment, 0.0 left-justifies the text; 1.0 right-justifies the text.

For vertical alignment, 0.0 bottom-justifies the text, 1.0 top-justifies the text. The defaults are as follows:

- *X*-Axis: [0.5, 1.0] (centered horizontally, top-justified vertically)
- Y-Axis: [1.0, 0.5] (right-justified horizontally, centered vertically)
- Z-Axis: [1.0, 0.5] (right-justified horizontally, centered vertically)

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TEXTBASELINE

A two- or three-element floating-point vector describing the direction in which the baseline of the tick text is to be oriented. Use this property in conjunction with the TEXTUPDIR property to specify the plane on which the tick text lies. The default is [1,0,0].

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TEXTPOS

An integer that indicates on which side of the axis to draw the tick text labels. The table below describes the placement of the tick text with each setting.

| Axis | TEXTPOS = 0 | TEXTPOS = 1 |
|---|---|---|
| **X** | Tick text will be drawn *below* the X axis, where *below* is defined as being toward the direction of the negative Y axis (this is the default). | Tick text will be drawn *above* the X axis, where *above* is described as being toward the direction of the positive Y axis. |

*Table 8-1: Values for the TEXTPOS property*

| Axis | TEXTPOS = 0 | TEXTPOS = 1 |
|---|---|---|
| **Y** | Tick text will be drawn to the *left* of the Y Axis, where *left* is defined as being toward the direction of the negative X axis (this is the default). | Tick text will be drawn to the *right* of the Y axis, where *right* is defined as being toward the direction of the positive X axis. |
| **Z** | Tick text will be drawn to the *left* of the Z axis, where *left* is defined as being toward the direction of the negative X axis (this is the default). | Tick text will be drawn to the *right* of the Z axis, where *right* is defined as being toward the direction of the positive X axis. |

*Table 8-1: Values for the TEXTPOS property*

In a property sheet, this property appears as an enumerated list. Options:

- Below/left: Text will be drawn below the axis and to the left.
- Above/right: Text will be drawn above the axis and to the right.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Text position | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TEXTUPDIR

A two- or three-element floating-point vector describing the direction in which the up-vector of the tick text is to be oriented. Use this property in conjunction with the TEXTBASELINE property to specify the plane on which the tick text lies. TEXTUPDIR should be orthogonal to TEXTBASELINE. The default is as follows:

- *X*-Axis: [0, 1, 0]
- *Y*-Axis: [0, 1, 0]
- *Z*-Axis: [0, 0, 1]

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value in points between 1.0 and 10.0 that specifies the line thickness used to draw the axis. The default is 1.0 points.

In a property sheet, this property appears as a Thickness drop-down list with the following options:


| **Property Type** | Thickness | | |
|---|---|---|---|
| **Name String** | Line thickness | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKDIR

An integer value of zero or one to indicate the tick mark direction.

| Axis | TICKDIR = 0 | TICKDIR = 1 |
|---|---|---|
| X | Tick marks will be drawn above the X axis, in the direction of the positive Y axis (this is the default). | Tick marks will be drawn below the X axis. |
| Y | Tick marks will be drawn to the right of the Y axis, in the direction of the positive X axis (this is the default). | Tick marks will be drawn to the left of the Y axis. |
| Z | Tick marks will be drawn to the right the Z axis, in the direction of the positive X axis (this is the default). | Tick marks will be drawn to the left of the Z axis. |

*Table 8-2: Tick Mark Direction Values*

In a property sheet, this property appears as an enumerated list, with the following options:

- Right/above: Tick marks will be drawn above the axis and to the right.
- Left/below: Tick marks will be drawn below the axis and to the left.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Tick direction | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKFORMAT

A string, or an array of strings, in which each string represents a format string or the name of a function to be used to format the tick mark labels. If an array is provided, each string corresponds to a level of the axis. (The TICKUNITS property determines the number of levels for an axis.) If the number of strings stored in this property is one, GetProperty returns a scalar string, otherwise GetProperty returns an array of strings.

If the string begins with an open parenthesis, it is treated as a standard format string. (See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual.)

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels.

### If TICKUNITS are not specified:

- The callback function is called with three parameters: *Axis*, *Index*, and *Value*, where:
- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis
- *Index* is the tick mark index (indices start at 0)
- *Value* is the data value at the tick mark (a double-precision floating point value)

### If TICKUNITS are specified:

The callback function is called with four parameters: *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled. (Level indices start at 0.)

Used with the LABEL_DATE function, this property can easily create axes with date/time labels.

| **Property Type** | String or string array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TICKFRMTDATA

A value of any type that will be passed via the DATA property to the user-supplied formatting function specified via the TICKFORMAT property, if any. By default, this value is 0, indicating that the DATA property will not be set (and furthermore, need not be supported by the user-supplied function.)

**Note**

TICKFRMTDATA will not be included in the structure returned via the ALL property to the IDLgrAxis::GetProperty method.

| **Property Type** | Scalar of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** | **Set:** | **Init:** | **Registered:** No |

## TICKINTERVAL

A floating-point scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis RANGE and the number of major tick marks (MAJOR). This property takes precedence over MAJOR.

For example, if TICKUNITS=['S','H','D'], and TICKINTERVAL=30, then the interval between major ticks for the first axis level will be 30 seconds.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Tick interval | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKLAYOUT

An integer scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

**Note**

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

In a property sheet, this property appears as an enumerated list with the following options:

- Axis plus labels: Same as the 0 value above.
- Labels only: Same as the 1 value above.
- Box style: Same as the 2 value above.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Tick layout | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKLEN

A floating-point value that specifies the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Major tick length | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKTEXT

An object reference to a single instance of the IDLgrText object class (with multiple strings) or a vector of instances of the IDLgrText object class (one per major tick) to specify the annotations to be assigned to the tickmarks. By default, with TICKTEXT set equal to a null object, IDL computes the tick labels based on major tick values. The positions of the provided text objects may be overwritten; position is determined according to tick mark location. The tickmark text will have the same color as the IDLgrAxis object, regardless of the color specified by the COLOR property of the IDLgrText object or objects, unless the USE_TEXT_COLOR property is specified.

**Note**

If IDL computes the tick labels, the text object it creates will be destroyed automatically when the axis object is destroyed, even if you have altered the properties of the text object. If you create your own text object containing tickmark text, however, it will *not* be destroyed automatically.

| **Property Type** | Object reference or string vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TICKUNITS

A string (or a vector of strings) indicating the units to be used for axis tick labeling. If the number of levels in the axis is one, GetProperty returns a scalar string, otherwise GetProperty returns an array of strings.

If more than one unit is provided, the axis will be drawn in multiple levels, one level per unit.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- ""- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the "Numeric" unit. This is the default setting.

If any of the time units are utilized, then the tick values are interpreted as Julian date/time values. Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS='Day' is equivalent to TICKUNITS='Days').

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000hidd, respectively.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | STRING | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKVALUES

A floating-point vector of data values representing the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the

axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TITLE

An object reference to an instance of the IDLgrText object class that specifies the title for the axis. The default is the null object, specifying that no title is drawn. The title will be centered along the axis, even if the text object itself has an associated location. The title will have the same color as the IDLgrAxis object, regardless of the color specified by the COLOR property of the IDLgrText object, unless the USE_TEXT_COLOR property is specified.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## USE_TEXT_COLOR

A Boolean value that indicates whether, for the tick text and/or title of the axis, the color property values set for the given IDLgrText objects are to be used to draw those text items. By default, this value is zero, indicating that the color properties of the IDLgrText objects will be ignored, and that the COLOR property for the axis object will be used for these text items instead.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, [$s_0$, $s_1$], of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** | **Set:** | **Init:** | **Registered:** No |

# IDLgrAxis::Cleanup

The IDLgrAxis::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrAxis::]Cleanup(*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrAxis::GetCTM

The IDLgrAxis::GetCTM function method returns the graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrAxis::]GetCTM([, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref*])

## Return Value

Returns the 4 x 4 double-precision floating-point graphics transform matrix.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the axis object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrAxis::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrAxis::GetProperty

The IDLgrAxis::GetProperty procedure method retrieves the value of a property or group of properties for the axis.

## Syntax

*Obj* -> [IDLgrAxis::]GetProperty [, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrAxis Properties” on page 3140 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 5.0

# IDLgrAxis::Init

The IDLgrAxis::Init function method initializes an axis object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

# Syntax

*Obj* = OBJ_NEW('IDLgrAxis' [, *Direction*] [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrAxis::]Init([*Direction*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

# Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

# Arguments

## Direction

An integer value specifying which axis is being created. Specify 0 (zero) to create an X axis, 1 (one) to create a Y axis, or 2 to create a Z axis.

# Keywords

Any property listed under "IDLgrAxis Properties" on page 3140 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrAxis::SetProperty

The IDLgrAxis::SetProperty procedure method sets the value of a property or group of properties for the axis.

## Syntax

*Obj* -> [IDLgrAxis::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrAxis Properties” on page 3140 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrBuffer

An IDLgrBuffer object is an in-memory, off-screen destination object. Object trees can be drawn to instances of the IDLgrBuffer object and the resulting image can be retrieved from the buffer using the Read() method. The off-screen representation avoids dithering artifacts by providing a full-resolution buffer for objects using either the RGB or Color Index color models.

**Note**

Objects or subclasses of this type can not be saved or restored.

## Superclasses

IDLitComponent

## Creation

See “IDLgrBuffer::Init” on page 3186.

## Properties

Objects of this class have the following properties. See “IDLgrBuffer Properties” on page 3170 for details on individual properties.

- ALL
- COLOR_MODEL
- DIMENSIONS
- GRAPHICS_TREE
- IMAGE_DATA
- N_COLORS
- PALETTE
- QUALITY
- REGISTER_PROPERTIES
- RESOLUTION
- SCREEN_DIMENSIONS

- UNITS
- ZBUFFER_DATA

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrBuffer::Cleanup
- IDLgrBuffer::Draw
- IDLgrBuffer::Erase
- IDLgrBuffer::GetContiguousPixels
- IDLgrBuffer::GetDeviceInfo
- IDLgrBuffer::GetFontnames
- IDLgrBuffer::GetProperty
- IDLgrBuffer::GetTextDimensions
- IDLgrBuffer::Init
- IDLgrBuffer::PickData
- IDLgrBuffer::Read
- IDLgrBuffer::Select
- IDLgrBuffer::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrBuffer Properties

IDLgrBuffer objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrBuffer::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrBuffer::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrBuffer::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the retrievable properties associated with this object (except IMAGE_DATA and ZBUFFER_DATA).

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR_MODEL

A Boolean value that determines the color model to be used for the buffer:

- 0 = RGB (default)
- 1 = Color Index

In a property sheet, this property appears as an enumerated list with the following options:

- RGB
- Indexed

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Color model | | |
| **Get:** Yes | **Set:** | **Init:** Yes | **Registered:** Yes |

## DIMENSIONS

A two-element integer vector of the form [*width*, *height*] that specifies the dimensions of the buffer in units specified by the UNITS property. The default is [640,480].

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GRAPHICS_TREE

An object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView that specifies the graphics tree of this object. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## IMAGE_DATA

A byte array representing the image that is currently rendered within the buffer. If the buffer uses an RGB color model, the returned array will have dimensions (3, *xdim*, *ydim*). If the window object uses an indexed color model, the returned array will have dimensions (*xdim*, *ydim*).

| **Property Type** | Byte array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## N_COLORS

An integer that determines the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to Color Index.

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Number of colors | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that specifies the red, green, and blue values to be loaded into the buffer's color lookup table.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## QUALITY

An integer that indicates the rendering quality at which graphics are to be drawn to the buffer. Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default)

In a property sheet, this property appears as an enumerated list with the following options:

- Low
- Medium

- High

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Draw quality | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESOLUTION

A two-element floating-point vector of the form [*xres*, *yres*] that specifies the device resolution in centimeters per pixel. This value is stored in double precision. The default value is: [0.035277778, 0.035277778] (72 DPI).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Resolution | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## SCREEN_DIMENSIONS

A two-element integer vector of the form [*width*, *height*] that specifies the maximum allowed dimensions (measured in device units) for the buffer object.

**Note**

The maximum buffer dimension size is always 2048 by 2048.

| | | | |
|---|---|---|---|
| **Property Type** | Integer vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## UNITS

An integer value that indicates the units of measure for the DIMENSIONS property. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to 1600 x 1200

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZBUFFER_DATA

A floating-point array representing the zbuffer that is currently within the buffer. The returned array will have dimensions (*xdim*, *ydim*).

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrBuffer::Cleanup

The IDLgrBuffer::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrBuffer::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrBuffer::Draw

The IDLgrBuffer::Draw procedure method draws the given picture to this graphics destination.

**Note**

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

# Syntax

*Obj* -> [IDLgrBuffer::]Draw [, *Picture*] [, CREATE_INSTANCE={1 | 2}] [, /DRAW_INSTANCE]

# Arguments

## Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object) or scene (an instance of an IDLgrScene object) to be drawn.

# Keywords

## CREATE_INSTANCE

Set this keyword equal to one to specify that this scene or view is the unchanging part of a drawing. Some destinations can make an instance from the current window contents without having to perform a complete redraw. If the view or scene to be drawn is identical to the previously drawn view or scene, this keyword can be set equal to 2 to hint the destination to create the instance from the current window contents if it can.

## DRAW_INSTANCE

Set this keyword to specify that this scene, viewgroup, or view is the changing part of the drawing. It is overlaid on the result of the most recent CREATE_INSTANCE draw.

# Version History

Introduced: 5.0

# IDLgrBuffer::Erase

The IDLgrBuffer::Erase procedure method erases this graphics destination.

## Syntax

*Obj* -> [IDLgrBuffer::]Erase [, COLOR=*index or RGB vector*]

## Arguments

None

## Keywords

### COLOR

Set this keyword to the color to be used for the erase. The color may be specified as a color lookup table index or as an RGB vector.

## Version History

Introduced: 5.0

# IDLgrBuffer::GetContiguousPixels

The IDLgrBuffer::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
[4,3,2,1,0]
```

## Syntax

*Result* = *Obj* -> [IDLgrBuffer::]GetContiguousPixels()

## Return Value

Returns an array of long integers whose length is equal to the number of colors available in the index color mode.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrBuffer::GetDeviceInfo

The IDLgrBuffer::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=1 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

## Syntax

*Obj* -> [IDLgrBuffer::]GetDeviceInfo [, ALL=*variable*]
[, MAX_NUM_CLIP_PLANES=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

## Arguments

None

## Keywords

### ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

### MAX_NUM_CLIP_PLANES

Set this keyword to a named variable that upon return will contain an integer that specifies the maximum number of user-defined clipping planes supported by the device.

### MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_TEXTURE_DIMENSIONS contains a two-element integer array that specifies the maximum texture size supported by the device.

### MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_VIEWPORT_DIMENSIONS contains a two-element integer array that specifies the maximum size of a graphics display supported by the device.

### NAME

Set this keyword equal to a named variable. Upon return, NAME contains the name of the rendering device as a string.

### NUM_CPUS

Set this keyword equal to a named variable. Upon return, NUM_CPUS contains an integer that specifies the number of CPUs that are known to, and available to IDL.

**Note**

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI IRIX, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

### VENDOR

Set this keyword equal to a named variable. Upon return, VENDOR contains the name of the rendering device creator as a string.

### VERSION

Set this keyword equal to a named variable. Upon return, VERSION contains the version of the rendering device driver as a string.

## Version History

Introduced: 5.0

MAX_NUM_CLIP_PLANES keyword: 5.6

# IDLgrBuffer::GetFontnames

The IDLgrBuffer::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned. See Appendix H, "Fonts" for more information.

## Syntax

*Result* = *Obj* -> [IDLgrBuffer::]GetFontnames( *FamilyName*[, IDL_FONTS={0 | 1 | 2 }] [, STYLES=*string*] )

## Return Value

Returns the list of available fonts that can be used in IDLgrFont objects.

## Arguments

### FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

## Keywords

### IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

### STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is

the string, “*”, which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

## Version History

Introduced: 5.0

# IDLgrBuffer::GetProperty

The IDLgrBuffer::GetProperty procedure method retrieves the value of a property or group of properties for the buffer.

## Syntax

*Obj* -> [IDLgrBuffer::]GetProperty[, *PROPERTY*=*variable*]

## Keywords

Any property listed under “IDLgrBuffer Properties” on page 3170 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s super-class.

## Version History

Introduced: 5.0

# IDLgrBuffer::GetTextDimensions

The IDLgrBuffer::GetTextDimensions function method retrieves the dimensions of a text or axis object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units. If the object specified is an axis object, the result encompasses the tick labels and the title of the axis (if any).

## Syntax

*Result* = *Obj* ->[IDLgrBuffer::]GetTextDimensions( *TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*] )

## Return Value

Returns the dimensions of a text or axis object that will be rendered in a window.

## Arguments

### TextObj

The object reference to a text or axis object for which text dimensions are requested.

## Keywords

### DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If

IDLgrBuffer::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.0

# IDLgrBuffer::Init

The IDLgrBuffer::Init function method initializes the buffer object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrBuffer' [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLgrBuffer::]Init([*PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrBuffer Properties" on page 3170 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrBuffer::PickData

The IDLgrBuffer::PickData function method maps a point in the two-dimensional device space of the buffer to a point in the three-dimensional data space of an object tree. The resulting 3-D data space coordinates are returned in a user-specified variable. The PickData function returns one if the specified location in the buffer's device space "hits" a graphic object, or zero otherwise.

## Syntax

*Result* = *Obj* -> [IDLgrBuffer::]PickData( *View*, *Object*, *Location*, *XYZLocation* [, DIMENSIONS=*[width,height]*][, PATH=*objref(s)*] [, PICK_STATUS=*variable*])

## Return Value

Returns one if the specified location in the buffer's device space "hits" a graphic object, or zero otherwise.

## Arguments

### View

The object reference of an IDLgrView object that contains the object being picked.

### Object

The object reference of a model or atomic graphic object from which the data space coordinates are being requested.

### Location

A two-element vector [*x*, *y*] specifying the location in the buffer's device space of the point to pick data from.

### XYZLocation

A named variable that will contain the three-dimensional double-precision floating-point data space coordinates of the picked point. Note that the value returned in this variable is a location, not a data value.

**Note**

If the atomic graphic object specified as the target has been transformed using either the LOCATION or DIMENSIONS properties (this is only possible with

IDLgrAxis, IDLgrImage, and IDLgrText objects), these transformations will *not* be included in the data coordinates returned by the PickData function. This means that you may need to re-apply the transformation accomplished by specifying LOCATION or DIMENSIONS once you have retrieved the data coordinates with PickData. This situation does not occur if you transform the axis, text, or image object using the [XYZ]COORD_CONV properties.

# Keywords

## DIMENSIONS

Set this keyword to a two-element array [*w, h*] to specify data picking should occur for all device locations that fall within a *pick box* of these dimensions. The pick box will be centered about the coordinates [*x, y*] specified in the *Location* argument, and will occupy the rectangle defined by:

```
(x-(w/2), y-(h/2)) - (x+(w/2), y+(h/2))
```

By default, the pick box covers a single pixel. The array returned via the *XYZLocation* argument will have dimensions [*3, w, h*].

## PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a data space coordinate. Each path object reference specified with this keyword must contain an alias. The data space coordinate is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## PICK_STATUS

Set this keyword to a named variable that will contain “hit” information for each pixel in the pick box. If the DIMENSIONS keyword is not set, the PICK_STATUS will be a scalar value exactly matching the *Result* of the method call. If the DIMENSIONS keyword is set, the PICK_STATUS variable will be an array matching the dimensions

of the pick box. Each value in the PICK_STATUS array corresponds to a pixel in the pick box, and will be set to one of the following values:

| Value | Description |
|---|---|
| -1 | The pixel falls outside of the window’s viewport. |
| 0 | No graphic object is “hit” at that pixel location. |
| 1 | A graphic object is “hit” at that pixel location. |

*Table 8-3: PICK_STATUS Keyword Values*

## Version History

Introduced: 5.0

PICK_STATUS keyword: 5.6

# IDLgrBuffer::Read

The IDLgrBuffer::Read function method reads an image from a buffer. The returned value is an instance of the IDLgrImage object class.

## Syntax

*Result* = *Obj* -> [IDLgrBuffer::]Read()

## Return Value

Returns an instance of the IDLgrImage object class.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrBuffer::Select

The IDLgrBuffer::Select function method returns a list of objects selected at a specified location. If no objects are selected, the Select function returns -1.

**Note**

IDL returns a maximum of 512 objects. This maximum may be smaller if any of the objects are contained in deep model hierarchies. Because of this limit, it is possible that not all objects eligible for selection will appear in the list.

## Syntax

*Result* = *Obj* -> [IDLgrBuffer::]Select(*Picture, XY* [, DIMENSIONS=*[width, height]*] [, /ORDER] [, UNITS={0 | 1 | 2 | 3}])

## Return Value

Returns a list of objects selected at a specified location.

## Arguments

### Picture

The view, viewgroup, or scene (an instance of the IDLgrView, IDLgrViewgroup, or IDLgrScene class) whose children are among the candidates for selection.

If the first argument is a scene or viewgroup, then the returned object list will contain one or more views. If the first argument is a view, the list will contain atomic graphic objects (or model objects which have their SELECT_TARGET property set). Objects are returned in order, according to their distance from the viewer. The closer an object is to the viewer, the lower its index in the returned object list. If multiple objects are at the same distance from the viewer (views in a scene or 2-D geometry), the first object drawn will appear at a lower index in the list. (The ORDER keyword can be used to change this behavior.)

### XY

A two-element array defining the center of the selection box in device space. By default, the selection box is 3 pixels by 3 pixels.

# Keywords

## DIMENSIONS

Set this keyword to a two-element array [*w*, *h*] to specify that the selection box will have a width *w* and a height *h*, and will be centered about the coordinates [*x*, *y*] specified in the *XY* argument. The box occupies the rectangle defined by:

```
(x-(w/2), y-(h/2)) - (x+(w/1), y+(h/2))
```

Any object which intersects this box is considered to be selected. By default, the selection box is 3 pixels by 3 pixels.

## ORDER

Set this keyword to control how objects that are the same distance from the viewer are ordered in the selection list. If ORDER=0 (the default), the order of objects in the selection list will be the same as the order in which the objects are drawn. If ORDER=1, the order of objects in the selection list will be the reverse of the order in which they are drawn. This keyword has no affect on the ordering of objects that are not at the same distance from the viewer.

**Tip**

If you are using DEPTH_TEST_FUNCTION=4 (“less than or equal”) on your graphics objects, set ORDER=1 to return objects at the same depth in the order in which they appear visually.

## UNITS

Set this keyword to indicate the units of measure. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of the graphics destination.

# Version History

Introduced: 5.0

# IDLgrBuffer::SetProperty

The IDLgrBuffer::SetProperty procedure method sets the value of a property or group of properties for the buffer.

## Syntax

*Obj* -> [IDLgrBuffer::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrBuffer Properties” on page 3170 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrClipboard

An IDLgrClipboard object will send Object Graphics output to the operating system native clipboard in bitmap format. The format of bitmaps sent to the clipboard is operating system dependent: output is stored as a device-independent bitmap under Windows and as an Encapsulated PostScript (EPS) image under UNIX.

**Note**

Objects or subclasses of this type can not be saved or restored.

## Superclasses

IDLitComponent

## Creation

See "IDLgrClipboard::Init" on page 3215.

## Properties

Objects of this class have the following properties. See "IDLgrClipboard Properties" on page 3197 for details on individual properties.

- ALL
- COLOR_MODEL
- DIMENSIONS
- GRAPHICS_TREE
- N_COLORS
- PALETTE
- QUALITY
- REGISTER_PROPERTIES
- RESOLUTION
- SCREEN_DIMENSIONS
- UNITS

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrClipboard::Cleanup
- IDLgrClipboard::Draw
- IDLgrClipboard::GetContiguousPixels
- IDLgrClipboard::GetDeviceInfo
- IDLgrClipboard::GetFontnames
- IDLgrClipboard::GetProperty
- IDLgrClipboard::GetTextDimensions
- IDLgrClipboard::Init
- IDLgrClipboard::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.1

# IDLgrClipboard Properties

IDLgrClipboard objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrClipboard::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrClipboard::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrClipboard::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure that contains the values of all of the retrievable properties associated with this object.

| | | | |
|---|---|---|---|
| **Property Type** | Anonymous structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR_MODEL

An integer value that determines whether to use the indexed color model for the clipboard buffer:

- 0 = RGB (default)
- 1 = Color Index

In a property sheet, this property appears as an enumerated list with the following options:

- RGB
- Indexed

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Color model | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## DIMENSIONS

A two-element integer vector of the form [*width, height*] to specify the dimensions of the clipboard buffer in units specified by the UNITS property. The default is [640,480].

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GRAPHICS_TREE

An object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView that specifies the graphic tree of this object. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## N_COLORS

An integer value that determines the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to Color Index.

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Number of colors | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that specifies the red, green, and blue values that are to be loaded into the clipboard buffer's color lookup table.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## QUALITY

An integer indicating the rendering quality at which graphics are to be drawn to the clipboard buffer. Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default)

In a property sheet, this property appears as an enumerated list with the following options:

- Low
- Medium
- High

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Draw quality | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESOLUTION

A two-element floating-point vector of the form [*xres*, *yres*] specifying the device resolution in centimeters per pixel. This value is stored in double precision. The default value is: [0.035277778, 0.035277778] (72 DPI).

**Note**

To match screen rendering on an IDLgrClipboard object, the following properties should be matched between the devices: DIMENSIONS, UNITS, RESOLUTION, COLOR_MODEL and N_COLORS.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Resolution | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## SCREEN_DIMENSIONS

A two-element integer vector of the form [*width*, *height*] that specifies the maximum allowed dimensions (measured in device units) for the clipboard object.

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## UNITS

An integer value that indicates the units of measure for the DIMENSIONS property. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters

- 3 = Normalized (relative to 1600 x 1200)

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLgrClipboard::Cleanup

The IDLgrClipboard::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj->* [IDLgrClipboard::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrClipboard::Draw

The IDLgrClipboard::Draw procedure method draws the given picture to this graphics destination.

**Note**

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

## Syntax

*Obj* -> [IDLgrClipboard::]Draw [, *Picture*] [, FILENAME=*string*] [, POSTSCRIPT=*value*] [, VECTOR={ 0 | 1 } ]

## Arguments

### Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object) or scene (an instance of an IDLgrScene object) to be drawn.

## Keywords

### FILENAME

Set this keyword to a string representing the name of a file to which the output should be written. By default, this keyword is the null string, indicating that the output is written to the clipboard.

### POSTSCRIPT

Set this keyword to a nonzero value to indicate that the generated output should be in PostScript format. By default, the generated output is in Windows Enhanced Metafile Format on Windows platforms and PostScript on UNIX platforms.

### VECTOR

Set this keyword to indicate the type of graphics primitives generated. Valid values include:

- 0 = Bitmap (default)
- 1 = Vector

If VECTOR = 0 (Bitmap), the Draw method renders the scene to a buffer and then copies the buffer to the printer in bitmap format. The bitmap retains the quality of the original image, but the user cannot scale the bitmap effectively on all devices.

If VECTOR = 1 (Vector), the Draw method renders the scene using simple vector operations that result in a representation of the Scene that is scalable to the printer. The vector representation does not retain all the attributes of the original image, however, a user can effectively scale it on other devices. On Windows, the representation is the Windows Enhanced Metafile (EMF). On UNIX platforms, the representation is PostScript.

## Examples

This example demonstrates the process of copying the contents of an IDL graphics display object (a buffer or a window) to the system clipboard, where it becomes available for pasting into another application. The example also uses the IDLgrClipboard::Draw method to create an encapsulated PostScript file in the current directory.

```
PRO SendingPlotToClipboard

; Determine the path to the "damp_sn2.dat" file.
signalFile = FILEPATH('damp_sn2.dat', $
   SUBDIRECTORY = ['examples', 'data'])

; Initialize the parameters of the data within the file.
signalSize = 512
signal = BYTARR(signalSize)

; Open the file, read in data, and then close the file.
OPENR, unit, signalFile, /GET_LUN
READU, unit, signal
FREE_LUN, unit

; Determine viewplane size and margins.
offsetScale = 150.
viewOffset = offsetScale*[-1., -1., 1., 1.]
signalRange = MAX(signal) - MIN(signal)

; Initialize the display objects.
windowSize = [512, 384]
oWindow = OBJ_NEW('IDLgrWindow', RETAIN = 2, $
   DIMENSIONS = windowSize, $
   TITLE = 'Damped Sine Wave with Noise')
oView = OBJ_NEW('IDLgrView', $
   VIEWPLANE_RECT = [0., 0., signalSize, signalRange] + $
   viewOffset)
```

```
oModel = OBJ_NEW('IDLgrModel')

; Initialize the plot object.
oPlot = OBJ_NEW('IDLgrPlot', signal, COLOR = [0, 0, 255])

; Obtain plot ranges.
oPlot -> GetProperty, XRANGE = xPlotRange, $
   YRANGE = yPlotRange

; Initialize axes objects, which are based on the plot
; ranges.
oXTitle = OBJ_NEW('IDLgrText', 'Time (seconds)')
oXAxis = OBJ_NEW('IDLgrAxis', 0, RANGE = xPlotRange, $
   LOCATION = [xPlotRange[0], yPlotRange[0]], /EXACT, $
   TITLE = oXTitle, TICKDIR = 0, $
   TICKLEN = (0.02*(yPlotRange[1] - yPlotRange[0])))
oYTitle = OBJ_NEW('IDLgrText', 'Amplitude (centimeters)')
oYAxis = OBJ_NEW('IDLgrAxis', 1, RANGE = yPlotRange, $
   LOCATION = [xPlotRange[0], yPlotRange[0]], /EXACT, $
   TITLE = oYTitle, TICKDIR = 0, $
   TICKLEN = (0.02*(xPlotRange[1] - xPlotRange[0])))

; Add plot and axes to model, which is added to the
; view, and then displayed in the window.
oModel -> Add, oPlot
oModel -> Add, oXAxis
oModel -> Add, oYAxis
oView -> Add, oModel
oModel -> Translate, -50., -50., 0.
oWindow -> Draw, oView

; Determine the screen resolution.
oWindow -> GetProperty, RESOLUTION = screenResolution

; Initialize clipboard destination object.
oClipboard = OBJ_NEW('IDLgrClipboard', QUALITY = 2, $
   DIMENSIONS = windowSize, $
   RESOLUTION = screenResolution)

; Get the current directory.
CD, CURRENT=dir

; Create a filename for the output EPS file.
epsfile = dir + PATH_SEP() + 'damp_sn2.eps'

; Display the view to the system clipboard.
oClipboard -> Draw, oView, /VECTOR

; Display the view to an Encapsulated PostScript file.
```

```
oClipboard -> Draw, oView, FILENAME = epsfile, $
   /POSTSCRIPT, /VECTOR
PRINT, 'Printed clibpoard contents to ', epsfile

; Cleanup object references.
OBJ_DESTROY, [oClipboard, oView, oXTitle, oYTitle]

END
```

## Version History

Introduced: 5.1

# IDLgrClipboard::GetContiguousPixels

The IDLgrClipboard::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
[4,3,2,1,0]
```

## Syntax

*Result* = *Obj* ->[IDLgrClipboard::]GetContiguousPixels()

## Return Value

Returns an array of long integers whose length is equal to the number of colors available in the index color mode.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrClipboard::GetDeviceInfo

The IDLgrClipboard::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=1 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

## Syntax

*Obj* -> [IDLgrClipboard::]GetDeviceInfo [, ALL=*variable*]
[, MAX_NUM_CLIP_PLANES=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

## Arguments

None

## Keywords

### ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

### MAX_NUM_CLIP_PLANES

Set this keyword to a named variable that upon return will contain an integer that specifies the maximum number of user-defined clipping planes supported by the device.

### MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_TEXTURE_DIMENSIONS contains a two element integer array that specifies the maximum texture size supported by the device.

### MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_VIEWPORT_DIMENSIONS contains a two element integer array that specifies the maximum size of a graphics display supported by the device.

### NAME

Set this keyword equal to a named variable. Upon return, NAME contains the name of the rendering device as a string.

### NUM_CPUS

Set this keyword equal to a named variable. Upon return, NUM_CPUS contains an integer that specifies the number of CPUs that are known to, and available to IDL.

**Note**

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI IRIX, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

### VENDOR

Set this keyword equal to a named variable. Upon return, VENDOR contains the name of the rendering device creator as a string.

### VERSION

Set this keyword equal to a named variable. Upon return, VERSION contains the version of the rendering device driver as a string.

## Version History

Introduced: 5.1

MAX_NUM_CLIP_PLANES keyword: 5.6

# IDLgrClipboard::GetFontnames

The IDLgrClipboard::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

## Syntax

*Result* = *Obj* -> [IDLgrClipboard::]GetFontnames( *FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*] )

## Return Value

Returns the list of available fonts that can be used in IDLgrFont objects.

## Arguments

### FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

## Keywords

### IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

### STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is

the string, “*”, which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

## Version History

Introduced: 5.1

# IDLgrClipboard::GetProperty

The IDLgrClipboard::GetProperty procedure method retrieves the value of a property or group of properties for the clipboard buffer.

## Syntax

*Obj* -> [IDLgrClipboard::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrClipboard Properties” on page 3197 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.1

# IDLgrClipboard::GetTextDimensions

The IDLgrClipboard::GetTextDimensions function method retrieves the dimensions of a text or axis object that will be rendered in the clipboard buffer. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units. If the object specified is an axis object, the result encompasses the tick labels and the title of the axis (if any).

## Syntax

*Result* = *Obj* ->[IDLgrClipboard::]GetTextDimensions( *TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*] )

## Return Value

Returns the dimensions of a text or axis object that will be rendered in the clipboard buffer.

## Arguments

### TextObj

The object reference to a text or axis object for which the text dimensions are requested.

## Keywords

### DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If

this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrClipboard::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.1

# IDLgrClipboard::Init

The IDLgrClipboard::Init function method initializes the clipboard object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrClipboard' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrClipboard::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrClipboard Properties" on page 3197 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.1

# IDLgrClipboard::SetProperty

The IDLgrClipboard::SetProperty procedure method sets the value of a property or group of properties for the clipboard buffer.

## Syntax

*Obj* -> [IDLgrClipboard::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrClipboard Properties” on page 3197 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.1

# IDLgrColorbar

The IDLgrColorbar object consists of a color-ramp with an optional framing box and annotation axis. The object can be horizontal or vertical.

An IDLgrColorbar object is a *composite object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

This object class is implemented in the IDL language. Its source code can be found in the file `idlgrcolorbar__define.pro` in the `lib` subdirectory of the IDL distribution.

## Superclasses

IDLgrModel

IDLitComponent

## Creation

See "IDLgrColorbar::Init" on page 3235.

## Properties

Objects of this class have the following properties. See "IDLgrColorbar Properties" on page 3221 for details on individual properties.

- ALL
- BLUE_VALUES
- COLOR
- DIMENSIONS
- GREEN_VALUES
- HIDE
- MAJOR
- MINOR
- PALETTE
- PARENT

- RED_VALUES
- SHOW_AXIS
- SHOW_OUTLINE
- SUBTICKLEN
- THICK
- THREED
- TICKFORMAT
- TICKFRMTDATA
- TICKLEN
- TICKTEXT
- TICKVALUES
- TITLE
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrColorbar::Cleanup
- IDLgrColorbar::ComputeDimensions
- IDLgrColorbar::GetProperty
- IDLgrColorbar::Init
- IDLgrColorbar::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.1

# IDLgrColorbar Properties

IDLgrColorbar objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrColorbar::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrColorbar::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrColorbar::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure that contains the values of all of the retrievable properties associated with this object.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BLUE_VALUES

A byte vector containing the blue values for the color palette. Setting this value is the same as specifying the aBlue argument to the IDLgrColorbar::Init method.

| | | | |
|---|---|---|---|
| **Property Type** | Byte vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

The color to be used as the foreground color for the axis and outline box. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

| **Property Type** | Color | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DIMENSIONS

A two element integer vector [*dx*, *dy*] that specifies the size of the ramp display (not the axis) in pixels. If *dx* > *dy*, the colorbar is drawn horizontally with the axis placed below or above the ramp box depending on the value of the SHOW_AXIS property. If *dx* < *dy*, the colorbar is drawn vertically with the axis placed to the right or left of the ramp box depending on the value of the SHOW_AXIS property. The default value is [16,256].

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GREEN_VALUES

A byte vector containing the green values for the color palette. Setting this value is the same as specifying the *aGreen* argument to the IDLgrColorbar::Init method.

| **Property Type** | Byte vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDE

A Boolean value to indicate whether this object should be drawn:

- 0 = Draw graphic (the default)

- 1 = Do not draw graphic

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## MAJOR

An integer that represents the number of major tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MAJOR equal to zero suppresses major tickmarks entirely.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## MINOR

An integer representing the number of minor tick marks. The default is -1, specifying that IDL will compute the number of tickmarks. Setting MINOR equal to zero suppresses minor tickmarks entirely.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PALETTE

An object reference to an instance of the IDLgrPalette object class. If this property is a valid object reference, the colors within the IDLgrPalette are used to specify the colors for the colorbar.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PARENT

An object reference to the object that contains this colorbar.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## RED_VALUES

A byte vector that contains the red values for the color palette. Setting this value is the same as specifying the *aRed* argument to the IDLgrColorbar::Init method.

| | | | |
|---|---|---|---|
| **Property Type** | Byte vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHOW_AXIS

An integer value that indicates whether the axis should be drawn:

- 0 = Do not display axis (the default)
- 1 = Display axis on left side or below the color ramp
- 2 = Display axis on right side or above the color ramp

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHOW_OUTLINE

A Boolean value indicating whether the colorbar bounds should be outlined:

- 0 = Do not display outline (the default)

- 1 = Display outline

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SUBTICKLEN

A floating-point scale ratio specifying the length of minor tick marks relative to the length of major tick marks. The default is 0.5, specifying that the minor tick mark is one-half the length of the major tick mark.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value between 1.0 and 10.0, specifying the line thickness used to draw the axis and box outline, in points. The default is 1.0 points.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THREED

A Boolean value that determines whether to create the colorbar as a graphic object that can be fully transformed in three dimensions on initialization. By default, the colorbar always faces the viewer and is drawn at z=0.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** | **Init:** Yes | **Registered:** No |

## TICKFORMAT

Either a standard IDL format string (see *"Format Codes"* in Chapter 10 of the *Building IDL Applications* manual for details on format codes) or a string containing the name of a user-supplied function that returns a string to be used to format the axis tick mark labels. The function should accept integer arguments for the direction of the axis, the index of the tick mark, and the value of the tick mark, and should return a string to be used as the tick mark's label. The function may optionally accept a keyword called DATA, which will be automatically set to the TICKFRMTDATA value. The default TICKFORMAT is '', the null string, which indicates that IDL will determine the appropriate format for each value.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TICKFRMTDATA

A user-defined value of any type passed via the DATA keyword to the user-supplied formatting function specified via the TICKFORMAT property, if any. By default, this value is 0, indicating that the DATA keyword will not be set (and furthermore, need not be supported by the user-supplied function). Note that TICKFRMTDATA will not be included in the structure returned via the ALL property to the IDLgrColorbar::GetProperty method.

| **Property Type** | Scalar of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TICKLEN

A floating-point value that specifies the length of each major tick mark, measured in data units. The recommended, and default, tick mark length is 0.2. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TICKTEXT

An object reference to either a single instance of the IDLgrText object class (with multiple strings) or to a vector of instances of the IDLgrText object class (each with a single string) that specifies the annotations to be assigned to the tick marks. By default, TICKTEXT is set to the NULL object, which indicates that IDL will compute tick annotations based upon the major tick values. The positions and orientation of the provided text object(s) may be overwritten by the colorbar.

| **Property Type** | Object reference or object reference vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TICKVALUES

A floating-point vector of data values that represent the values at each tick mark. If TICKVALUES is set to 0, the default, IDL computes the tick values based on the axis range and the number of major ticks. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TITLE

An object reference to an instance of the IDLgrText object class to specify the title for the axis. The default is the null object, specifying that no title is drawn. The title will be centered along the axis, even if the text object itself has an associated location.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element double-precision floating-point vector of the form [*xmin*, *xmax*] specifying the range of the *x* data coordinates covered by the colorbar.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that converts Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of the *Y* data coordinates covered by the colorbar.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, [$s_0$, $s_1$], of scaling factors that converts Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element double-precision floating-point vector of the form [*zmin*, *zmax*] specifying the range of the *Z* data coordinates covered by the colorbar.

**Note**

Until the colorbar is drawn to the destination object, the [XYZ]RANGE properties will be zero. Use the ComputeDimensions method on the colorbar object to get the data dimensions of the colorbar prior to a draw operation.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrColorbar::Cleanup

The IDLgrColorbar::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY,*Obj*

or

*Obj* -> [IDLgrColorbar::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrColorbar::ComputeDimensions

The IDLgrColorbar::ComputeDimensions function method retrieves the dimensions of a colorbar object for the given destination object. The result is a three-element double-precision floating-point vector [*xDim, yDim, zDim*] representing the dimensions of the colorbar object measured in data units.

## Syntax

*Result = Obj* ->[IDLgrColorbar::]ComputeDimensions( *DestinationObj* [, PATH=*objref(s)*] )

## Return Value

Returns the dimensions of a colorbar object for the given destination object.

## Arguments

### DestinationObject

The object reference to a destination object (IDLgrBuffer, IDLgrClipboard, IDLgrPrinter, or IDLgrWindow) for which the dimensions of the colorbar are being requested.

## Keywords

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrColorbar::ComputeDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.1

# IDLgrColorbar::GetProperty

The IDLgrColorbar::GetProperty procedure method retrieves the value of a property or group of properties for the colorbar.

## Syntax

*Obj* -> [IDLgrColorbar::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrColorbar Properties” on page 3221 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.1

# IDLgrColorbar::Init

The IDLgrColorbar::Init function method initializes the colorbar object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW( 'IDLgrColorbar' [, *aRed*, *aGreen*, *aBlue*] [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrColorbar::]Init([*aRed*, *aGreen*, *aBlue*] [, *PROPERTY*=*value*]) (*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### aRed

A vector containing the red values for the color palette. These values should be within the range of 0 < *Value* < 255. The number of elements comprising the *aRed* vector must not exceed 256.

### aGreen

A vector containing the green values for the color palette. These values should be within the range of 0 < *Value* < 255. The number of elements comprising the *aGreen* vector must not exceed 256.

### aBlue

A vector containing the blue values for the color palette. These values should be within the range of 0 < *Value* < 255. The number of elements comprising the *aBlue* vector must not exceed 256.

If *aRed*, *aGreen*, and *aBlue* are not provided, the color palette will default to a 256 entry greyscale ramp.

## Keywords

Any property listed under "IDLgrColorbar Properties" on page 3221 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.1

# IDLgrColorbar::SetProperty

The IDLgrColorbar::SetProperty procedure method sets the value of a property or group of properties for the colorbar.

## Syntax

*Obj* -> [IDLgrColorbar::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrColorbar Properties” on page 3221 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.1

# IDLgrContour

The IDLgrContour object draws a contour plot from data stored in a rectangular array or from a set of unstructured points. Both line contours and filled contour plots can be created.

An IDLgrContour object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

The object stores the following argument or property in double-precision if the DOUBLE_DATA property is specified, and in single-precision otherwise.

## Superclasses

IDLitComponent

## Creation

See “IDLgrContour::Init” on page 3273.

## Properties

Objects of this class have the following properties. See “IDLgrContour Properties” on page 3241 for details on individual properties.

- ALL
- ANISOTROPY
- C_FILL_PATTERN
- C_LABEL_NOGAPS
- C_LABEL_SHOW
- C_THICK
- C_USE_LABEL_ORIENTATION
- CLIP_PLANES
- DATA_VALUES
- DEPTH_OFFSET
- DEPTH_TEST_FUNCTION
- AM_PM
- C_COLOR
- C_LABEL_INTERVAL
- C_LABEL_OBJECTS
- C_LINESTYLE
- C_USE_LABEL_COLOR
- C_VALUE
- COLOR
- DAYS_OF_WEEK
- DEPTH_TEST_DISABLE
- DEPTH_WRITE_DISABLE

- DOUBLE_DATA
- DOUBLE_GEOM
- DOWNHILL
- FILL
- GEOM
- GEOMX
- GEOMY
- GEOMZ
- HIDE
- LABEL_FONT
- LABEL_FORMAT
- LABEL_FRMTDATA
- LABEL_UNITS
- MAX_VALUE
- MIN_VALUE
- MONTHS
- N_LEVELS
- PALETTE
- PARENT
- PLANAR
- POLYGONS
- REGISTER_PROPERTIES
- SHADE_RANGE
- SHADING
- TICKINTERVAL
- TICKLEN
- USE_TEXT_ALIGNMENTS
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrContour::AdjustLabelOffsets
- IDLgrContour::Cleanup
- IDLgrContour::GetCTM
- IDLgrContour::GetLabelInfo
- IDLgrContour::GetProperty
- IDLgrContour::Init
- IDLgrContour::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.1

# IDLgrContour Properties

IDLgrContour objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrContour::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrContour::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrContour::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the retrievable properties associated with this object.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## AM_PM

A string vector of two values indicating the names of the AM and PM strings when processing explicitly formatted dates (CAPA, CApA, and CapA format codes) with the LABEL_FORMAT property.

| | | | |
|---|---|---|---|
| **Property Type** | String vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ANISOTROPY

A three-element floating-point vector [*x*, *y*, *z*] that represents the multipliers to be applied to the internally computed correction factors along each axis that account for anisotropic geometry. Correcting for anisotropy is particularly important for the appropriate representations of downhill tickmarks.

By default, IDL will automatically compute correction factors for anisotropy based on the [XYZ] range of the contour geometry. If the geometry (as provided via the GEOMX, GEOMY, and GEOMZ keywords) falls within the range [*xmin*, *ymin*, *zmin*] to [*xmax*, *ymax*, *zmax*], then the default correction factors are computed as follows:

```
dx = xmax - xmin
dy = ymax - ymin
dz = zmax - zmin
; Get the maximum of the ranges:
maxRange = (dx > dy) > dz
IF (dx EQ 0) THEN xcorrection = 1.0 ELSE $
   xcorrection = maxRange / dx
IF (dy EQ 0) THEN ycorrection = 1.0 ELSE $
   ycorrection = maxRange / dy
IF (dz EQ 0) THEN zcorrection = 1.0 ELSE $
   zcorrection = maxRange / dz
```

This internally computed correction is then multiplied by the corresponding [*x, y, z*] values of the ANISOTROPY property. The default value for this property is [1,1,1]. IDL converts, maintains, and returns this data as double-precision floating-point.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Anistrophy | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## C_COLOR

A vector of colors that represents the colors to be applied at each contour level. If there are more contour levels than elements in this vector, the colors will be cyclically repeated. If C_COLOR is set to 0, all contour levels will be drawn in the color specified by the COLOR property (this is the default).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Colors | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## C_FILL_PATTERN

An array of IDLgrPattern objects that represent the patterns to be applied at each contour level if the FILL property is non-zero. If there are more contour levels than fill patterns, the patterns will be cyclically repeated. If this property is set to 0, all contour levels are filled with a solid color (this is the default).

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Fill patterns | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## C_LABEL_INTERVAL

A floating-point vector that indicates the distance (measured parametrically relative to the length of each contour path) between labels for each contour level. If the number of contour levels exceeds the number of provided intervals, the C_LABEL_INTERVAL values will be repeated cyclically. The default is 0.4.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## C_LABEL_NOGAPS

An integer vector that indicates whether gaps should be computed for the labels at the corresponding contour value. A zero value indicates that gaps will be computed for labels at that contour value; a non-zero value indicates that no gaps will be computed for labels at that contour value. If the number of contour levels exceeds the number of elements in this vector, the C_LABEL_NOGAPS values will be repeated cyclically. By default, gaps for the labels are computed for all levels (so that a contour line does not pass through the label).

| | | | |
|---|---|---|---|
| **Property Type** | Integer vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## C_LABEL_OBJECTS

An array of object references that provides examples of labels to be drawn for each contour level. The objects specified via this property must inherit from one of the following classes:

- IDLgrSymbol
- IDLgrText

If a single object is provided, and it is an IDLgrText object, each of its strings will correspond to a contour level. If a vector of objects is used, any IDLgrText objects should have only a single string; each object will correspond to a contour level.

By default, with C_LABEL_OBJECTS set equal to a null object, IDL computes text labels that are the string representations of the corresponding contour level values. Note that the objects specified via this property are used as descriptors only. The actual objects drawn as labels are generated by IDL, and may be accessed via the IDLgrContour::GetLabelInfo method. The contour labels will have the same color as the corresponding contour level (see C_COLOR) unless the C_USE_LABEL_COLOR property is specified. The orientation of the label will be automatically computed unless the C_USE_LABEL_ORIENTATION property is specified. The horizontal and vertical alignment of any text labels will default to 0.5 (i.e., centered) unless the USE_TEXT_ALIGNMENTS property is specified.

**Note**

The object(s) set via this property will not be destroyed automatically when the contour is destroyed.

| **Property Type** | Object reference array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## C_LABEL_SHOW

An integer vector that indicates whether labels are shown. For each contour value, if the corresponding value in the C_LABEL_SHOW vector is non-zero, the contour line for that contour value will be labeled. If the number of contour levels exceeds the

number of elements in this vector, the C_LABEL_SHOW values will be repeated cyclically. The default is 0 indicating that no contour levels will be labeled.

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## C_LINESTYLE

An integer array of linestyles that represent the linestyles to be applied at each contour level. The array may be either a vector of integers representing pre-defined linestyles, or an array of 2-element vectors representing a stippling pattern specification. If there are more contour levels than linestyles, the linestyles will be cyclically repeated. If this property is set to 0, all levels are drawn as solid lines (this is the default).

To use a pre-defined line style, set the C_LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Linestyles | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## C_THICK

A floating-point array of line thicknesses that represent the thickness to be applied at each contour level, where each element is a value between 1.0 and 10.0. If there are more contour levels than line thicknesses, the thicknesses will be cyclically repeated.

If this property is set to 0, all contour levels are drawn with a line thickness of 1.0 points (this is the default).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Thicknesses | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## C_USE_LABEL_COLOR

An integer vector that indicates whether the COLOR property value for each of the label objects (for the corresponding contour level) is to be used to draw that label. If the number of contour levels exceeds the number of elements in this vector, the C_USE_LABEL_COLOR values will be repeated cyclically. By default, this value is zero, indicating that the COLOR properties of the label objects will be ignored, and the C_COLOR property for the contour object will be used instead.

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## C_USE_LABEL_ORIENTATION

An integer vector that indicates whether the orientation for each of the label objects (for the corresponding contour level) is to be used when drawing the label. For text, the orientation of the object corresponds to the BASELINE and UPDIR property values; for a symbol, this refers to the default (un-rotated) orientation of the symbol. If the number of contour levels exceeds the number of elements in this vector, the C_USE_LABEL_ORIENTATION values will be repeated cyclically. By default, this value is zero, indicating that orientation of the label object(s) will be set to automatically computed values (to correspond to the direction of the contour paths).

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## C_VALUE

A floating-point value or a floating-point vector for which contour values are to be drawn. If this property is set to 0, contour levels will be evenly sampled across the range of the DATA_VALUES, using the value of the N_LEVELS property to determine the number of samples. IDL converts, maintains, and returns this data as double-precision floating-point.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Level values | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CLIP_PLANES

A 4-by-*N* floating-point array of dimensions that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES keyword of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

The color to be used to draw the contours. The color may be specified as a color lookup table index or as an RGB vector. The default is [0,0,0]. This value will be ignored if the C_COLOR property is set to a vector.

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DATA_VALUES

A floating-point vector or two-dimensional array that specifies the values to be contoured. The property is the same as the *Values* argument described in the Arguments section above. IDL converts and stores this data as double-precision floating-point if the argument is of type DOUBLE or if the DOUBLE_DATA property is set. Otherwise, the data is stored in single-precision. IDL returns the data as double-precision if it was stored in double-precision.

| **Property Type** | Floating-point vector or array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DAYS_OF_WEEK

A string vector of 7 values that indicates the names to be used for the days of the week when processing explicitly formatted dates (CDWA, CDwA, and CdwA format codes) with the LABEL_FORMAT property.

| **Property Type** | String vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_OFFSET

An integer value that specifies an offset in depth to be used when rendering filled primitives. This offset is applied along the viewing axis, with positive values moving the primitive away from the viewer.

The units are “Z-Buffer units,” where a value of 1 is used to specify a distance that corresponds to a single step in the device’s Z-Buffer.

Use DEPTH_OFFSET to always cause a filled primitive to be rendered slightly deeper than other primitives, independent of model transforms. This is useful for avoiding stitching artifacts caused by rendering lines or polygons on top of other polygons at the same depth.

**Note**

RSI suggests using this feature to remove stitching artifacts and not as a means for “layering” complex scenes with multiple DEPTH_OFFSET values. It is safest to use only a DEPTH_OFFSET value of 0, the default, and one other non-zero value, such as 1. Many system-level graphics drivers are not consistent in their handling of DEPTH_OFFSET values, particularly when multiple non-zero values are used. This can lead to portability problems because a set of DEPTH_OFFSET values may produce better results on one machine than on another. Using IDL’s software renderer will help improve the cross-platform consistency of scenes that use DEPTH_OFFSET.

**Note**

DEPTH_OFFSET has no effect unless the FILL property is set.

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Depth offset | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.

- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DOUBLE_DATA

A Boolean value that indicates whether the object is to store data provided by either the *Values* argument or the DATA_VALUES property parameter in double-precision or single-precision floating-point.

- 0 = Single-precision floating-point
- 1 = Double-precision floating-point

IDL converts any value data already stored in the object to the requested precision, if necessary.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DOUBLE_GEOM

A Boolean value that indicates whether the object is to store data provided by any of the GEOMX, GEOMY, or GEOMZ property parameters in double-precision or single-precision floating-point.

- 0 = Single-precision floating-point
- 1 = Double-precision floating-point

IDL converts any geometry data already stored in the object to the requested precision, if necessary.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DOWNHILL

A Boolean value that indicates whether downhill tick marks should be rendered as part of each contour level to indicate the downhill direction relative to the contour line.

- 0 = Do not render downhill tick marks.
- 1 = Render downhill tick marks

In a property sheet, this property appears as an enumerated list with the following options:

- Hide

- Show

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Downhill ticks | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## FILL

A Boolean value that indicates whether the contours should be filled. The default is to draw the contour levels as lines without filling. Filling contour may produce less than satisfactory results if your data contains NaNs, or if the contours are not closed.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Fill contours | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## GEOM

A floating-point value that contains the geometry associated with the contour. IDL returns this data in single-precision floating-point by default or in double-precision floating-point if the DOUBLE_GEOM property is set in the IDLgrContour::Init method.

| **Property Type** | Floating-point | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## GEOMX

A floating-point vector or two-dimensional array that specifies the X coordinates of the geometry with which the contour values correspond. If X is a vector, it must match the number of elements in the *Values* argument or DATA_VALUES property value, or it must match the first of the two dimensions of the *Values* argument or DATA_VALUES property value (in which case, the X coordinates will be repeated for each row of data values). IDL converts and maintains this data as double-precision floating-point if the parameter is of type DOUBLE or if the DOUBLE_GEOM property is non-zero. Otherwise, the data is stored in single-

precision. IDL returns the data as double-precision if it was stored in double-precision.

| **Property Type** | Floating-point vector or array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GEOMY

A floating-point vector or two-dimensional array specifying the Y coordinates of the geometry with which the contour values correspond. If Y is a vector, it must match the number of elements in the *Values* argument or DATA_VALUES property value, or it must match the second of the two dimensions of the *Values* argument or DATA_VALUES property value (in which case, the Y coordinates will be repeated for each column of data values). IDL converts and maintains this data as double precision floating point if the parameter is of type DOUBLE or if the DOUBLE_GEOM property is non-zero. Otherwise, the data is stored in single precision. IDL returns the data as double precision if it was stored in double precision.

| **Property Type** | Floating-point vector or array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GEOMZ

A floating-point scalar, a vector, or a two-dimensional array specifying the Z coordinates of the geometry with which the contour values correspond.

- If GEOMZ is a scalar, and the PLANAR property is set, the resulting contour geometry will be projected onto the plane Z=GEOMZ. If GEOMZ is a scalar, and the PLANAR property is not set, any geometry associated with the contour will be freed.
- If GEOMZ is a vector of Z coordinates, the number of elements in the vector should be the same as the number of elements in DATA_VALUES.
- If GEOMZ is an array and the leading dimension is 3, then the data is treated as a list or array of 3-D vertices. The product of the array dimensions following the 3 should equal the number of DATA_VALUES.

- If GEOMZ is an array and the leading dimension is not 3, then the data is treated as a list or array of single Z coordinates. If the number of dimensions is 2, then the data is treated as a 2-D array of Z values. Otherwise, it is treated as a vector of Z values. In either case, the total number of elements in the array should be the same as the number of DATA_VALUES.
- If GEOMZ is not set, the geometry will be derived from the DATA_VALUES property (if it is set to a two-dimensional array). In this case, the connectivity is implied. The X and Y coordinates match the row and column indices of the array, and the Z coordinates match the data values.

IDL converts and maintains this data as double precision floating point if the parameter is of type DOUBLE or if the DOUBLE_GEOM property is non-zero. Otherwise, the data is stored in single precision. IDL returns the data as double precision if it was stored in double precision.

| **Property Type** | Floating-point scalar, vector, or array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDE

A Boolean value that indicates whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LABEL_FONT

An object reference to an IDLgrFont object that describes the default font to be used for contour labels. This font will be used for all text labels automatically generated by

IDL (i.e., if C_LABEL_SHOW is set but the corresponding C_LABEL_OBJECTS text object is not provided), or for any text label objects provided via C_LABEL_OBJECTS that do not already have the font property set. The default value for this property is a NULL object reference, indicating that 12 pt. Helvetica will be used.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LABEL_FORMAT

A string that represents a format string or the name of a function to be used to format the contour labels. If the string begins with an open parenthesis, it is treated as a standard format string. (Refer to the Format Codes in the IDL Reference Guide.) If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate contour level labels.

The callback function is called with three parameters: Axis, Index, and Value, where:

- Axis is simply the value 2 to indicate that values along the Z axis are being formatted. (This allows a single callback routine to be used for both axis labeling and contour labeling.)
- Index is the contour level index (indices start at 0).
- Value is the data value of the current contour level.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LABEL_FRMTDATA

A user-defined value of any type passed via the DATA keyword to the user-supplied formatting function specified via the LABEL_FORMAT property, if any. By default, this value is 0, indicating that the DATA keyword will not be set (and furthermore, need not be supported by the user-supplied function).

**Note**

LABEL_FRMTDATA will not be included in the structure returned via the ALL property to the IDLgrContour::GetProperty method.

| **Property Type** | Scalar of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## LABEL_UNITS

A string that indicates the units to be used for default contour level labeling.

Valid unit strings include:

- "Numeric"
- "Years"
- "Months"
- "Days"
- "Hours"
- "Minutes"
- "Seconds"
- "Time" - Use this value to indicate that the contour levels correspond to time values; IDL will determine the appropriate label format based upon the range of values covered by the contour Z data.
- "" - The empty string is equivalent to the "Numeric" unit. This is the default.

If any of the time units are utilized, then the contour values are interpreted as Julian date/time values.

**Note**

The singular form of each of the time unit strings is also acceptable (for example, LEVEL_UNITS='Day' is equivalent to LEVEL_UNITS='Days').

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## MAX_VALUE

A floating point value that indicates the maximum value to be plotted. Data values greater than this value are treated as missing data. The default is the maximum value of the input Z data. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Maximum value | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MONTHS

A string vector of 12 values indicating the names to be used for the months when processing explicitly formatted dates (CMOA, CMoA, and CmoA format codes) with the C_LABEL_FORMAT keyword.

| **Property Type** | String vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## MIN_VALUE

A floating-point value that indicates the minimum value to be plotted. Data values less than this value are treated as missing data. The default is the minimum value of

the input Z data. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Minimum value | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## N_LEVELS

An integer value that indicates the number of contour levels to generate. This property is ignored if the C_VALUE property is set to a vector, in which case, the number of levels is derived from the number of elements in that vector. Set this property to zero to indicate that IDL should compute a default number of levels based on the range of data values. This is the default.

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Number of levels | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that defines the color palette of this object. This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this contour.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## PLANAR

A Boolean value that indicates whether the contoured data is to be projected onto a plane. This property is ignored if GEOMZ is not a scalar. The default is non-planar (i.e., to display the contoured data at the Z locations provided by the GEOMZ property.

In a property sheet, this property appears as an enumerated list with the following options:

- Planar (the default)
- Three-D

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Projection | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## POLYGONS

An integer array of polygon descriptions that represents the connectivity information for the data to be contoured (as specified in the *Values* argument or the DATA_VALUES property). A polygon description is an integer or long word array of the form: [*n*, i0, i1, ..., i*n*-1], where *n* is the number of vertices that define the polygon, and i0..i*n*-1 are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices. To ignore an entry in the POLYGONS array, set the vertex count, *n*, to 0. To end the drawing list, even if additional array space is available, set *n* to -1. If this property is not specified, a single polygon will be generated.

**Note**

The connectivity array described by POLYGONS allows an individual object to contain more than one polygon. Vertex, normal, and color information can be

shared by the multiple polygons. Consequently, the polygon object can represent an entire mesh and compute reasonable normal estimates in most cases.

| | | | |
|---|---|---|---|
| **Property Type** | Integer array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## SHADE_RANGE

A two-element integer array that specifies the range of pixel values (color indices) to use for shading. The first element is the color index for the darkest pixel. The second element is the color index for the brightest pixel. This value is ignored when the contour is drawn to a graphics destination that uses the RGB color model.

| | | | |
|---|---|---|---|
| **Property Type** | Integer array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHADING

An integer that indicates the type of shading to use:

- 0 = Flat (default): The color has a constant intensity for each face of the contour, based on the normal vector.
- 1 = Gouraud: The colors are interpolated between vertices, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

In a property sheet, this property appears as an enumerated list with the following options:

- Flat (the default)
- Gouraud

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Shading | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKINTERVAL

A floating-point value that indicates the distance between downhill tickmarks, in data units. If TICKINTERVAL is not set, or if you explicitly set it to zero, IDL will compute the distance based on the geometry of the contour. IDL converts, maintains, and returns this data as double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | FLOAT | | |
| **Name String** | Downhill tick interval | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TICKLEN

A floating-point value that indicates the length of the downhill tickmarks, in data units. If TICKLEN is not set, or if you explicitly set it to zero, IDL will compute the length based on the geometry of the contour. IDL converts, maintains, and returns this data as double-precision floating-point

| | | | |
|---|---|---|---|
| **Property Type** | FLOAT | | |
| **Name String** | Downhill tick length | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## USE_TEXT_ALIGNMENTS

A Boolean value that indicates whether, for any IDLgrText labels (as specified via the C_LABEL_OBJECTS property), the ALIGNMENT and

VERTICAL_ALIGNMENT property values for the given IDLgrText object(s) are to be used to draw the corresponding labels. By default, this value is zero, indicating that the ALIGNMENT and VERTICAL_ALIGNMENT properties of the label IDLgrText object(s) will be set to default values (0.5 for each, indicating centered labels).

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element double-precision floating-point vector of the form [*xmin*, *xmax*] specifying the range of the *X* data coordinates covered by the contour.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of the *Y* data coordinates covered by the contour.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that converts Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of the *Z* data coordinates covered by the contour.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrContour::AdjustLabelOffsets

The IDLgrContour::AdjustLabelOffsets procedure method adjusts the offsets at which contour labels are positioned.

## Syntax

*Obj* -> [IDLgrContour::]AdjustLabelOffsets, *LevelIndex*, *LabelOffsets*

## Arguments

### LevelIndex

The index of the contour level for which the label offsets are being adjusted. This value must be greater than or equal to zero and less than the number of levels (refer to the N_LEVELS property in the IDLgrContour::Init method).

### LabelOffsets

A scalar or vector of floating point offsets, [t0, t1, …], that indicate the parametric offsets along the length of each contour line at which each label is to be positioned. The number of elements in this vector must exactly match the number of elements returned in the LABEL_OFFSETS vector retrieved via the IDLgrContour::GetLabelInfo method for the same level.

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrContour::Cleanup

The IDLgrContour::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrContour::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrContour::GetCTM

The IDLgrContour::GetCTM method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrContour::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref*] )

## Return Value

Returns the graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the surface object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrContour::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.1

# IDLgrContour::GetLabelInfo

The IDLgrContour::GetLabelInfo procedure method retrieves information about the labels for a contour. The returned information is only valid until the next time the C_LABEL_INTERVAL or C_LABEL_OBJECTS property is modified using the IDLgrContour::SetProperty method, or the offsets are adjusted using the IDLgrContour::AdjustLabelOffsets method.

# Syntax

*Obj* -> [IDLgrContour::]GetLabelInfo, *Destination*, *LevelIndex*
[, LABEL_OFFSETS=*variable*] [, LABEL_POLYS=*variable*]
[, LABEL_OBJECTS=*variable*]

# Arguments

## Destination

A reference to a destination object (such as an IDLgrWindow or IDLgrBuffer object). The contour label information will be computed so that the requested font size is satisfied for this destination device.

## LevelIndex

The index of the contour level for which the label information is being requested. This value must be greater than or equal to zero and less than the number of levels (refer to the N_LEVELS keyword in the IDLgrContour::Init method).

# Keywords

## LABEL_OFFSETS

Set this keyword to a named variable that upon return will contain a vector of floating point offsets, [t0, t1, …], that indicate the parametric offsets along the length of each contour line at which the contour labels are positioned.

## LABEL_POLYLINES

Set this keyword to a named variable that upon return will contain a vector of contour polyline indices, [$P_0$, $P_1$, …], that indicate which contour lines are labeled. $P_i$ corresponds to the ith contour line.

Note that if a given contour line has more than one label along its perimeter, then the corresponding polyline index may appear more than once in the LABEL_POLYLINES vector.

### LABEL_OBJECTS

Set this keyword to a named variable that upon return will contain a vector of objects that represent the labels for each contour label.

## Version History

Introduced: 5.1

# IDLgrContour::GetProperty

The IDLgrContour::GetProperty procedure method retrieves the value of a property or group of properties for the contour.

## Syntax

*Obj* -> [IDLgrContour::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrContour Properties” on page 3241 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.1

# IDLgrContour::Init

The IDLgrContour::Init function method initializes the contour object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrContour' [, *Values*] [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrContour::]Init([*Values*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Values

A vector or two-dimensional array of values to be contoured. If no values are provided, the values will be derived from the GEOMZ keyword value (if set and the PLANAR keyword is not set). In this case, the values to be contoured will match the Z coordinates of the provided geometry. IDL converts and maintains this data as double-precision floating-point if the argument is of type DOUBLE or if the DOUBLE_DATA keyword is set. Otherwise, the data is stored in single-precision. IDL returns the data as double-precision if it was stored in double-precision.

## Keywords

Any property listed under “IDLgrContour Properties” on page 3241 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.1

AM_PM, C_LABEL_INTERVAL, CLIP_PLANES, C_LABEL_OBJECTS, C_LABEL_NOGAPS, C_LABEL_SHOW, C_USE_LABEL_COLOR, C_USE_LABEL_ORIENTATION, DAYS_OF_WEEK, LABEL_FONT, LABEL_FORMAT, LABEL_FRMATDATA, LABEL_UNITS, MONTHS, USE_TEXT_ALIGNMENTS keywords: 5.6

# IDLgrContour::SetProperty

The IDLgrContour::SetProperty procedure method sets the value of a property or group of properties for the contour.

## Syntax

*Obj* -> [IDLgrContour::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrContour Properties” on page 3241 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.1

# IDLgrFont

A font object represents a typeface, style, weight, and point size that may be associated with text objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrFont::Init" on page 3281.

## Properties

Objects of this class have the following properties. See "IDLgrFont Properties" on page 3277 for details on individual properties.

- ALL
- SIZE
- SUBSTITUTE
- THICK

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrFont::Cleanup
- IDLgrFont::GetProperty
- IDLgrFont::Init
- IDLgrFont::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrFont Properties

IDLgrFont objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrFont::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrFont::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrFont::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL..

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## SIZE

A floating-point value representing the point size of the font. The default is 12.0 points.

| **Property Type** | Floating-point | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SUBSTITUTE

A string that indicates the font to use as a substitute if the specified *Fontname* is not available on the graphics destination. Valid values are only those fonts that are

available on all destination objects (the fonts included with IDL). These are: 'Helvetica' (the default), 'Courier', 'Times', 'Symbol', or 'Hershey'.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value between 1.0 and 10.0, indicating the line thickness (measured in points) to use for the Hershey vector fonts. The default is 1.0 points.

| **Property Type** | Floating-point | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLgrFont::Cleanup

The IDLgrFont::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrFont::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrFont::GetProperty

The IDLgrFont::GetProperty procedure method retrieves the value of a property or group of properties for the font.

## Syntax

*Obj* -> [IDLgrFont:]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrFont Properties” on page 3277 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrFont::Init

The IDLgrFont::Init function method initializes the font object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

# Syntax

*Obj* = OBJ_NEW('IDLgrFont' [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrFont::]Init([*Fontname*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

# Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

# Arguments

## Fontname

A string representing the name of the font to be used. This string should take the form 'fontname*modifier1*modifier2*...*modifierN'. All destination objects support the following fontnames: Helvetica, Courier, Times, Symbol, and Monospace Symbol. (These fonts are included with IDL; you may have other fonts installed on your system as well.) Valid modifiers for each of these fonts (except Symbol and Monospace Symbol) are:

- *Font weight:* Bold
- *Font angle:* Italic

For example, 'Helvetica*Bold*Italic'.

To select a Hershey font, use a fontname of the form: 'Hershey*fontnum'. See Appendix H, “Fonts” for further information and a list of fonts supported by IDL.

**Note**

Beginning with IDL version 5.1, only TrueType and Hershey fonts are supported in the Object Graphics system.

## Keywords

Any property listed under “IDLgrFont Properties” on page 3277 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrFont::SetProperty

The IDLgrFont::SetProperty procedure method sets the value of a property or group of properties for the font.

## Syntax

*Obj* -> [IDLgrFont:]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrFont Properties” on page 3277 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrImage

An image object represents a mapping from a two-dimensional array of data values to a two dimensional array of pixel colors, resulting in a flat 2-D-scaled version of the image, drawn at Z = 0.

The image object is drawn at Z =0 and is positioned and sized with respect to two points:

```
p1 = [LOCATION(0), LOCATION(1), 0]
p2 = [LOCATION(0) + DIMENSION(0), LOCATION(1) + DIMENSION(1), 0].
```

where LOCATION and DIMENSION are properties of the image object. These points are transformed in three dimensions, resulting in screen space points designated as p1' and p2'. The image data is drawn on the display as a 2-D image within the 2-D rectangle defined by (p1'[0], p1'[1] - p2'[0], p2'[1]). The 2-D image data is scaled in 2-D (not rotated) to fit into this projected rectangle and then drawn with Z buffering disabled

**Note**

Image objects do not take into account the Z locations of other objects that may be included in the view object. This means that objects that are drawn to the destination object (window or printer) *after the image is drawn* will appear to be in front of the image, even if they are located at a negative Z value (behind the image object). Objects are drawn to a destination device in the order that they are added (via the Add method) to the model, view, or scene that contains them. To rotate or position image objects in three-dimensional space, use the IDLgrPolygon object with texture mapping enabled.

An IDLgrImage object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See “IDLgrImage::Init” on page 3304.

## Properties

Objects of this class have the following properties. See “IDLgrImage Properties” on page 3287 for details on individual properties.

- ALL
- BLEND_FUNCTION
- CHANNEL
- CLIP_PLANES
- DATA
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- DIMENSIONS
- GREYSCALE
- HIDE
- INTERLEAVE
- INTERPOLATE
- LOCATION
- NO_COPY
- ORDER
- PALETTE
- PARENT
- REGISTER_PROPERTIES
- RESET_DATA
- SHARE_DATA
- SUB_RECT
- XCOORD_CONV
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrImage::Cleanup
- IDLgrImage::GetCTM
- IDLgrImage::GetProperty
- IDLgrImage::Init
- IDLgrImage::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrImage Properties

IDLgrImage objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrImage::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrImage::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrImage::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BLEND_FUNCTION

A two-element integer vector that controls how the alpha channel values will be interpreted. Set this property equal to a two-element vector [*src*, *dst*] specifying one of the functions listed below for each of the source and destination objects. These are only valid for RGB model destinations. If an alpha channel is not specified in an image, the image’s alpha blend factor is assumed to be 1.0. The values of the blending function ($V_{src}$ and $V_{dst}$) are used in the following equation

$$C_d' = (V_{src} \cdot C_i) + (V_{dst} \cdot C_d)$$

where $C_d$ is the initial color of a pixel on the destination device (the background color), $C_i$ is the color of the pixel in the image, and $C_d'$ is the resulting color of the pixel.

Setting *src* and *dst* in the BLEND_FUNCTION vector to the following values determine how each term in the equation is calculated:

| src or dst | $V_{src}$ or $V_{dst}$ | What the function does |
|---|---|---|
| 0 | n/a | Alpha blending is disabled, which is the default setting. $C_d' = C_i$ |
| 1 | 0 | The value of $V_{src}$ or $V_{dst}$ in the equation is zero, thus the value of the term is zero. |
| 2 | 1 | The value of $V_{src}$ or $V_{dst}$ in the equation is one, thus the value of the term is the same as the color value. |
| 3 | $Image_a$ | The value of $V_{src}$ or $V_{dst}$ in the equation is the blend factor of the image's alpha channel. |
| 4 | $1\text{-}Image_a$ | The value of $V_{src}$ or $V_{dst}$ in the equation is one minus the blend factor of the image's alpha channel. |

*Table 8-4: Values for src and dst in BLEND_FUNCTION*

For example, setting BLEND_FUNCTION = [3, 4] creates an image in which you can see through the foreground image to the background to the extent defined by the alpha channel values of the foreground image.

Since the alpha blending operation is dependent on the values of pixels already drawn to the destination for some blending functions, the final result may depend more on the order of drawing the images, and not necessarily on their relative location along the Z axis. IDL draws images in the order that they are stored in the IDLgrModel object that contains them.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Blend function | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CHANNEL

A hexadecimal bitmask that defines which color channel(s) to draw. Each bit that is a 1 is drawn; each bit that is a 0 is not drawn. For example, 'ff0000'X represents a Blue channel write. The default is to draw all channels, and is represented by the hexadecimal value 'ffffff'X.

**Note**

This property is ignored for CI destination objects.

This property is registered, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | INTEGER | | |
| **Name String** | Color channel | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CLIP_PLANES

A 4-by-*N* floating-point array of dimensions [4,N] specifying the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES keyword of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATA

A *n* x *m*, *2 x n x m*, *3 x n* x *m*, or *4 x n* x *m* array (any type) of image data for the object. The *n* and *m* values may be in any position as specified by the INTERLEAVE property. This property is equivalent to the optional argument, *ImageData*.

| | | | |
|---|---|---|---|
| **Property Type** | Array of any type | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DIMENSIONS

A two-element integer vector of the form [*width*, *height*] specifying the dimensions of the rectangle in which the image is to be drawn on the device. The image will be resampled as necessary to fit within this rectangle. The default is derived from the dimensions of the given image data and is measured in pixels. IDL converts, maintains, and returns this data as double-precision floating-point.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Draw dimensions | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## GREYSCALE

A Boolean value that determines whether the image is drawn through a palette.

0 = Use palette (the default).

1 = Do not use a palette.

If this property is not set, for an RGB color model destination, if a palette is present in the image object, it is used. If there is no current destination palette, a greyscale palette is used. For a Color Index color model destination, the current destination palette is used.

**Note**

Only single band images (i.e. *1 x n x m*) are affected by this property. By default, GREYSCALE is disabled.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Grayscale | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value that indicates whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## INTERLEAVE

An integer value that indicates the dimension over which color is interleaved for images with more than one channel:

- 0 = Pixel interleaved: Images with dimensions (3, *m*, *n*)
- 1 = Scan line interleaved (row interleaved): Images with dimensions (*m*, 3, *n*)
- 2 = Planar interleaved: Images with dimensions (*m*, *n*, 3).

**Note**

If an alpha channel is present, the 3s should be replaced by 4s. In a greyscale image with an alpha channel, the 3s should be replaced by 2s.

In a property sheet, this property appears as an enumerated list with the following options:

- Pixel
- Scanline
- Planar.

This property is registered, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Interleaving | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## INTERPOLATE

An integer value to determine whether to display the IDLgrImage object using bilinear interpolation. The default is to use nearest neighbor interpolation.

- 0 = Nearest neighbor interpolation (the default)
- 1 = Bilinear interpolation

In a property sheet, this property appears as an enumerated list with the following options:

- Nearest neighbor
- Bilinear

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Interpolation | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LOCATION

A two- or three-element floating-point vector [*x*, *y*] or [*x*, *y*, *z*] specifying the position of the lower lefthand corner of the image, measured in data units. If the vector is of the form [*x*, *y*], then the *z* value is set equal to zero. The default is [0, 0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Location | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## NO_COPY

A Boolean value that determines whether to relocate the image data from the input variable to the image object, leaving the input variable *ImageData* undefined. Only the *ImageData* argument is affected. If this property is omitted, the input image data will be duplicated and a copy will be stored in the object.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ORDER

A Boolean value that determines whether to force the rows of the image data to be drawn from top to bottom. By default, image data is drawn from the bottom row up to the top row.

In a property sheet, this property appears as and enumerated list with the following options:

- Bottom-to-top
- Top-to-bottom

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Row order | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that specifies the red, green, and blue values of the color lookup table to be associated with the image if it is an indexed color image. This property is ignored if the image is a greyscale or RGB image.

**Note**

This table is only used when the destination is an RGB model device. The Indexed color model writes the indices directly to the device. In order to ensure that these colors are used when the image is displayed, this palette must be copied to the graphics destination's palette for any graphics destination that uses the Indexed color model.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESET_DATA

A Boolean value that determines whether to treat the data provided via the DATA property as a new data set unique to this object, rather than overwriting data that is shared by other objects.

- 0 = Overwrite data that is shared by other objects (the default).
- 1 = Treat DATA as a new data set unique to this object.

There is no reason to use this property if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This property has no effect if no new data is provided via the DATA property.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHARE_DATA

An object reference to an object with which data is to be shared by this image. An image may only share data with another image. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SUB_RECT

A four-element floating-point vector, [*x, y, xdim, ydim*], specifying the position of the lower left-hand corner and the dimensions of the sub-rectangle to display.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Sub-rectangle | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A floating-point vector, [$s_0$, $s_1$], of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

Two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrImage::Cleanup

The IDLgrImage::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrImage::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrImage::GetCTM

The IDLgrImage::GetCTM function method returns the 4 x 4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrImage::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the image object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrImage::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrImage::GetProperty

The IDLgrImage::GetProperty procedure method retrieves the value of the property or group of properties for the image.

## Syntax

*Obj* -> [IDLgrImage::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrImage Properties” on page 3287 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrImage::Init

The IDLgrImage::Init function method initializes the image object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

# Syntax

*Obj* = OBJ_NEW('IDLgrImage' [, *ImageData*] [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLgrImage::]Init([*ImageData*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

# Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

# Arguments

## ImageData

An array of data values to be displayed as an image. If this argument is not already of byte type, it is converted to byte type when the image object is created. Since IDL maintains the image data using the byte type, the input data values should range from 0 through 255. Image objects can have a single channel (one value per pixel—greyscale or color indexed), two channels (greyscale and alpha), three channels (red, green, and blue), or four channels (red, green, blue, and alpha). The alpha channel, if present, determines the transparency of the pixel. The BLEND_FUNCTION property controls the interpretation of the alpha channel values. With channels, the data value of 0 specifies minimum intensity and the data value of 255 specifies maximum intensity. The alpha channel values are also specified in the image data in the range 0

through 255, with an image data value of 0 corresponding to an alpha blend factor of 0 and an image data value of 255 corresponding to an alpha blend factor of 1.0. *ImageData* can be any of the following, where *n* is the width of the image, and *m* is the height:

- An *n* x *m* array of color lookup table indices.
- An *n* x *m* greyscale image, or a 2 x *n* x *m*, *n* x 2 x *m*, or *n* x *m* x 2 greyscale image with an alpha channel. (The alpha channel is ignored if the destination device uses indexed color mode.)
- A 3 x *n* x *m*, *n* x 3 x *m*, or *n* x *m* x 3 RGB image, or a 4 x *n* x *m*, *n* x 4 x *m*, or *n* x *m* x 4 RGB image with an alpha channel.

If the array has more than one channel, the interleave is specified by the INTERLEAVE property.

## Keywords

Any property listed under "IDLgrImage Properties" on page 3287 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrImage::SetProperty

The IDLgrImage::SetProperty procedure method sets the value of the property or group of properties for the image.

## Syntax

*Obj* -> [IDLgrImage::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrImage Properties” on page 3287 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrLegend

The IDLgrLegend object provides a simple interface for displaying a legend. The legend itself consists of a (filled and/or framed) box around one or more legend items (arranged in a single column) and an optional title string. Each legend item consists of a glyph patch positioned to the left of a text string. The glyph patch is drawn in a square which is a fraction of the legend label font height. The glyph itself can be in one of two types (see the TYPE keyword). In line type, the glyph is a line segment with linestyle, thickness and color attributes and an optional symbol object drawn over it. In fill type, the glyph is a square patch drawn with color and optional pattern object attributes.

An IDLgrLegend object is a *composite object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

This object class is implemented in the IDL language. Its source code can be found in the file `idlgrlegend__define.pro` in the `lib` subdirectory of the IDL distribution.

## Superclasses

IDLgrModel

IDLitComponent

## Creation

See “IDLgrLegend::Init” on page 3324.

## Properties

Objects of this class have the following properties. See “IDLgrLegend Properties” on page 3310 for details on individual properties.

- ALL
- BORDER_GAP
- COLUMNS
- FILL_COLOR
- FONT

- GAP
- GLYPH_WIDTH
- HIDE
- ITEM_COLOR
- ITEM_LINESTYLE
- ITEM_NAME
- ITEM_OBJECT
- ITEM_THICK
- ITEM_TYPE
- OUTLINE_COLOR
- OUTLINE_THICK
- PARENT
- RECOMPUTE
- SHOW_FILL
- SHOW_OUTLINE
- TEXT_COLOR
- TITLE
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrLegend::Cleanup
- IDLgrLegend::ComputeDimensions

- IDLgrLegend::GetProperty
- IDLgrLegend::Init
- IDLgrLegend::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.1

# IDLgrLegend Properties

IDLgrLegend objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrLegend::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrLegend::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrLegend::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the retrievable properties associated with this object.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BORDER_GAP

A floating-point value to indicate the amount of blank space to be placed around the outside of the glyphs and text items. The units for this property are fractions of the legend label font height. The default is 0.1 (10% of the label font height).

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLUMNS

An integer value to indicate the number of columns the legend items should be displayed in. The default is one column.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FILL_COLOR

The color to be used to fill the legend background box. The color may be specified as a color lookup table index or as an RGB vector. The default is [255,255,255].

| | | | |
|---|---|---|---|
| **Property Type** | COLOR | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FONT

An object reference to an instance of an IDLgrFont object class that describes the font to use to draw the legend labels. The default is 12 point Helvetica.

**Note**

If the default font is in use, retrieving the value of the FONT property (using the GetProperty method) will return a font object that will be destroyed when this legend object is destroyed, leaving a dangling object reference.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GAP

A floating-point value that indicates the amount of blank space to be placed vertically between each legend item. The units for this property are fractions of the legend label

font height. The default is 0.1 (10% of the label font height). The same gap is placed horizontally between the legend glyph and the legend text string.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GLYPH_WIDTH

A floating-point value to indicate the width of the glyphs, measured as a fraction of the font height. The default is 0.8 (80% of the font height).

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDE

A Boolean value that indicates whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ITEM_COLOR

An array of colors defining the color of each item. The array defines *M* different colors, and should be either of the form [3,*M*] or [*M*]. In the first case, the three values are used as an RGB triplet, in the second case, the single value is used as a color index value. The default color is [0,0,0].

| | | | |
|---|---|---|---|
| **Property Type** | Color array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ITEM_LINESTYLE

An integer array of integers defining the style of the line to be drawn if the TYPE property is set to zero. The array can be of the form [*M*] or [2,*M*]. The first form selects the linestyle for each legend item from the predefined defaults:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot
- 5 = long dash
- 6 = no line drawn

The second form specifies the stippling pattern explicitly for each legend item (see the LINESTYLE property to IDLgrPolyline::Init for details).

| **Property Type** | Integer array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ITEM_NAME

An string array representing the names of items in the legend. Specifying this property is the same as providing the *aName* argument for the IDLgrLegend::Init method.

| **Property Type** | String array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ITEM_OBJECT

An array of object references of type IDLgrSymbol or IDLgrPattern that represents the shapes of the items in the legend. A symbol object is drawn only if the TYPE property is set to zero. A pattern object is used when drawing the color patch if the TYPE property is set to one. The default object is the NULL object.

**Note**

If one or more IDlgrSymbol object references are provided, the SIZE property of those objects may be modified by this legend to suit its layout needs.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ITEM_THICK

A floating-point array of floating-point values that define the thickness of each item line, in points, where each element is a value between 1.0 and 10.0. This property is only used if the TYPE property is set to zero. The default is 1.0 points.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ITEM_TYPE

An integer array that defines the type of glyph to be displayed for each item:

- 0 = line type (the default)
- 1 = filled box type

| | | | |
|---|---|---|---|
| **Property Type** | Integer array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## OUTLINE_COLOR

The color to be used to draw the legend outline box. The color may be specified as a color lookup table index or as an RGB vector. The default is [0,0,0].

| | | | |
|---|---|---|---|
| **Property Type** | Color | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## OUTLINE_THICK

A floating-point value between 1.0 and 10.0 that defines the thickness of the outline frame, in points. The default is 1.0 points.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PARENT

An object reference to the object that contains this legend.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## RECOMPUTE

A Boolean value that determines whether to recompute the legend dimensions when the legend is redrawn.

- 0 = Prevent IDL from recomputing legend dimensions (the default).
- 1 = Recompute the legend dimensions when the legend is redrawn.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** No | **Registered:** No |

## SHOW_FILL

A Boolean value that indicates whether the background should be filled with a color:

- 0 = Do not fill background (the default)
- 1 = Fill background

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHOW_OUTLINE

A Boolean value indicating whether the outline box should be displayed:

- 0 = Do not display outline (the default)
- 1 = Display outline

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TEXT_COLOR

The color to be used to draw the legend item text. The color may be specified as a color lookup table index or as an RGB vector. The default is [0,0,0].

| **Property Type** | Color | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TITLE

An object reference to an instance of the IDLgrText object class to specify the title for the legend. The default is the null object, specifying that no title is drawn. The

title will be centered at the top of the legend, even if the text object itself has an associated location.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of the *X* data coordinates covered by the legend.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of the *Y* data coordinates covered by the legend.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of the *Z* data coordinates covered by the legend.

**Note**

Until the legend is drawn to the destination object, the [XYZ]RANGE properties will be zero. Use the ComputeDimensions method on the legend object to get the data dimensions of the legend prior to a draw operation.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrLegend::Cleanup

The IDLgrLegend::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrLegend::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrLegend::ComputeDimensions

The IDLgrLegend::ComputeDimensions function method retrieves the dimensions of a legend object for the given destination object. The result is a three-element double-precision floating-point vector [*xDim, yDim, zDim*] representing the dimensions of the legend object measured in data units.

## Syntax

*Result* = *Obj* ->[IDLgrLegend::]ComputeDimensions( *DestinationObject* [, PATH=*objref(s)*] )

## Return Value

Returns the dimensions of a legend object for the given destination object.

## Arguments

### DestinationObject

The object reference to a destination object (IDLgrBuffer, IDLgrClipboard, IDLgrPrinter, or IDLgrWindow) for which the dimensions of the legend are being requested.

## Keywords

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrLegend::ComputeDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.1

# IDLgrLegend::GetProperty

The IDLgrLegend::GetProperty procedure method retrieves the value of a property or group of properties for the legend.

## Syntax

*Obj* -> [IDLgrLegend::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrLegend Properties" on page 3310 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.1

# IDLgrLegend::Init

The IDLgrLegend::Init function method initializes the legend object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrLegend' [, *aItemNames*] [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrLegend::]Init([*aItemNames*] [, *PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### aItemNames

An array of strings to be used as the displayed item label. The length of this array is used to determine the number of items to be displayed. Each item is defined by taking one element from the ITEM_NAME, ITEM_TYPE, ITEM_LINESTYLE, ITEM_THICK, ITEM_COLOR, and ITEM_OBJECT vectors. If the number of items (as defined by the ITEM_NAME array) exceeds any of the attribute vectors, the attribute defaults will be used for any additional items.

## Keywords

Any property listed under “IDLgrLegend Properties” on page 3310 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.1

# IDLgrLegend::SetProperty

The IDLgrLegend::SetProperty procedure method sets the value of a property or group of properties for the legend.

## Syntax

*Obj*->[IDLgrLegend::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrLegend Properties” on page 3310 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.1

# IDLgrLight

A light object represents a source of illumination for three-dimensional graphic objects. Lights may be either ambient, positional, directional, or spotlights. A maximum of 8 lights per view are allowed. Lights are not required for objects displayed in two dimensions.

An IDLgrLight object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrLight::Init" on page 3340.

## Properties

Objects of this class have the following properties. See "IDLgrLight Properties" on page 3329 for details on individual properties.

- ALL
- ATTENUATION
- COLOR
- CONEANGLE
- DIRECTION
- FOCUS
- HIDE
- INTENSITY
- LOCATION
- PALETTE
- PARENT
- REGISTER_PROPERTIES

- TYPE
- XCOORD_CONV
- YCOORD_CONV
- ZCOORD_CONV

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrLight::Cleanup
- IDLgrLight::GetCTM
- IDLgrLight::GetProperty
- IDLgrLight::Init
- IDLgrLight::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrLight Properties

IDLgrLight objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrLight::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrLight::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrLight::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure that contains the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ATTENUATION

A 3-element floating-point vector of the form [constant, linear, quadratic] that describes the factor by which light intensity is to fall with respect to distance from the light source. ATTENTUATION applies only to Positional and Spot lights, as specified by the TYPE property. The overall attenuation factor is computed as follows:

```
attenuation = 1/(constant + linear*distance +
quadratic*distance^2)
```

By default, the values are [1, 0, 0].

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Attenuation | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## COLOR

A three-element byte vector specifying the RGB color of the light. The default is [255, 255, 255], which is a white light. The color of a light is ignored when graphics are sent to graphics destinations using the Indexed color model, in which case light intensities are scaled into the range of colors available on the graphics destination.

In a property sheet, this property appears as a color property.

| | | | |
|---|---|---|---|
| **Property Type** | COLOR | | |
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CONEANGLE

A floating-point value that specifies the angle (measured in degrees) of coverage for a spotlight. The default is 60.

| | | | |
|---|---|---|---|
| **Property Type** | FLOAT | | |
| **Name String** | Spotlight cone angle | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DIRECTION

A three-element floating-point vector representing the direction in which a spotlight is to be pointed. The default is [0,0,-1].

**Note**

For directional lights, the light's parallel rays follow a vector beginning at the position specified by LOCATION and ending at [0, 0, 0].

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Spotlight direction | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## FOCUS

A floating-point value that describes the attenuation of intensity for spotlights as the distance from the center of the cone of coverage increases. This factor is used as an exponent to the cosine of the angle between the direction of the spotlight and the direction from the light to the vertex being lighted. The default is 0.0.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Spotlight attenuation | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value that indicates whether this light should be enabled:

- 0 = Enable light (the default)
- 1 = Disable light

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic.

**Note**

If no lights are present in the view (or if all lights in the view are hidden), an ambient light will be provided by default..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## INTENSITY

A floating-point value between 0.0 (darkest) and 1.0 (brightest) that indicates the intensity of the light. The default is 1.0.

| | | | |
|---|---|---|---|
| **Property Type** | FLOAT | | |
| **Name String** | Intensity | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LOCATION

A floating-point vector of the form [*x*, *y*, *z*] describing the position of the light. By default, the position is [0, 0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Location | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that specifies the red, green, and blue values of the color lookup table to be associated with the image if it is an indexed color image. This property is ignored if the image is a greyscale or RGB image.

**Note**

This table is only used when the destination is an RGB model device. The Indexed color model writes the indices directly to the device. In order to ensure that these colors are used when the image is displayed, this palette must be copied to the graphics destination's palette for any graphics destination that uses the Indexed color model.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## TYPE

An integer that indicates the type of light. Valid values are:

- 0 = Ambient light. An ambient light is a universal light source, which has no direction or position. An ambient light illuminates every surface in the scene equally, which means that no edges are made visible by contrast. Ambient lights control the overall brightness and color of the entire scene. If no value is specified for the TYPE property, an ambient light is created.
- 1 = Positional light. A positional light supplies divergent light rays, and will make the edges of surfaces visible by contrast if properly positioned. A positional light source can be located anywhere in the scene.

- 2 = Directional light. A directional light supplies parallel light rays. The effect is that of a positional light source located at an infinite distance from scene.
- 3 = Spot light. A spot light illuminates only a specific area defined by the light's position, direction, and the cone angle, or angle which the spotlight covers.

In a property sheet, this property appears as an enumerated list with the following options:

- Ambient
- Positional
- Directional
- Spotlight

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Type | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Double-precision floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Double-precision floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors that convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Double-precision floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLgrLight::Cleanup

The IDLgrLight::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrLight::]Cleanup (*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrLight::GetCTM

The IDLgrLight::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrLight::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the light object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrLight::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrLight::GetProperty

The IDLgrLight::GetProperty procedure method retrieves the value of a property or group of properties for the light.

## Syntax

*Obj* -> [IDLgrLight::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrLight Properties” on page 3329 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrLight::Init

The IDLgrLight::Init function method initializes the light object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrLight' [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLgrLight::]Init([*PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrLight Properties" on page 3329 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrLight::SetProperty

The IDLgrLight::SetProperty procedure method sets the value of a property or group of properties for the light.

## Syntax

*Obj* -> [IDLgrLight::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrLight Properties” on page 3329 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrModel

A model object represents a graphical item or group of items that can be transformed (rotated, scaled, and/or translated). It serves as a container of other IDLgrModel objects or atomic graphic objects. IDLgrModel applies a transform to the current view tree.

## Superclasses

IDL_Container

## Creation

See "IDLgrModel::Init" on page 3359.

## Properties

Objects of this class have the following properties. See "IDLgrModel Properties" on page 3345 for details on individual properties.

- ALL
- CLIP_PLANES
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- HIDE
- LIGHTING
- PARENT
- REGISTER_PROPERTIES
- SELECT_TARGET
- TRANSFORM

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has this following methods:

- IDLgrModel::Add
- IDLgrModel::Cleanup
- IDLgrModel::Draw
- IDLgrModel::GetByName
- IDLgrModel::GetCTM
- IDLgrModel::GetProperty
- IDLgrModel::Init
- IDLgrModel::Reset
- IDLgrModel::Rotate
- IDLgrModel::Scale
- IDLgrModel::SetProperty
- IDLgrModel::Translate

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrModel Properties

IDLgrModel objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrModel::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrModel::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrModel::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with this object.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## CLIP_PLANES

An 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B ,C, D], where A$x$ + B$y$ + C$z$ + D = 0.

Portions of this object that fall in the half space A$x$ + B$y$ + C$z$ + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Note - Clipping planes are applied in the data space of the objects this model contains (prior to the application of this model's transform).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Clipping planes | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always

sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.

- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value indicating whether this object should be drawn:

- 0 = Draw model and children (the default)
- 1 = Do not draw model or children

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic.

**Note**

HIDE only controls the display attributes of IDLgrModel children since the IDLgrModel object itself lacks geometry..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LIGHTING

An integer value that indicates whether lighting is to be enabled or disabled for all atomic graphic objects that have this model as a parent. IDLgrModel objects that have this model as a parent will not be effected, as they have their own value for this

property. If this value is set to 0, any lights added as children of this model will be used to illuminate any other models in the view hierarchy that have lighting enabled.

- 0 = Disable lighting
- 1 = Enable single-sided lighting
- 2 = Enable double-sided lighting (the default)

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Lighting | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## SELECT_TARGET

A Boolean value that tags the model object as the target object to be returned when any object contained by the model is selected via the IDLgrWindow::Select method.

- 0 = Do not tag the model object as the target object (default).

- 1 = Tag the model object as the target object.

By default, an IDLgrModel object cannot be returned as the target of a SELECT operation since it contains no geometry.

This property is registered as a Boolean property, but it is hidden by default.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Select target | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TRANSFORM

A 4-by-4 floating-point transformation matrix to be applied to the object. This matrix will be multiplied by its parent's transformation matrix (if the parent has one). The default is the identity matrix. IDL converts, maintains, and returns this data as double-precision floating-point.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Model transform | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

# IDLgrModel::Add

The IDLgrModel::Add procedure method adds a child to this Model.

## Syntax

*Obj* -> [IDLgrModel::]Add, *Object* [, /ALIAS] [, POSITION=*index*]

## Arguments

### Object

An instance of an atomic graphic object or another model object to be added to the model object.

## Keywords

### ALIAS

Set this keyword to a nonzero value to indicate that an alias—rather than the object itself—is to be added to the model. With this keyword you can add the same object to multiple models without duplicating that object and its children. If this keyword is set, the PARENT keyword on the object being added will not change. Furthermore, if this keyword is set, the object being added will not be destroyed when the model is destroyed.

### POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

## Version History

Introduced: 5.0

# IDLgrModel::Cleanup

The IDLgrModel::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrModel::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrModel::Draw

The IDLgrModel::Draw procedure method draws the specified picture to the specified graphics destination. *This method is provided for purposes of sub-classing only, and is intended to be called only from the Draw method of a subclass of IDLgrModel.*

**Note**

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

## Syntax

*Obj* -> [IDLgrModel::]Draw, *Destination*, *Picture*

## Arguments

### Destination

The destination object (IDLgrBuffer, IDLgrClipboard, IDLgrPrinter, or IDLgrWindow) to which the specified view object will be drawn.

### Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object), or scene (an instance of an IDLgrScene object) to be drawn.

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrModel::GetByName

The IDLgrModel::GetByName function method finds contained objects by name and returns the object reference to the named object. If the named object is not found, the GetByName function returns a null object reference.

**Note**

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

## Syntax

*Result* = *Obj* -> [IDLgrModel::]GetByName(*Name*)

## Return Value

Returns the object reference to the named object or a null object reference.

## Arguments

### Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX file system. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrModel::GetCTM

The IDLgrModel::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrModel::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the model object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrModel::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrModel::GetProperty

The IDLgrModel::GetProperty procedure method retrieves the value of a property or group of properties for the model.

## Syntax

*Obj* -> [IDLgrModel::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrModel Properties” on page 3345 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrModel::Init

The IDLgrModel::Init procedure method initializes the model object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrModel' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrModel::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrModel Properties" on page 3345 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrModel::Reset

The IDLgrModel::Reset procedure method sets the current transform matrix for the model object to the identity matrix.

**Note**

Using this method is functionally identical to the following statement:

```
Obj ->[IDLgrModel::]SetProperty, TRANSFORM=IDENTITY(4)
```

## Syntax

*Obj* -> [IDLgrModel::]Reset

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrModel::Rotate

The IDLgrModel::Rotate procedure method rotates the model about the specified axis by the specified angle. IDL computes and maintains the resulting transform matrix in double-precision floating-point.

## Syntax

*Obj* -> [IDLgrModel::]Rotate, *Axis*, *Angle* [, /PREMULTIPLY]

## Arguments

### Axis

A three-element vector of the form [*x*, *y*, *z*] describing the axis about which the model is to be rotated.

### Angle

The angle (measured in degrees) by which the rotation is to occur.

## Keywords

### PREMULTIPLY

Set this keyword to cause the rotation matrix specified by *Axis* and *Angle* to be pre-multiplied to the model's transformation matrix. By default, the rotation matrix is post-multiplied.

## Version History

Introduced: 5.0

# IDLgrModel::Scale

The IDLgrModel::Scale procedure method scales the model by the specified scaling factors. IDL computes and maintains the resulting transform matrix in double-precision floating-point.

## Syntax

*Obj* -> [IDLgrModel::]Scale, *Sx, Sy, Sz* [, /PREMULTIPLY]

## Arguments

### Sx, Sy, Sz

The scaling factors in the *x*, *y*, and *z* dimensions by which the model is to be scaled.

## Keywords

### PREMULTIPLY

Set this keyword to cause the scaling matrix specified by *Sx, Sy, Sz* to be pre-multiplied to the model's transformation matrix. By default, the scaling matrix is post-multiplied.

## Version History

Introduced: 5.0

# IDLgrModel::SetProperty

The IDLgrModel::SetProperty procedure method sets the value of a property or group of properties for the model.

## Syntax

*Obj* -> [IDLgrModel::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrModel Properties” on page 3345 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrModel::Translate

The IDLgrModel::Translate procedure method translates the model about the specified axis by the specified translation offsets. IDL computes and maintains the resulting transform matrix in double-precision floating-point.

## Syntax

*Obj* -> [IDLgrModel::]Translate, *Tx, Ty, Tz* [, /PREMULTIPLY]

## Arguments

### Tx, Ty, Tz

The offsets in *X*, *Y*, and *Z*, respectively, by which the model is to be translated.

## Keywords

### PREMULTIPLY

Set this keyword to cause the translation matrix specified by *Tx, Ty, Tz* to be pre-multiplied to the model's transformation matrix. By default, the translation matrix is post-multiplied.

## Version History

Introduced: 5.0

# IDLgrMPEG

An IDLgrMPEG object creates an MPEG movie file from an array of image frames.

**Note**

The MPEG standard does not allow movies with odd numbers of pixels to be created.

**Note**

MPEG support in IDL requires a special license. For more information, contact your RSI sales representative or technical support.

## Superclasses

IDLitComponent

## Creation

See "IDLgrMPEG::Init" on page 3377.

## Properties

Objects of this class have the following properties. See "IDLgrMPEG Properties" on page 3368 for details on individual properties.

- ALL
- BITRATE
- DIMENSIONS
- FILENAME
- FORMAT
- FRAME_RATE
- IFRAME_GAP
- INTERLACED
- MOTION_VEC_LENGTH
- QUALITY
- SCALE

- STATISTICS
- TEMP_DIRECTORY

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrMPEG::Cleanup
- IDLgrMPEG::GetProperty
- IDLgrMPEG::Init
- IDLgrMPEG::Put
- IDLgrMPEG::Save
- IDLgrMPEG::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.1

# IDLgrMPEG Properties

IDLgrMPEG objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrMPEG::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrMPEG::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrMPEG::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the retrievable properties associated with this object.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BITRATE

A double-precision floating-point value to specify the MPEG movie bit rate. Higher bit rates will create higher quality MPEGs but will increase file size. The following table describes the valid values:

| MPEG Version | Range |
|---|---|
| MPEG 1 | 0.1 to 104857200.0 |
| MPEG 2 | 0.1 to 429496729200.0 |

*Table 8-5: BITRATE Value Range*

Set this property to 0.0 (the default setting) to indicate that IDL should compute the BITRATE value based upon the value you have specified for the QUALITY property. The value of BITRATE returned by IDLgrMPEG::GetProperty is either the value computed by IDL from the QUALITY value or the last non-zero valid value stored in this property.

**Note**

Only use the BITRATE property if changing the QUALITY property value does not produce the desired results. It is highly recommended to set the BITRATE to at least several times the frame rate to avoid unusable MPEG files or file generation errors.

| **Property Type** | Floating-point | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DIMENSIONS

A two-element integer array specifying the dimensions (in pixels) of each of the images to be used as frames for the movie. If this property is not specified, the dimensions of the first image loaded will be used. Once IDLgrMPEG::Put has been called, this property can no longer be set.

**Note**

When creating MPEG files, you must be aware of the capabilities of the MPEG decoder you will be using to view it. Some decoders only support a limited set of sampling and bitrate parameters to normalize computational complexity, buffer size, and memory bandwidth. For example, the Windows Media Player supports a limited set of sampling and bitrate parameters. In this case, it is best to use 352 x 240 x 30 fps or 352 x 288 x 25 fps when determining the dimensions and frame rate for your MPEG file. When opening a file in Windows Media Player that does not use these dimensions, you will receive a “Bad Movie File” error message. The file is not “bad”, this decoder just doesn’t support the dimensions of the MPEG.

| **Property Type** | Integer array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FILENAME

A string that represents the name of the file in which the encoded MPEG sequence is to be stored. The default is `'idl.mpg'`.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FORMAT

A Boolean value that specifies the type of MPEG encoding to use:

- 0 = MPEG1 (the default)
- 1 = MPEG2

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FRAME_RATE

An integer value that specifies the frame rate used in creating the MPEG file:

| Value | Descriptions |
|---|---|
| 1 | 23.976 frames/sec: NTSC encapsulated film rate |
| 2 | 24 frames/sec: Standard international film rate |
| 3 | 25 frames/sec: PAL video frame rate |
| 4 | 29.97 frames/sec: NTSC video frame rate |
| 5 | 30 frames/sec: NTSC drop frame video frame rate (the default) |
| 6 | 50 frames/sec: Double frame rate/progressive PAL |
| 7 | 59.94 frames/sec: Double frame rate NTSC |
| 8 | 60 frames/sec: Double frame rate NTSC drop frame video |

*Table 8-6: FRAME_RATE Values*

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## IFRAME_GAP

A positive integer value that specifies the number of frames between I frames to be created in the MPEG file. I frames are full-quality image frames that may have a number of predicted or interpolated frames between them.

Set this property to 0 (the default setting) to indicate that IDL should compute the IFRAME_GAP value based upon the value you have specified for the QUALITY property. The value of IFRAME_GAP returned by IDLgrMPEG::GetProperty is either the value computed by IDL from the QUALITY value or the last non-zero valid value stored in this property.

**Note**

Only use the IFRAME_GAP property if changing the QUALITY property value does not produce the desired results.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## INTERLACED

A Boolean value that indicates whether frames in the encoded MPEG file should be interlaced.

- 0 = Non-interlaced (the default)
- 1 = Interlaced

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## MOTION_VEC_LENGTH

An integer value that specifies the length of the motion vectors to be used to generate predictive frames. The following table describes the valid values:

| Value | Description |
|---|---|
| 1 | Small motion vectors. |
| 2 | Medium motion vectors. |
| 3 | Large motion vectors. |

*Table 8-7: MOTION_VEC_LENGTH Values*

0 (the default setting) indicates that IDL should compute the MOTION_VEC_LENGTH value based upon the value you have specified for the QUALITY property. The value of MOTION_VEC_LENGTH returned by IDLgrMPEG::GetProperty is either the value computed by IDL from the QUALITY value or the last non-zero value stored in this property.

**Note**

Only use the MOTION_VEC_LENGTH property if changing the QUALITY value does not produce the desired results.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## QUALITY

An integer value between 0 (low quality) and 100 (high quality), inclusive, that specifies the quality at which the MPEG stream is to be stored. Higher quality values result in lower rates of time compression and less motion prediction which provide higher quality MPEGs but with substantially larger file size. Lower quality factors may result in longer MPEG generation times. The default is 50.

**Note**

Since MPEG uses JPEG (lossy) compression, the original picture quality cannot be reproduced even when setting QUALITY to its highest setting.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SCALE

A two-element floating-point vector, [*xscale*, *yscale*], indicating the scale factors to be stored with the MPEG file as hints for playback. The default is [1.0, 1.0], indicating that the movie should be played back at the dimensions of the stored image frames.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## STATISTICS

A Boolean value that determines whether to save statistical information about MPEG encoding for the supplied image frames in a file when the IDLgrMPEG::Save method is called. The information will be saved in a file with a name that matches that specified by the FILENAME property, with the extension "`.stat`".

- 0 = Statistics are not saved (the default).
- 1 = Save statistics.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TEMP_DIRECTORY

A string value that specifies the directory in which to place temporary files while creating the MPEG movie file. The default value is platform specific.

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLgrMPEG::Cleanup

The IDLgrMPEG::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrMPEG::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrMPEG::GetProperty

The IDLgrMPEG::GetProperty procedure method retrieves the value of a property or group of properties for the MPEG object.

## Syntax

*Obj* -> [IDLgrMPEG::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrMPEG Properties” on page 3368 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.1

# IDLgrMPEG::Init

The IDLgrMPEG::Init function method initializes the MPEG object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

**Note**

MPEG support in IDL requires a special license. For more information, contact your RSI sales representative or technical support.

## Syntax

*Obj* = OBJ_NEW('IDLgrMPEG' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrMPEG::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrMPEG Properties" on page 3368 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.1

# IDLgrMPEG::Put

The IDLgrMPEG::Put procedure method puts a given image into the MPEG sequence at the specified frame. Note that all images in a given MPEG movie must have matching dimensions. If no dimensions were explicitly specified when the MPEG object was initialized, the dimensions will be set according to the dimensions of the first image.

## Syntax

*Obj* -> [IDLgrMPEG::]Put, *Image*[, *Frame*]

## Arguments

### Image

An instance of an IDLgrImage object or a *m* x *n* or 3 x *m* x *n* array representing the image to be loaded at the given frame.

### Frame

An integer specifying the index of the frame at which the image is to be added. Frame indices start at zero. If *Frame* is not supplied, the frame number used will be one more than the last frame that was put. Frame number need not be consecutive; in case of a gap in frame numbers, the frame before the gap is repeated to fill the space.

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrMPEG::Save

The IDLgrMPEG::Save procedure method encodes and saves the MPEG sequence to the specified filename.

**Note**

The MPEG standard does not allow movies with odd numbers of pixels to be created.

## Syntax

*Obj* -> [IDLgrMPEG::]Save [, FILENAME=*string*]

## Arguments

None

## Keywords

### FILENAME

Set this keyword to a string representing the name of the file in which the encoded MPEG sequence is to be stored. The default is `idl.mpg`.

### Obsolete Keywords

The following keywords are obsolete:

- CREATOR_TYPE

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

## Version History

Introduced: 5.1

# IDLgrMPEG::SetProperty

The IDLgrMPEG::SetProperty procedure method sets the value of a property or group of properties for the MPEG object.

## Syntax

*Obj* -> [IDLgrMPEG::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under "IDLgrMPEG Properties" on page 3368 that contains the word "Yes" in the "Set" column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.1

# IDLgrPalette

A palette object represents a color lookup table that maps indices to red, green, and blue values.

## Superclasses

This class has no superclass.

## Creation

See “IDLgrPalette::Init” on page 3390.

## Properties

Objects of this class have the following properties. See “IDLgrPalette Properties” on page 3384 for details on individual properties.

- ALL
- BLUE_VALUES
- BOTTOM_STRETCH
- GAMMA
- GREEN_VALUES
- N_COLORS
- RED_VALUES
- TOP_STRETCH

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has this following methods:

- IDLgrPalette::Cleanup
- IDLgrPalette::GetRGB
- IDLgrPalette::GetProperty
- IDLgrPalette::Init

- IDLgrPalette::LoadCT
- IDLgrPalette::NearestColor
- IDLgrPalette::SetRGB
- IDLgrPalette::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrPalette Properties

IDLgrPalette objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrPalette::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrPalette::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrPalette::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure that contains the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BLUE_VALUES

A byte vector containing the blue values for the color palette. Setting this value is the same as specifying the *aBlue* argument to the IDLgrPalette::Init method.

| | | | |
|---|---|---|---|
| **Property Type** | Byte vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## BOTTOM_STRETCH

An integer value in the range of 0 ≤ *Value* ≤ 100 to indicate what percentage of the palette entries at the bottom of the palette should be filled with the value of the first palette entry. The entire range of red, green, and blue values will be compressed to fit within the range of palette entries beginning at this entry and ending at the entry specified by the value of the TOP_STRETCH property. The default is 0 (zero).

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GAMMA

A floating-point value that indicates the gamma value to be applied to the color palette. This value should be in the range of 0.1 ≤ *Gamma* ≤ 10.0. The default is 1.0.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GREEN_VALUES

A byte vector containing the green values for the color palette. Setting this value is the same as specifying the *aGreen* argument to the IDLgrPalette::Init method.

| | | | |
|---|---|---|---|
| **Property Type** | Byte-vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## N_COLORS

An integer value that determines the number of elements in the color palette.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## RED_VALUES

A byte vector containing the red values for the color palette. Setting this value is the same as specifying the *aRed* argument to the IDLgrPalette::Init method.

| **Property Type** | Byte vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TOP_STRETCH

A floating-point value in the range of $0 \leq Value \leq 100$ to indicate what percentage of the palette entries at the top of the palette should be filled with the value of the last palette entry. The entire range of red, green, and blue values will be compressed to fit within the range of palette entries beginning at the entry specified by the value of the BOTTOM_STRETCH property and ending at this entry. The default is 0 (zero).

| **Property Type** | Floating-point | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLgrPalette::Cleanup

The IDLgrPalette::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrPalette::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPalette::GetRGB

The IDLgrPalette::GetRGB function method returns the RGB values contained in the palette at the given index. The returned value is a three-element vector of the form [red, green, blue].

## Syntax

*Result* = *Obj* -> [IDLgrPalette::]GetRGB(*Index*)

## Return Value

Returns the RGB values contained in the palette at the given index.

## Arguments

### Index

The index whose RGB values are desired. This value should be in the range of $0 \leq Index < N\_COLORS$, where N_COLORS is the number of elements in the color palette, as returned by the N_COLORS keyword to the IDLgrPalette:GetProperty method.

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPalette::GetProperty

The IDLgrPalette::GetProperty procedure method retrieves the value of a property or group of properties for the palette.

## Syntax

*Obj* -> [IDLgrPalette::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrPalette Properties" on page 3384 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.0

# IDLgrPalette::Init

The IDLgrPalette::Init function method initializes a palette object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrPalette', *aRed*, *aGreen*, *aBlue* [, *PROPERTY=value*])

or

*Result* = *Obj*`->` [IDLgrPalette::]Init([*aRed*, *aGreen*, *aBlue*] [, *PROPERTY=value*]) (*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### aRed

A vector containing the red values for the color palette. These values should be within the range of 0 ≤ Value ≤ 255. The number of elements comprising the *aRed* vector must not exceed 256.

### aGreen

A vector containing the green values for the color palette. These values should be within the range of 0 ≤ Value ≤ 255. The number of elements comprising the *aGreen* vector must not exceed 256.

### aBlue

A vector containing the blue values for the color palette. These values should be within the range of 0 ≤ Value ≤ 255. The number of elements comprising the *aBlue* vector must not exceed 256.

## Keywords

Any property listed under "IDLgrPalette Properties" on page 3384 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrPalette::LoadCT

The IDLgrPalette::LoadCT procedure method loads one of the IDL predefined color tables into an IDLgrPalette object.

## Syntax

*Obj* -> [IDLgrPalette::]LoadCT, *TableNum* [, FILENAME=*colortable filename*]

## Arguments

### TableNum

The number of the pre-defined IDL color table to load, from 0 to 40.

## Keywords

### FILE

Set this keyword to the name of a colortable file to be used instead of the file `colors1.tbl` in the IDL distribution. The MODIFYCT procedure can be used to create and modify colortable files.

## Version History

Introduced: 5.0

# IDLgrPalette::NearestColor

The IDLgrPalette::NearestColor function method returns the index of the color in the palette that best matches the given RGB values.

## Syntax

*Result* = *Obj*->[IDLgrPalette::]NearestColor(*Red*, *Green*, *Blue*)

## Return Value

Returns the index of the color in the palette that best matches the given RGB values.

## Arguments

### Red

The red value of the color that should be matched. This value should be within the range of 0 ≤ Value ≤ 255.

### Green

The green value of the color that should be matched. This value should be within the range of 0 ≤ Value ≤ 255.

### Blue

The blue value of the color that should be matched. This value should be within the range of 0 ≤ Value ≤ 255.

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPalette::SetRGB

The IDLgrPalette::SetRGB procedure method sets the color values at a specified index in the palette to the specified Red, Green and Blue values.

## Syntax

*Obj* -> [IDLgrPalette::]SetRGB, *Index*, *Red*, *Green*, *Blue*

## Arguments

### Index

The index within the Palette object to be set. This value should be in the range of $0 \leq Value < N\_COLORS$.

### Red

The red value to set in the color palette.

### Green

The green value to set in the color palette.

### Blue

The blue value to set in the color palette.

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPalette::SetProperty

The IDLgrPalette::SetProperty procedure method sets the value of a property or group of properties for the palette.

## Syntax

*Obj* -> [IDLgrPalette::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPalette Properties” on page 3384 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrPattern

A pattern object describes which pixels are filled and which are left blank when an area is filled. Pattern objects are used by setting the FILL_PATTERN property of a polygon object equal to the object reference of the pattern object.

## Superclasses

IDLitComponent

## Creation

See “IDLgrPattern::Init” on page 3403.

## Properties

Objects of this class have the following properties. See “IDLgrPattern Properties” on page 3398 for details on individual properties.

- ALL
- ORIENTATION
- PATTERN
- SPACING
- STYLE
- THICK

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has this following methods:

- IDLgrPattern::Cleanup
- IDLgrPattern::GetProperty
- IDLgrPattern::Init
- IDLgrPattern:SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrPattern Properties

IDLgrPattern objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrPattern::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrPattern::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrPattern:SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ORIENTATION

An integer representing the angle (measured in degrees counterclockwise from the horizontal) of the lines used in a Line Fill. This property is ignored unless the *Style* argument (or STYLE property) is set to one.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PATTERN

A 32 x 32 bit array (bitmap) describing the pattern that will be tiled over a polygon when a pattern fill is used. The bitmap must be configured as a 4 x 32 “bitmap byte array” as created by the CVTTOBM function. Each bit that is a 1 is drawn, each bit that is 0 is not drawn. Each bit in this array represents a 1 point by 1 point square area of pixels on the destination device. This property is ignored unless the *Style* argument (or STYLE property) is set to 2.

| | | | |
|---|---|---|---|
| **Property Type** | Integer array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SPACING

A floating-point value representing the distance (measured in points) between the lines used for a Line Fill. This property is ignored unless the *Style* argument (or STYLE property) is set to 1. The default is 2.0 points.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## STYLE

An integer value that specifies the type of pattern, as follows:

- 0 = Solid (default)
- 1 = Line Fill
- 2 = Pattern

This property is the same as the *Style* argument described above.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value between 1.0 and 10.0 that specifies the line thickness to be used to draw the pattern lines for a Line Fill, in points. The default is 1.0 points. This property is ignored unless the *Style* argument or STYLE property is set to 1.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLgrPattern::Cleanup

The IDLgrPattern::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrPattern::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPattern::GetProperty

The IDLgrPattern::GetProperty procedure method retrieves the value of a property or group of properties for the pattern.

## Syntax

*Obj* -> [IDLgrPattern::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPattern Properties” on page 3398 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrPattern::Init

The IDLgrPattern::Init function method initializes the pattern object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrPattern' [, *Style*] [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLgrPattern::]Init([*Style*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Style

A integer value representing the type of pattern. Valid values are:

- 0 = Solid color (default)
- 1 = Line Fill
- 2 = Pattern

## Keywords

Any property listed under "IDLgrPattern Properties" on page 3398 that contains the word "Yes" in the "Init" column of the properties table can be initialized during

object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrPattern:SetProperty

The IDLgrPattern::SetProperty procedure method sets the value of a property or group of properties for the pattern.

## Syntax

*Obj* -> [IDLgrPattern::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPattern Properties” on page 3398 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrPlot

A plot object creates a set of polylines connecting data points in two-dimensional space.

An IDLgrPlot object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrPlot::Init" on page 3426.

## Properties

Objects of this class have the following properties. See "IDLgrPlot Properties" on page 3408 for details on individual properties.

- ALL
- COLOR
- DATAX
- DATAY
- DOUBLE
- HIDE
- HISTOGRAM
- LINESTYLE
- MAX_VALUE
- MIN_VALUE
- NSUM
- PALETTE
- PARENT
- POLAR
- REGISTER_PROPERTIES
- RESET_DATA
- SHARE_DATA
- SYMBOL
- THICK
- USE_ZVALUE
- VERT_COLORS
- XCOORD_CONV
- XRANGE
- YCOORD_CONV

- YRANGE
- ZCOORD_CONV
- ZRANGE
- ZVALUE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrPlot::Cleanup
- IDLgrPlot::GetCTM
- IDLgrPlot::GetProperty
- IDLgrPlot::Init
- IDLgrPlot::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrPlot Properties

IDLgrPlot objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrPlot::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrPlot::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrPlot::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## CLIP_PLANES

A 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES keyword of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

The color to be used as the foreground color for this plot. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0].

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DATA

The plot data of any type in a 3 x *n* array, [*DataX*, *DataY, DataZ*].

| **Property Type** | Array of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## DATAX

A vector of any type that specifies the X values to be plotted. This property is the same as the X argument.

| **Property Type** | Vector of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATAY

A vector of any type that specifies the Y values to be plotted. This property is the same as the Y argument.

| **Property Type** | Vector of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DOUBLE

A Boolean value that indicates whether data provided by any of the input arguments will be stored in this object as using double-precision floating-point format.

- Set this property equal to 1 to convert input data to double-precision floating-point format.
- Set this property equal to 0 to convert input data to single-precision floating-point format.
- If you do not specify a value for this property, no data type conversion will be performed, and the data will be stored with its original precision.

Setting this property may be desirable if the data consists of large integers that cannot be accurately represented in single-precision floating-point arithmetic. This property is also automatically set to 1 if any of the input arguments are stored using a variable of type DOUBLE.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDE

A Boolean value that indicates whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HISTOGRAM

A Boolean value that determines whether to use only horizontal and vertical lines to connect the plotted points.

- 0 = The points are connected using a single straight line (the default)..
- 1 = Use only horizontal and vertical lines to connect the plotted points.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Histogram plot | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LINESTYLE

An integer value that indicates the line style to be used to draw the plot lines. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot

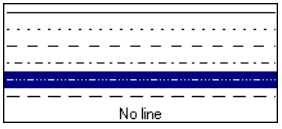
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

In a property sheet, this property appears as follows:




| **Property Type** | LINESTYLE | | |
|---|---|---|---|
| **Name String** | Line style | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MAX_VALUE

A double-precision floating-point value that determines the maximum value to be plotted. When this property is set, data values greater than the value of MAX_VALUE are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Maximum value | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MIN_VALUE

A double-precision floating-point value that determines the minimum value to be plotted. If this property is present, data values less than the value of MIN_VALUE

are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Minimum value | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## NSUM

An integer value representing the number of data points to average when plotting. If NSUM is larger than 1, every group of NSUM points is averaged to produce one plotted point. If there are M data points, then M/NSUM points are plotted.

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Number of points to average | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class). This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## POLAR

A Boolean value that determines whether to create a polar plot. The *X* and *Y* arguments must both be present. The *X* argument represents the radius, and the *Y* argument represents the angle expressed in radians.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Polar plot | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESET_DATA

A Boolean value that determines whether to treat the data provided via one of the DATA[XY] properties as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this property if the object on which the property is being set does not currently share data with another

object (that is, if the SHARE_DATA property is not in use). This property has no effect if no new data is provided via a DATA property.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHARE_DATA

An object reference to an object with which data is to be shared by this plot. A plot may only share data with another plot. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SYMBOL

An object reference vector containing instances of the IDLgrSymbol object class. Each symbol in the vector will be drawn at the corresponding plotted point. If there are more points than elements in SYMBOL, the elements of the SYMBOL vector are cyclically repeated. By default, no symbols are drawn. To remove symbols from a plot, set the SYMBOL property equal to a null object reference.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value between 1.0 and 10.0, specifying the line thickness to be used to draw the plotted lines, in points. The default is 1.0 points.

In a property sheet, this property appears as follows:


| **Property Type** | THICKNESS | | |
|---|---|---|---|
| **Name String** | Thickness | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## USE_ZVALUE

A Boolean value that determines whether to use the current ZVALUE. The plot is considered three-dimensional if this property is set.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## VERT_COLORS

A vector of colors to be used to draw at each vertex. Color is interpolated between vertices. If there are more plot points than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the plot is all drawn in the single color provided by the COLOR property. If the VERT_COLORS is provided, the COLOR property is ignored. Moreover, when VERT_COLORS is used with symbols, the vertex colors override any colors specified by the symbol object or any colors specified by graphic atoms contained in a user-defined symbol.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Vertex colors | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element floating-point vector of the form [*xmin*, *xmax*] specifying the range of *x* data coordinates covered by the graphic object. If this property is not specified, the minimum and maximum data values are used. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element floating-point vector of the form [*ymin*, *ymax*] specifying the range of *y* data values covered by the graphic object. If this property is not specified, the minimum and maximum data values are used. IDL converts, maintains, and returns this data as double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element floating-point vector of the form [*zmin*, *zmax*] specifying the range of *z* data values covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

**Note**

The XRANGE and YRANGE properties can also be retrieved via the GetProperty method; ZRANGE, however, can only be retrieved, not initialized (Init method) or set (SetProperty method).

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZVALUE

A floating-point value to be used as the Z coordinate for the entire plot. By default, 0.0 is used as the Z coordinate.

**Note**

The USE_ZVALUE property needs to be set in order for ZVALUE to take effect.

| **Property Type** | Floating-point | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLgrPlot::Cleanup

The IDLgrPlot::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrPlot::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPlot::GetCTM

The IDLgrPlot::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrPlot::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the plot object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPlot::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrPlot::GetProperty

The IDLgrPlot::GetProperty procedure method retrieves the value of the property or group of properties for the plot.

## Syntax

*Obj* -> [IDLgrPlot::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPlot Properties” on page 3408 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrPlot::Init

The IDLgrPlot::Init function method initializes the plot object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrPlot' [, [*X*,] *Y*] [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrPlot::]Init([[*X*,] *Y*] [, *PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### X

A vector representing the abscissa values to be plotted. If *X* is provided, *Y* is plotted as a function of *X*. The value for this argument is double-precision floating-point if the DOUBLE keyword is set or the inputted value is of type DOUBLE. Otherwise it is converted to single-precision floating-point.

### Y

Either a vector of two-element arrays [*x, y*] representing the points to be plotted, or a vector representing the ordinate values to be plotted. If *Y* is a vector of ordinate values and *X* is not specified, *Y* is plotted as a function of the vector index of *Y*. The value for this argument is double-precision floating-point if the DOUBLE keyword is

set or the inputted value is of type DOUBLE. Otherwise it is converted to single-precision floating-point.

## Keywords

Any property listed under “IDLgrPlot Properties” on page 3408 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrPlot::SetProperty

The IDLgrPlot::SetProperty procedure method sets the value of the property or group of properties for the plot.

## Syntax

*Obj* -> [IDLgrPlot::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPlot Properties” on page 3408 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrPolygon

A polygon object represents one or more polygons that share a given set of vertices and rendering attributes. All polygons must be convex—that is, a line connecting any pair of vertices on the polygon cannot fall outside the polygon. Concave polygons can be converted to a set of convex polygons using the IDLgrTessellator object.

An IDLgrPolygon object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrPolygon::Init" on page 3454.

## Properties

Objects of this class have the following properties. See "IDLgrPolygon Properties" on page 3431 for details on individual properties.

- ALL
- BOTTOM
- CLIP_PLANES
- COLOR
- DATA
- DEPTH_OFFSET
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- DOUBLE
- FILL_PATTERN
- HIDDEN_LINES
- HIDE
- LINESTYLE
- NORMALS
- PALETTE
- PARENT
- POLYGONS
- REGISTER_PROPERTIES
- REJECT
- RESET_DATA
- SHADE_RANGE
- SHADING
- SHARE_DATA

- STYLE
- TEXTURE_COORD
- TEXTURE_INTERP
- TEXTURE_MAP
- THICK
- VERT_COLORS
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZERO_OPACITY_SKIP
- ZRANGE
-

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrPolygon::Cleanup
- IDLgrPolygon::GetCTM
- IDLgrPolygon::GetProperty
- IDLgrPolygon::Init
- IDLgrPolygon::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrPolygon Properties

IDLgrPolygon objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrPolygon::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrPolygon::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrPolygon::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BOTTOM

An RGB color for drawing the bottom of the surface. Set this property to a scalar to draw the bottom with the same color as the top. Setting a bottom color is only supported when the destination device uses RGB color mode.

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Bottom color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CLIP_PLANES

A 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

An RGB or indexed color for drawing polygons. The default color is [0, 0, 0] (black). If the TEXTURE_MAP property is used, the final color is modulated by the texture map pixel values. This property is ignored if the VERT_COLORS property is provided.

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DATA

A *2*-by-*n* or a *3*-by-*n* array of any type which defines, respectively, the 2-D or 3-D vertex data. DATA is equivalent to the optional arguments, X, Y, and Z. This property is stored as double precision floating point values if the property variable is of type DOUBLE or if the DOUBLE property parameter is also specified, otherwise it is converted to single precision floating point.

| | | | |
|---|---|---|---|
| **Property Type** | Array of any type | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_OFFSET

An integer value that specifies an offset in depth to be used when rendering filled primitives. This offset is applied along the viewing axis, with positive values moving the primitive away from the viewer.

The units are “Z-Buffer units,” where a value of 1 is used to specify a distance that corresponds to a single step in the device’s Z-Buffer.

Use DEPTH_OFFSET to always cause a filled primitive to be rendered slightly deeper than other primitives, independent of model transforms. This is useful for avoiding stitching artifacts caused by rendering lines or polygons on top of other polygons at the same depth.

**Note**

RSI suggests using this feature to remove stitching artifacts and not as a means for “layering” complex scenes with multiple DEPTH_OFFSET values. It is safest to use only a DEPTH_OFFSET value of 0, the default, and one other non-zero value, such as 1. Many system-level graphics drivers are not consistent in their handling of DEPTH_OFFSET values, particularly when multiple non-zero values are used. This can lead to portability problems because a set of DEPTH_OFFSET values may produce better results on one machine than on another. Using IDL’s software renderer will help improve the cross-platform consistency of scenes that use DEPTH_OFFSET.

**Note**

DEPTH_OFFEST has no effect unless the value of the STYLE property is 2 (Filled).

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Depth offset | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object’s depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object’s pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DOUBLE

A Boolean value that indicates whether data provided by any of the input arguments will be stored in this object as using double-precision floating-point format.

- Set this property equal to 1 to convert input data to double-precision floating-point format.
- Set this property equal to 0 to convert input data to single-precision floating-point format.
- If you do not specify a value for this property, no data type conversion will be performed, and the data will be stored with its original precision.

Setting this property may be desirable if the data consists of large integers that cannot be accurately represented in single-precision floating-point arithmetic. This property is also automatically set to 1 if any of the input arguments are stored using a variable of type DOUBLE.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FILL_PATTERN

An object reference to an IDLgrPattern object (or an array of IDLgrPattern objects) that specifies the fill pattern to use for filling the polygons. By default, FILL_PATTERN is set to a null object reference, specifying a solid fill.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDDEN_LINES

A Boolean value that determines whether to draw point and wireframe surfaces using hidden line (point) removal. By default, hidden line removal is disabled.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Remove hidden | | |
| **Get:** No | **Set:** Nos | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value that indicates whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LINESTYLE

An integer value that indicates the line style that should be used to draw the polygon. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot

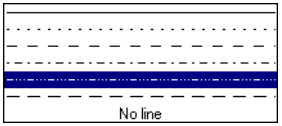
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off).

In a property sheet, this property appears as follows:




| **Property Type** | LINESTYLE | | |
|---|---|---|---|
| **Name String** | Line style | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## NORMALS

A *3*-by-*n* floating-point array of unit polygon normals at each vertex. If this property is not set, vertex normals are computed by averaging shared polygon normals at each vertex. Normals are computed using the Right Hand Rule; that is, if the polygon is facing the viewer, vertices are taken in counterclockwise order. To remove previously specified normals, set NORMALS to a scalar.

**Note**

Computing normals is a computationally expensive operation. Rendering speed increases significantly if you supply the surface normals explicitly. You can compute the array of polygon normals used by this property automatically. See "COMPUTE_MESH_NORMALS" on page 276 for details.

Once you use the NORMALS property in a call to IDLgrPolygon::Init or IDLgrPolygon::SetProperty, you are responsible for that IDLgrPolygon's normals from then on. IDL will not calculate that IDLgrPolygon's normals for you automatically, even if you draw the IDLgrPolygon after vertices or connectivity have been changed.

If you do not use the NORMALS property, IDL calculates normals the first time it draws the IDLgrPolygon. IDL reuses those normals for subsequent draws unless it determines that a fresh recalculation of normals is required, such as if the vertices of the IDLgrPolygon are changed, or you supply new normals via the NORMALS property.

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class). This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## POLYGONS

An integer array of polygon descriptions. A polygon description is an integer or long word array of the form: [*n*, $i_0$, $i_1$, ..., $i_{n-1}$], where *n* is the number of vertices that define the polygon, and $i_0$..$i_{n-1}$ are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices. To ignore an entry in the POLYGONS array, set the vertex count, *n*, to 0. To end the drawing list, even if additional array space is available, set *n* to -1. If this property is not specified, a single polygon will be generated.

**Tip**

To ignore an entry in the POLYGONS array, set the entry to 0.

**Note**

The connectivity array described by POLYGONS allows an individual object to contain more than one polygon. Vertex, normal, and color information can be shared by the multiple polygons. Consequently, the polygon object can represent an entire mesh and compute reasonable normal estimates in most cases.

| **Property Type** | Integer array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## REJECT

An integer value to reject polygons as being hidden depending on the orientation of their normals. Select from one of the following values:

- 0 = No polygons are hidden
- 1 = Polygons whose normals point away from the viewer are hidden
- 2 = Polygons whose normals point toward the viewer are hidden

Set this property to zero to draw all polygons regardless of the direction of their normals.

In a property sheet, this property appears as an enumerated list with the following options:

- None
- Normals point away
- Normals point toward

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Polygon rejection | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## RESET_DATA

A Boolean value that determines whether to treat the data provided via the DATA property as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this property if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This property has no effect if no new data is provided via the DATA property.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHADE_RANGE

A two-element integer array that specifies the range of pixel values (color indices) to use for shading. The first element is the color index for the darkest pixel. The second element is the color index for the brightest pixel. The default is [0, 255]. This

property is ignored when the polygons are drawn to a graphics destination that uses the RGB color model.

| **Property Type** | Integer array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHADING

An integer that represents the type of shading to use:

- 0 = Flat (default): The color of the first vertex in each polygon is used to define the color for the entire polygon. The color has a constant intensity based upon the normal vector.
- 1 = Gouraud: The colors along each line are interpolated between vertex colors, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

In a property sheet, this property appears as an enumerated list with the following options:

- Flat
- Gouraud

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Shading | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## SHARE_DATA

An object reference to an object with which data is to be shared by this polygon(s). Polygons may only share data with another polygons object or a polyline. The

SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## STYLE

An integer value that specifies how the polygon should be drawn:

- 0 = Points: Only vertices are drawn, using either COLOR or VERT_COLORS.
- 1 = Lines: Each polygon is outlined by connecting vertices.
- 2 = Filled (default): The polygon faces are shaded.

In a property sheet, this property appears as an enumerated list with the following options:

- Points
- Lines
- Filled

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Style | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TEXTURE_COORD

A 2 by *n* array containing the texture map coordinates, where *n* is the number of polygon vertices. Each two-element entry in this array specifies the texture coordinates for the corresponding vertex in the vertex list. One texture coordinate pair should exist for each vertex. Use this property in conjunction with the TEXTURE_MAP property to wrap images over 2-D and 3-D polygons. Default coordinates are not provided.

Texture coordinates are normalized. This means that the *m* x *n* image object specified via the TEXTURE_MAP property is mapped into the range [0.0, 0.0] to [1.0, 1.0]. If texture coordinates outside the range [0.0, 0.0] to [1.0, 1.0] are specified, the image object is tiled into the larger range.

For example, suppose the image object specified via TEXTURE_MAP is a 256 x 256 array, and we want to map the image into a square two units on each side. To completely fill the square with a single copy of the image:

```
TEXTURE_COORD = [[0,0], [1,0], [1,1], [0,1]]
```

To fill the square with four tiled copies of the image:

```
TEXTURE_COORD = [[0,0], [2,0], [2,2], [0,2]]
```

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TEXTURE_INTERP

A Boolean value that indicates whether bilinear sampling is to be used for texture mapping an image onto the polygon(s). The default is nearest neighbor sampling.

In a property sheet, this property appears as an enumerated list with the following options:

- Nearest neighbor
- Bilinear

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Texture interpolation | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TEXTURE_MAP

An object reference to an IDLgrImage object to be texture mapped onto the polygons. The tiling or mapping of the texture is defined expressly by TEXTURE_COORD. If this property is omitted, polygons are filled with the color specified by the COLOR or VERT_COLORS property. If both TEXTURE_MAP and COLORS or VERT_COLORS properties exist, the color of the texture is modulated by the base color of the object. (This means that for the clearest display of the texture image, the COLOR property should be set equal to [255,255,255].) To remove a texture map, set TEXTURE_MAP equal to a null object reference.

Setting TEXTURE_MAP to the object reference of an IDLgrImage that contains an alpha channel allows you to create a transparent IDLgrPolygon object. If an alpha

channel is present in the IDLgrImage object, IDL blends the texture using the blend function src=alpha and dst=1 – alpha, which corresponds to a BLEND_FUNCTION of (3,4) as described for the IDLgrImage object.

If the width and/or height of the provided image is not an exact power of two, then the texture map will consist of the given image pixel values resampled to the nearest larger dimensions that are exact powers of two.

**Note**

Texture mapping is disabled when rendering to a destination object that uses Indexed color mode.

**Note**

Texture mapping is applied to all styles that are set by the STYLE property.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Texture map | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## THICK

A floating-point value between 1.0 and 10.0, specifying the size of the points or the thickness of the lines to be drawn when STYLE is set to either 0 (Points) or 1 (Lines), in points. The default is 1.0 points.

**Note**

The value of this property is ignored if STYLE is set to 2 (Filled).

In a property sheet, this property appears as follows:


| **Property Type** | THICKNESS | | |
|---|---|---|---|
| **Name String** | Thickness | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VERT_COLORS

A vector of colors to be used to draw at each vertex. Color is interpolated between vertices if SHADING is set to 1 (Gouraud). If there are more vertices than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the polygons are all drawn in the single color provided by the COLOR property. To remove vertex colors, set VERT_COLORS to a scalar.

**Note**

If the polygon object is being rendered on a destination device that uses the Indexed color model, and the view that contains the polygon also contains one or more light objects, the VERT_COLORS property is ignored and the SHADE_RANGE property is used instead.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Vertex colors | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating point vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZERO_OPACITY_SKIP

A Boolean value that makes it possible to gain finer control over the rendering of textured polygon pixels (texels) with an opacity of 0 in the texture map. Texels with zero opacity do not affect the color of a screen pixel since they have no opacity.

- 1 = Any texels are “skipped” and not rendered at all (the default).
- 0 = The Z-buffer is updated for these pixels and the display image is not affected as noted above.

By updating the Z-buffer without updating the display image, the polygon can be used as a *clipping* surface for other graphics primitives drawn after the current graphics object. The default value for this property is 1.

**Note**

This property has no effect if no texture map is used or if the texture map in use does not contain an opacity channel.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Skip zero opacity | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ZRANGE

A two-element floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrPolygon::Cleanup

The IDLgrPolygon::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrPolygon::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPolygon::GetCTM

The IDLgrPolygon::GetCTM The IDLgrPolygon::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrPolygon::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the polygon object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPolygonl::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrPolygon::GetProperty

The IDLgrPolygon::GetProperty procedure method retrieves the value of the property or group of properties for the polygons.

## Syntax

*Obj* -> [IDLgrPolygon::]GetProperty[, *PROPERTY=variable*]

## Arguments

There are no arguments for this methods.

## Keywords

Any property listed under "IDLgrPolygon Properties" on page 3431 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.0

# IDLgrPolygon::Init

The IDLgrPolygon::Init function method initializes the polygons object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrPolygon' [, *X* [, *Y*[, *Z*]]] [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrPolygon::]Init([*X*, [*Y*, [*Z*]]] [, *PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### X

A vector argument providing the X coordinates of the vertices. The vector must contain at least three elements. If the Y and Z arguments are not provided, X must be an array of either two or three vectors (i.e., [2,*] or [3,*]), in which case, X[0,*] specifies the X values, X[1,*] specifies the Y values, and X[2,*] specifies the Z values.

This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is converted to single precision floating point.

### Y

A vector argument providing the Y coordinates of the vertices. The vector must contain at least three elements. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is converted to single precision floating point.

### Z

A vector argument providing the Z coordinates of the vertices. The vector must contain at least three elements. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is converted to single precision floating point.

## Keywords

Any property listed under “IDLgrPolygon Properties” on page 3431 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrPolygon::SetProperty

The IDLgrPolygon::SetProperty procedure method sets the value of the property or group of properties for the polygons.

## Syntax

*Obj* -> [IDLgrPolygon::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPolygon Properties” on page 3431 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrPolyline

A polyline object represents one or more polylines that share a set of vertices and rendering attributes.

An IDLgrPolyline object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrPolyline::Init" on page 3479.

## Properties

Objects of this class have the following properties. See "IDLgrPolyline Properties" on page 3459 for details on individual properties.

- ALL
- COLOR
- DEPTH_TEST_DISABLE
- DEPTH_WRITE_DISABLE
- HIDE
- LABEL_OFFSETS
- LABEL_POLYLINES
- LINESTYLE
- PARENT
- REGISTER_PROPERTIES
- SHADING
- SYMBOL
- USE_LABEL_COLOR
- CLIP_PLANES
- DATA
- DEPTH_TEST_FUNCTION
- DOUBLE
- LABEL_NOGAPS
- LABEL_OBJECTS
- LABEL_USE_VERTEX_COLOR
- PALETTE
- POLYLINES
- RESET_DATA
- SHARE_DATA
- THICK
- USE_LABEL_ORIENTATION

- USE_TEXT_ALIGNMENTS
- VERT_COLORS
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrPolyline::Cleanup
- IDLgrPolyline::GetCTM
- IDLgrPolyline::GetProperty
- IDLgrPolyline::Init
- IDLgrPolyline::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrPolyline Properties

IDLgrPolyline objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrPolyline::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrPolyline::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrPolyline::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL..

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## CLIP_PLANES

A 4-by-*N* floating-point array of dimensions that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A$x$ + B$y$ + C$z$ + D = 0. Portions of this object that fall in the half space A$x$ + B$y$ + C$z$ + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects..

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

An RGB or indexed color for drawing polylines. The default color is [0, 0, 0] (black). This property is ignored if the VERT_COLORS property is provided..

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DATA

A 2-by-*n* or a 3-by-*n* floating-point array which defines, respectively, the 2-D or 3-D vertex data. DATA is equivalent to the optional arguments, *X*, *Y*, and *Z*. This property is converted to double-precision floating-point values if the DOUBLE property is set. Otherwise, it is converted to single-precision floating-point..

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.

- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DOUBLE

A Boolean value that indicates whether data provided by any of the input arguments will be stored in this object as using double-precision floating-point format.

- Set this property equal to 1 to convert input data to double-precision floating-point format.
- Set this property equal to 0 to convert input data to single-precision floating-point format.

- If you do not specify a value for this property, no data type conversion will be performed, and the data will be stored with its original precision.

Setting this property may be desirable if the data consists of large integers that cannot be accurately represented in single-precision floating-point arithmetic. This property is also automatically set to 1 if any of the input arguments are stored using a variable of type DOUBLE.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDE

A Boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LABEL_NOGAPS

An integer vector of values indicating whether gaps should be computed for the corresponding label. A zero value indicates that a gap will be computed for the labels; a non-zero value indicates that no gap will be computed for the label. If the number of labels exceeds the number of elements in this vector, the LABEL_NOGAPS values

will be repeated cyclically. By default, gaps are computed for all labels (so that the polyline does not pass through the label)..

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LABEL_OFFSETS

A scalar or vector of floating-point offsets, [t0, t1, …], that indicate the parametric offsets along the length of each polyline (specified via the LABEL_POLYLINES property) at which each label (as specified via the LABEL_OBJECTS property) would be positioned. If LABEL_OFFSETS is set to a scalar less than zero, then the offsets will be automatically computed to be evenly distributed along the length of the polyline. If a scalar value greater than or equal to zero is provided, it is used for all labels. If a vector is provided, the number of offsets must match the number of labels provided via LABEL_OBJECTS. By default, this property is set to the scalar, -1, indicating that the label offsets will be automatically computed..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LABEL_OBJECTS

An object reference (or vector of object references) to specify the labels to be drawn along the polyline path(s). The objects specified via this property must inherit from one of the following classes:

- IDLgrSymbol
- IDLgrText

If a single object is provided, and it is an IDLgrText object, each of its strings will correspond to a label. If a vector of objects is used, any IDLgrText objects should have only a single string; each object will correspond to a label.

If one or more IDLgrText objects are provided, the LOCATION property of the provided text object(s) may be overwritten; position is determined according to the values provided via the LABEL_OFFSETS property. The labels will have the same color as the corresponding polyline (see the COLOR property) unless the

USE_LABEL_COLOR property is specified. The orientation of the label objects USE_LABEL_ORIENTATION property is specified. The horizontal and vertical alignment for any text labels will each default to 0.5 (i.e., centered) unless the USE_TEXT_ALIGNMENTS property is specified.

**Note**

The objects provided via this property will not be destroyed automatically when this IDLgrPolyline is destroyed..

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LABEL_POLYLINES

An integer or integer vector of polyline indices, [P0, P1, …], that indicate which polylines are to be labeled. Pi corresponds to the ith polyline specified via the POLYLINES property. This property is intended to be used in conjunction with the LABEL_OBJECTS property. If a scalar is provided, all labels will be drawn along the single indicated polyline. If a vector is provided, the number of polyline indices must match the number of labels provided via LABEL_OBJECTS.

By default, this property is set to the scalar, 0, indicating that only the first polyline will be labeled.

**Note**

If a given polyline has more than one label, then the corresponding polyline index may appear more than once in the LABEL_POLYLINES vector..

| **Property Type** | Integer or integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LABEL_USE_VERTEX_COLOR

An integer value that indicates whether labels should be colored according to the vertex coloring (if the VERT_COLORS property is set).

- A non-zero value = labels should be colored according to the vertex coloring

- Zero (the default) = the label will be drawn using the color specified via the COLOR property of the polyline object (unless the USE_LABEL_COLOR property is set)..

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LINESTYLE

An integer or array value that indicates the line style to be used to draw the polyline. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

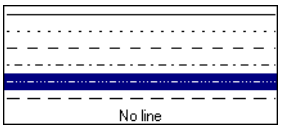
- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1's or 0's in the *bitmask* should be repeated. (That is, if three consecutive 0's appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off)..

In a property sheet, this property appears as follows:




| **Property Type** | LINESTYLE | | |
|---|---|---|---|
| **Name String** | Line style | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that defines the color palette of this object. This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp)..

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object..

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## POLYLINES

An integer array of polyline descriptions. A polyline description is an integer or long word array of the form: [*n*, $i_0$, $i_1$, ..., $i_{n-1}$], where *n* is the number of vertices that

define the polyline, and $i_0..i_{n-1}$ are indices into the *X*, *Y*, and *Z* arguments that represent the vertices of the polyline(s). To ignore an entry in the POLYLINES array, set the vertex count, *n*, and all associated indices to 0. To end the drawing list, even if additional array space is available, set *n* to -1. If this property is not specified, a single connected polyline will be generated from the *X*, *Y*, and *Z* arguments.

**Note**

The connectivity array described by POLYLINES allows an individual object to contain more than one polyline. Vertex, normal and color information can be shared by the multiple polylines. Consequently, the polyline object can represent an entire mesh and compute reasonable normal estimates in most cases..

| | | | |
|---|---|---|---|
| **Property Type** | Integer array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESET_DATA

A Boolean value that determines whether to treat the data provided via one of the DATA property as a new data set unique to this object, rather than overwriting data that is shared by other objects. There is no reason to use this property if the object on which the property is being set does not currently share data with another object (that

is, if the SHARE_DATA property is not in use). This property has no effect if no new data is provided via the DATA property. .

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHADING

An integer representing the type of shading to use:

- 0 = Flat (default): The color of the second vertex in a line segment is used to define the color for the entire line segment. The color has a constant intensity based upon the normal vector.
- 1 = Gouraud: The colors along each line are interpolated between vertex colors.

Gouraud shading may be slower than flat shading, but results in a smoother appearance..

In a property sheet, this property appears as an enumerated list with the following options:

- Flat
- Gouraud

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Shading | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## SHARE_DATA

An object reference to an object whose data is to be shared by this polyline. A polyline may only share data with a polygon object or another polyline. The

SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property..

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SYMBOL

An object reference vector containing one or more instances of the IDLgrSymbol object class to indicate the plotting symbols to be used at each vertex of the polyline. If there are more vertices than elements in SYMBOL, the elements of the SYMBOL vector are cyclically repeated. By default, no symbols are drawn. To remove symbols from a polyline, set SYMBOL to a scalar..

| **Property Type** | Object reference vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value between 1.0 and 10.0, specifying the line thickness to be used to draw the polyline, in points. The default is 1.0 points..

In a property sheet, this property appears as follows:


| **Property Type** | THICKNESS | | |
|---|---|---|---|
| **Name String** | Thickness | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## USE_LABEL_COLOR

An integer vector of values to indicate whether the COLOR property value for the corresponding label object is to be used to draw that label. If the number of labels exceeds the number of elements in this vector, the USE_LABEL_COLOR values will be repeated cyclically. By default, this value is zero, indicating that the COLOR property of each label object will be ignored, and the COLOR property for the polyline object will be used instead..

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## USE_LABEL_ORIENTATION

An integer vector of values to indicate whether the orientation of the corresponding label object is to be used to draw that label. For IDLgrText objects, this refers to the BASELINE and UPDIR property values. For IDLgrSymbol objects, this refers to the default (un-rotated) orientation of the symbol. If the number of labels exceeds the number of elements in this vector, the USE_LABEL_ORIENTATION values will be repeated cyclically. By default, USE_LABEL_ORIENTATION is zero, indicating that the orientation will be automatically computed so that the baseline is parallel to the polyline, and the updir is perpendicular to the polyline. .

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## USE_TEXT_ALIGNMENTS

A Boolean value that indicates whether, for any IDLgrText labels (as specified via the LABEL_OBJECTS property), the ALIGNMENT and VERTICAL_ALIGNMENT property values for the given IDLgrText object(s) are to be used to draw those labels. By default, this value is zero, indicating that the ALIGNMENT and VERTICAL_ALIGNMENT properties of the IDLgrText

object(s) will be overwritten with default values (0.5 for each, indicating centered labels)..

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## VERT_COLORS

A vector of colors to be used to draw at each vertex. Color is interpolated between vertices if SHADING is set to 1 (Gouraud). If there are more vertices than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the polyline is drawn in the single color provided by the COLOR property. When VERT_COLORS is used with symbols, the vertex colors override any colors specified by the symbol object or any colors specified by graphic atoms contained in a user-defined symbol. To remove vertex colors, set VERT_COLORS to a scalar.

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Vertex colors | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, [$s_0$, $s_1$], of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrPolyline::Cleanup

The IDLgrPolyline::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrPolyline::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPolyline::GetCTM

The IDLgrPolyline::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrPolyline::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the polyline object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPolyline::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrPolyline::GetProperty

The IDLgrPolyline::GetProperty procedure method retrieves the value of a property or group of properties for the polylines.

## Syntax

*Obj* -> [IDLgrPolyline::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPolyline Properties” on page 3459 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrPolyline::Init

The IDLgrPolyline::Init function method initializes the polylines object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrPolyline' [, *X* [, *Y*[, *Z*]]] [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrPolyline::]Init([*X*, [*Y*, [*Z*]]] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### X

A vector providing the X components of the points to be connected. If the Y and Z arguments are not provided, X must be an array of either two or three vectors (i.e., [2,*] or [3,*]), in which case, X[0,*] specifies the X values, X[1,*] specifies the Y values, and X[2,*] specifies the Z values. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

### Y

A vector providing the Y coordinates of the points to be connected. This argument is stored as double precision floating point values if the argument variable is of type

DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

### Z

A vector providing the Z coordinates of the points to be connected. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

## Keywords

Any property listed under “IDLgrPolyline Properties” on page 3459 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES, LABEL_NOGAPS, LABEL_POLYLINES, LABEL_OFFSETS, LABEL_OBJECTS, LABEL_USE_VERTEX_COLOR, USE_LABEL_COLOR, USE_LABEL_ORIENTATION, USE_TEXT_ALIGNMENTS keywords: 5.6

# IDLgrPolyline::SetProperty

The IDLgrPolylines::SetProperty procedure method sets the value of a property or group of properties for the polylines.

## Syntax

*Obj* -> [IDLgrPolyline::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPolyline Properties” on page 3459 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrPrinter

A printer object represents a hardcopy graphics destination. When a printer object is created, the printer device to which it refers is the default system printer. To change the printer, utilize the printer dialogs (see “DIALOG_PRINTJOB” on page 508 and “DIALOG_PRINTERSETUP” on page 506.)

**Note**

Objects or subclasses of this type can not be saved or restored.

## Superclasses

This class has no superclass.

## Creation

See “IDLgrPrinter::Init” on page 3500.

## Properties

Objects of this class have the following properties. See “IDLgrPrinter Properties” on page 3484 for details on individual properties.

- ALL
- COLOR_MODEL
- DIMENSIONS
- GAMMA
- GRAPHICS_TREE
- LANDSCAPE
- N_COLORS
- N_COPIES
- PALETTE
- PRINT_QUALITY
- QUALITY
- REGISTER_PROPERTIES

- RESOLUTION
- UNITS

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrPrinter::Cleanup
- IDLgrPrinter::Draw
- IDLgrPrinter::GetContiguousPixels
- IDLgrPrinter::GetFontnames
- IDLgrPrinter::GetProperty
- IDLgrPrinter::GetTextDimensions
- IDLgrPrinter::Init
- IDLgrPrinter::NewDocument
- IDLgrPrinter::NewPage
- IDLgrPrinter::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrPrinter Properties

IDLgrPrinter objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrPrinter::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrPrinter::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrPrinter::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR_MODEL

An integer value that determines the color model to be used for the buffer:

- 0 = RGB (default)
- 1 = Color Index

In a property sheet, this property appears as an enumerated list with the following options:

- RGB

- Indexed

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Color model | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## DIMENSIONS

A two-element integer vector of the form [*width*, *height*] specifying the overall 'drawable' area that may be printed on a page. By default, the dimensions are measured in device units (refer to the UNITS property).

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## GAMMA

An object reference to an IDLgrPalette object whose entries will be used as the gamma correction table for color printing. Gamma correction only applies if COLOR_MODEL=1 (Indexed).

When the color palette (specified via the PALETTE property) is loaded for the printer, if a gamma correction table is provided, then each of the [R,G,B] entries in the color palette will be translated through the gamma correction table. For example, at color index *i*:

```
correctedRed[i] = gammaRed[paletteRed[i]]
correctedGreen[i] = gammaGreen[paletteGreen[i]]
correctedBlue[i] = gammaBlue[paletteBlue[i]]
```

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GRAPHICS_TREE

An object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView that specifies the graphics tree of this object. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will

cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## LANDSCAPE

A Boolean value that indicates whether to produce hardcopy output in landscape mode. The default value of zero indicates Portrait mode.

**Note**

The printer driver may not support the LANDSCAPE option; in general, it is best to use the printer dialogs to set orientation.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## N_COLORS

An integer value that indicates the number of colors (between 2 and 256) to be used if the COLOR_MODEL is set to Indexed (1). This property is ignored if the COLOR_MODEL is set to RGB (0).

| | | | |
|---|---|---|---|
| **Property Type** | INTEGER | | |
| **Name String** | Number of colors | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## N_COPIES

An integer that determines the number of copies of print data to be generated. The default is 1 copy.

**Note**

Your specific printer driver may not support the N_COPIES option. You can also use the printer dialogs to set the number of copies.

| | | | |
|---|---|---|---|
| **Property Type** | Integer | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the graphics destination's color lookup table if the Indexed color model is used.

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PRINT_QUALITY

An integer value indicating the print quality at which graphics are to be drawn to the printer. Note that the print quality is independent of the rendering quality (as set by the QUALITY property). Valid values are:

- 0 = Low
- 1 = Normal (this is the default)
- 2 = High

Generally, setting the print quality to a lower value will increase the speed of the printing job, but decrease the resolution; setting it to a higher value will cause the printing job to take more time, but will increase the resolution.

**Note**

Some printer drivers may not be able to support different printing qualities. In these cases, the setting of the PRINT_QUALITY property will be quietly ignored.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## QUALITY

An integer value that indicates the rendering quality at which graphics are to be drawn to this destination. Note that the rendering quality is independent of the print quality (as set by the PRINT_QUALITY property). Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default)

In a property sheet, this property appears as an enumerated list with the following options:

- Low
- Medium
- High

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Draw quality | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the

object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESOLUTION

A floating-point vector of the form [*xres*, *yres*] defining the pixel resolution, measured in centimeters per pixel. This value is stored in double precision.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Resolution | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** Yes |

## UNITS

An integer value that indicates the units of measure for the DIMENSIONS property. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the drawable area on a page.

**Note**

If you change the value of the UNITS property (using the SetProperty method), IDL will convert the current value of the DIMENSIONS property to the new units.

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLgrPrinter::Cleanup

The IDLgrPrinter::Cleanup procedure method performs all cleanup on the object. If a document is open (that is, if graphics have been draw to the printer), the document is closed and the pending graphics are sent to the current printer.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrPrinter::]Cleanup (*Only in subclass' Cleanup method.*)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPrinter::Draw

The IDLgrPrinter::Draw procedure method draws the given picture to this graphics destination.

**Note**

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

## Syntax

*Obj* -> [IDLgrPrinter::]Draw [, *Picture*] [, VECTOR={ 0 | 1 } ]

## Arguments

### Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object), or scene (an instance of an IDLgrScene object) to be drawn.

## Keywords

### VECTOR

Set this keyword to indicate the type of graphics primitives generated. Valid values include:

- 0 = Bitmap (default)
- 1 = Vector

If VECTOR = 0 (Bitmap), the Draw method renders the scene to a buffer and then copies the buffer to the printer in bitmap format. The bitmap retains the quality of the original image.

If VECTOR = 1 (Vector), the Draw method renders the scene using simple vector operations that result in a representation of the Scene that is scalable to the printer. The vector representation does not retain all the attributes of the original image. The vector representation is sent to the printer.

# Examples

This example demonstrates the process of printing the contents of an IDL graphics display object (a buffer or a window) to an IDLgrPrinter object. The resolution of the printed page is based on the resolution of the screen. The model object in the printer object must be scaled to maintain the same size as displayed on the screen. The location of the view must also be changed to center the display on the page.

```
PRO PrintingAnImage

; Determine the path to the "convec.dat" file.
convecFile = FILEPATH('convec.dat', $
   SUBDIRECTORY = ['examples', 'data'])

; Initialize the parameters of the image with the file.
convecSize = [248, 248]
convecImage = BYTARR(convecSize[0], convecSize[1])

; Open the file, read in the image, and then close the
; file.
OPENR, unit, convecFile, /GET_LUN
READU, unit, convecImage
FREE_LUN, unit

; Initialize the display objects.
windowSize = convecSize
oWindow = OBJ_NEW('IDLgrWindow', RETAIN = 2, $
   DIMENSIONS = windowSize, $
   TITLE = 'Earth Mantle Convection')
oView = OBJ_NEW('IDLgrView', $
   VIEWPLANE_RECT = [0., 0., windowSize])
oModel = OBJ_NEW('IDLgrModel')

; Initialize the image object with its palette.
oPalette = OBJ_NEW('IDLgrPalette')
oPalette -> LOADCT, 27
oImage = OBJ_NEW('IDLgrImage', convecImage, $
   PALETTE = oPalette)

; Add image to model, which is added to the view, and
; then the view is displayed in the window.
oModel -> Add, oImage
oView -> Add, oModel
oWindow -> Draw, oView

; Determine the centimeter measurements of the image
; on the screen.
oWindow -> GetProperty, RESOLUTION = screenResolution
```

```
windowSizeCM = windowSize*screenResolution

; Initialize printer destination object.
oPrinter = OBJ_NEW('IDLgrPrinter', PRINT_QUALITY = 2, $
   QUALITY = 2)

; Obtain page parameters to determine the page
; size in centimeters.
oPrinter -> GetProperty, DIMENSIONS = pageSize, $
   RESOLUTION = pageResolution
pageSizeCM = pageSize*pageResolution

; Calculate a ratio between screen size and page size.
pageScale = windowSizeCM/pageSizeCM

; Use ratio to scale the model within the printer to the
; same size as the model on the screen.
oModel -> Scale, pageScale[0], pageScale[1], 1.

; Determine the center of the page and the image in
; pixels.
centering = ((pageSizeCM - windowSizeCM)/2.) $
   /pageResolution

; Move the view to center the image.
oView -> SetProperty, LOCATION = centering

; Display the view within the printer destination.
oPrinter -> Draw, oView
oPrinter -> NewDocument

; Cleanup object references.
OBJ_DESTROY, [oPrinter, oView, oPalette]

END
```

## Version History

Introduced: 5.0

# IDLgrPrinter::GetContiguousPixels

The IDLgrPrinter::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
[4,3,2,1,0]
```

## Syntax

*Result* = *Obj* -> [IDLgrPrinter::]GetContiguousPixels()

## Return Value

Returns an array of long integers whose length is equal to the number of colors available in the index color mode.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPrinter::GetFontnames

The IDLgrPrinter::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

## Syntax

*Result* = *Obj* -> [IDLgrPrinter::]GetFontnames( *FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*] )

## Return Value

Returns the list of available fonts that can be used in IDLgrFont objects.

## Arguments

### FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

## Keywords

### IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

### STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is

the string, “*”, which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

## Version History

Introduced: 5.0

# IDLgrPrinter::GetProperty

The IDLgrPrinter::GetProperty procedure method retrieves the value of a property or group of properties for the printer.

## Syntax

*Obj* -> [IDLgrPrinter::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrPrinter Properties" on page 3484 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.0

# IDLgrPrinter::GetTextDimensions

The IDLgrPrinter::GetTextDimensions function method retrieves the dimensions of a text or axis object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units. If the object specified is an axis object, the result encompasses the tick labels and the title of the axis (if any).

## Syntax

*Result* = *Obj* ->[IDLgrPrinter::]GetTextDimensions( *TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*] )

## Return Value

Returns a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units.

## Arguments

### TextObj

The object reference to a text or axis object for which the text dimensions are requested.

## Keywords

### DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If

this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrPrinter::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.0

# IDLgrPrinter::Init

The IDLgrPrinter::Init function method initializes the printer object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrPrinter' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrPrinter::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrPrinter Properties" on page 3484 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrPrinter::NewDocument

The IDLgrPrinter::NewDocument procedure method closes the current document (a page or group of pages), which causes any pending output to be sent to the printer, finishing the printer job.

## Syntax

*Obj* -> [IDLgrPrinter::]NewDocument

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPrinter::NewPage

The IDLgrPrinter::NewPage procedure method issues a new page command to the printer.

## Syntax

*Obj* -> [IDLgrPrinter::]NewPage

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrPrinter::SetProperty

The IDLgrPrinter::SetProperty procedure method sets the value of a property or group of properties for the printer.

## Syntax

*Obj* -> [IDLgrPrinter::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrPrinter Properties” on page 3484 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrROI

The IDLgrROI object class is an object graphics representation of a region of interest.

## Superclasses

IDLanROI

IDLitComponent

## Creation

See “IDLgrROI::Init” on page 3518.

## Properties

Objects of this class have the following properties. See “IDLgrROI Properties” on page 3507 for details on individual properties.

- ALL
- CLIP_PLANES
- COLOR
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- DOUBLE
- HIDE
- LINESTYLE
- PALETTE
- REGISTER_PROPERTIES
- STYLE
- SYMBOL
- THICK
- XCOORD_CONV
- XRANGE

- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

The IDLgrROI object class has the following methods:

- IDLgrROI::Cleanup
- IDLgrROI::GetProperty
- IDLgrROI::Init
- IDLgrROI::PickVertex
- IDLgrROI::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.3

# IDLgrROI Properties

IDLgrROI objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrROI::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrROI::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrROI::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure with the values of all of the properties associated with the state of this object. State information about the object may include things like color, line style, etc., but not vertex data or user values.

**Note**

The fields in this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## CLIP_PLANES

A 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

A vector that indicates an RGB or indexed color for drawing the region. The default color is [0, 0, 0].

In a property sheet, this property appears as a color property.

| | | | |
|---|---|---|---|
| **Property Type** | COLOR | | |
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DOUBLE

A Boolean value that indicates whether data provided by any of the input arguments will be stored in this object as using double-precision floating-point format.

- Set this property equal to 1 to convert input data to double-precision floating-point format.
- Set this property equal to 0 to convert input data to single-precision floating-point format.
- If you do not specify a value for this property, no data type conversion will be performed, and the data will be stored with its original precision.

Setting this property may be desirable if the data consists of large integers that cannot be accurately represented in single-precision floating-point arithmetic. This property

is also automatically set to 1 if any of the input arguments are stored using a variable of type DOUBLE.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDE

A Boolean value indicating whether this region should be drawn:

- 0 = draw the region (the default)
- 1 = do not draw the region

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LINESTYLE

An integer that indicates the line style to be used to draw the region. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern. The valid values for the pre-defined line styles are:

- 0 = solid (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash

- 6 = no line drawn

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that defines the color palette of this object. This property is only used for Object Graphics destinations using the RGB color model. In this case, if the color value for the region is specified as a color index value, this palette is used to look up the color for the region. If the PALETTE property is not set, the destination object PALETTE property is used, which defaults to a gray scale ramp.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## STYLE

An integer value that indicates the geometrical primitive to use to represent the region when displayed. Valid values include:

- 0 = points
- 1 = open polyline

- 2 = closed polyline (the default)

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SYMBOL

An object reference to an IDLgrSymbol object for the symbol used for display when STYLE = 0 (points). By default, a dot is used.

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value between 1.0 and 10.0, specifying the size of the points, or the thickness of the lines, measured in points. The default is 1.0 points.

In a property sheet, this property appears as follows:


| **Property Type** | THICKNESS | | |
|---|---|---|---|
| **Name String** | Thickness | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A vector, $[s_0, s_1]$, of scaling factors used to convert *X* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max} - X_{min}),\ 1.0/(X_{max} - X_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Double-precision floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert *Y* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max} - Y_{min}),\ 1.0/(Y_{max} - Y_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert *Z* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max} - Z_{min}),\ 1.0/(Z_{max} - Z_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrROI::Cleanup

The IDLgrROI::Cleanup procedure method performs all cleanup for a region of interest object.

**Note**

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrROI::]Cleanup (In a subclass' Cleanup method only.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.3

# IDLgrROI::GetProperty

The IDLgrROI::GetProperty procedure method retrieves the value of a property or group of properties for the Object Graphics region.

## Syntax

*Obj* -> [IDLgrROI::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrROI Properties" on page 3507 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.3

# IDLgrROI::Init

The IDLgrROI::Init function method initializes an Object Graphics region of interest.

**Note**

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW( 'IDLgrROI' [, *X*[, *Y*[, *Z*]]] [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrROI::]Init([*X*[, *Y*[, *Z*]]] [, *PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### X

A vector providing the X components of the vertices for the region. If the Y and Z arguments are not specified, X must be a two-dimensional array with the leading dimension either 2 or 3 ([2, *] or [3, *]), in which case, X[0, *] represents the X values, X[1, *] represents the Y values, and X[2, *] represents the Z values. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is converted and stored as single precision floating point.

### Y

A vector providing the Y components of the vertices. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is converted and stored as single precision floating point.

### Z

A scalar or vector providing the Z components of the vertices. If not provided, Z values default to 0.0. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero. Otherwise it is converted and stored as single precision floating point.

## Keywords

Any property listed under “IDLgrROI Properties” on page 3507 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.3

CLIP_PLANES keyword: 5.6

# IDLgrROI::PickVertex

The IDLgrROI::PickVertex function method picks a vertex of the region which, when projected onto the given destination device, is nearest to the given 2-D device coordinate.

## Syntax

*Result* = *Obj* -> [IDLgrROI::]PickVertex( *Dest*, *View*, *Point* [, PATH=*objref*] )

## Return Value

Returns the index of the nearest region vertex. If two or more vertices are equally nearest to the point, the smallest index of those vertices is returned.

## Arguments

### Dest

An object reference to an IDLgrWindow or IDLgrBuffer for which the pick is to occur.

### View

An object reference to the IDLgrView containing this region.

### Point

A two-element vector, [*x*, *y*], representing the device location used for picking a nearest vertex.

## Keywords

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a location in the data space of the region. Each path object reference specified with this keyword must contain an alias. The selected vertex is computed for the version of the object falling within the specified path. If this keyword is not set, the parent properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

## Version History

Introduced: 5.3

# IDLgrROI::SetProperty

The IDLgrROI::SetProperty procedure method sets the value of a property or group of properties for the Object Graphics region.

## Syntax

*Obj* -> [IDLgrROI::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrROI Properties” on page 3507 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.3

# IDLgrROIGroup

The IDLgrROIGroup object class is an Object Graphics representation of a group of regions of interest.

## Superclasses

IDLanROIGroup.

IDLitComponent

## Creation

See “IDLgrROIGroup::Init” on page 3535.

## Properties

Objects of this class have the following properties. See “IDLgrROIGroup Properties” on page 3525 for details on individual properties.

- ALL
- CLIP_PLANES
- COLOR
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- HIDE
- PARENT
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

The IDLgrROIGroup class has the following methods:

- IDLgrROIGroup::Add
- IDLgrROIGroup::Cleanup
- IDLgrROIGroup::GetProperty
- IDLgrROIGroup::Init
- IDLgrROIGroup::PickRegion
- IDLgrROIGroup::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.3

# IDLgrROIGroup Properties

IDLgrROIGroup objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrROIGroup::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrROIGroup::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrROIGroup::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure with the values of all of the properties associated with the state of this object.

**Note**

The fields in this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## CLIP_PLANES

A 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any x, y, or z coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects..

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

An RGB or indexed color for drawing the region group. The default color is [0,0,0]..

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value indicating whether this region group should be drawn:

- 0 = draw the region group (the default)
- 1 = do not draw the region group.

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object..

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert $X$ coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max} - X_{min}),\ 1.0/(X_{max} - X_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point..

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert $Y$ coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max} - Y_{min}),\ 1.0/(Y_{max} - Y_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert *Z* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max} - Z_{min}),\ 1.0/(Z_{max} - Z_{min})\ ]$$

IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrROIGroup::Add

The IDLgrROIGroup::Add procedure method adds a region to the region group. Only objects of the IDLgrROI class may be added to the group. The regions in the group must all be of the same type: all points, all paths, or all polygons.

## Syntax

*Obj* -> [IDLgrROIGroup::]Add, *ROI*

## Arguments

### ROI

A reference to an instance of the IDLgrROI object class representing the region of interest to add to the group.

## Keywords

Accepts all keywords accepted by the IDLanROIGroup::Add method.

## Version History

Introduced: 5.3

# IDLgrROIGroup::Cleanup

The IDLgrROIGroup::Cleanup procedure method performs all cleanup for an Object Graphics region of interest group object.

**Note**

Cleanup methods are special life cycle methods, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrROIGroup::]Cleanup (In a subclass' Cleanup method only.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.3

# IDLgrROIGroup::GetProperty

The IDLgrROIGroup::Get Property procedure method retrieves the value of a property or group of properties for the region group.

## Syntax

*Obj* -> [IDLgrROIGroup::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrROIGroup Properties” on page 3525 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.3

# IDLgrROIGroup::Init

The IDLgrROIGroup::Init function method initializes an Object Graphics region of interest group object.

**Note**

Init methods are special life cycle methods, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrROIGroup' [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLgrROIGroup::]Init([*PROPERTY=value*])
(*Only in a subclass' Init method*.)

**Note**

Keywords can be used in either form. They are omitted in the second form for brevity.

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrROIGroup Properties" on page 3525 that contains the word "Yes" in the "Init" column of the properties table can be initialized during

object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.3

CLIP_PLANES keyword: 5.6

# IDLgrROIGroup::PickRegion

The IDLgrROIGroup::PickRegion function method picks a region within the group which, when projected onto the given destination device, is nearest to the given 2-D device coordinate.

## Syntax

*Result* = *Obj* -> [IDLgrROIGroup::]PickRegion( *Dest*, *View*, *Point* [, PATH=*objref*] )

## Return Value

Returns the object reference of the nearest region. If two or more regions are equally nearest to the point, the one that was added to the region group first is returned.

## Arguments

### Dest

An object reference to an IDLgrWindow or IDLgrBuffer for which the pick is to occur.

### View

An object reference to the IDLgrView containing this region.

### Point

A two-element vector, [*x*, *y*], representing the device location to use for picking a nearest region.

## Keywords

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a location in the data space of the region. Each path object reference specified with this keyword must contain an alias. The selected region is computed for the version of the object falling within the specified path. If this keyword is not set, the parent properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

## Version History

Introduced: 5.3

# IDLgrROIGroup::SetProperty

The IDLgrROIGroup::Set Property procedure method sets the value of a property or group of properties for the region group.

## Syntax

*Obj* -> [IDLgrROIGroup::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrROIGroup Properties” on page 3525 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.3

# IDLgrScene

A scene object represents the entire scene to be drawn and serves as a container of IDLgrView or IDLgrViewgroup objects.

## Superclasses

TrackBall.

IDLitComponent

## Creation

See “IDLgrScene::Init” on page 3550.

## Properties

Objects of this class have the following properties. See “IDLgrScene Properties” on page 3542 for details on individual properties.

- ALL
- COLOR
- HIDE
- REGISTER_PROPERTIES
- TRANSPARENT

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrScene::Add
- IDLgrScene::Cleanup
- IDLgrScene::GetByName
- IDLgrScene::GetProperty
- IDLgrScene::Init
- IDLgrScene::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrScene Properties

IDLgrScene objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrScene::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrScene::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrScene::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR

The color to which the scene should be erased before drawing. The color may be specified as a color lookup table index or an RGB vector.

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Background color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

For IDLgrScene, the available properties (and their iTool data types) are:

- HIDE (Boolean)

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## TRANSPARENT

A Boolean value that determines whether to disable window clearing. If this property is not set, the destination object in use by the scene is automatically erased when the scene is initialized.

| | | | |
|---|---|---|---|
| **Property Type** | BOOLEAN | | |
| **Name String** | Transparent | | |
| **Get:** Yes | **Set:** Yes | **Init:** No | **Registered:** Yes |

# IDLgrScene::Add

The IDLgrScene::Add function method verifies that the added item is an instance of an IDLgrView or IDLgrViewgroup object. If it is, IDLgrScene:Add adds the view or viewgroup to the specified scene.

## Syntax

*Obj* -> [IDLgrScene::]Add, *View* [, POSITION=*index*]

## Arguments

### View

An instance of the IDLgrView or IDLgrViewgroup object class.

## Keywords

### POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

## Version History

Introduced: 5.0

# IDLgrScene::Cleanup

The IDLgrScene::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrScene::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrScene::GetByName

The IDLgrScene::GetByName function method finds contained objects by name and returns the object reference to the named object. If the named object is not found, the GetByName function returns a null object reference.

**Note**

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

## Syntax

*Result* = *Obj* -> [IDLgrScene::]GetByName(*Name*)

## Return Value

Returns the object reference to the named object. If the named object is not found, returns a null object reference.

## Arguments

### Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX filesystem. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrScene::GetProperty

The IDLgrScene::GetProperty procedure method retrieves the value of a property or group of properties for the contour.

## Syntax

*Obj* -> [IDLgrScene::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrScene Properties” on page 3542 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrScene::Init

The IDLgrScene::Init function method initializes the scene object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrScene' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrScene::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrScene Properties" on page 3542 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrScene::SetProperty

The IDLgrScene::SetProperty procedure method sets the value of a property or group of properties for the buffer.

## Syntax

*Obj* -> [IDLgrScene::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrScene Properties” on page 3542 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrSurface

A surface object represents a shaded or vector representation of a mesh grid.

An IDLgrSurface object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrSurface::Init" on page 3579.

## Properties

Objects of this class have the following properties. See "IDLgrSurface Properties" on page 3555 for details on individual properties.

- ALL
- BOTTOM
- CLIP_PLANES
- COLOR
- DATA
- DATAX
- DATAY
- DATAZ
- DEPTH_OFFSET
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- DOUBLE
- EXTENDED_LEGO
- HIDDEN_LINES
- HIDE
- LINESTYLE
- MAX_VALUE
- MIN_VALUE
- PALETTE
- PARENT
- REGISTER_PROPERTIES
- RESET_DATA
- SHADE_RANGE
- SHADING
- SHARE_DATA
- SHOW_SKIRT
- SKIRT

- STYLE
- TEXTURE_COORD
- TEXTURE_HIGHRES
- TEXTURE_INTERP
- TEXTURE_MAP
- THICK
- USE_TRIANGLES
- VERT_COLORS
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZERO_OPACITY_SKIP
- ZRANGE
-

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrSurface::Cleanup
- IDLgrSurface::GetCTM
- IDLgrSurface::GetProperty
- IDLgrSurface::Init
- IDLgrSurface::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrSurface Properties

IDLgrSurface objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrSurface::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrSurface::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrSurface::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## BOTTOM

An RGB color for drawing the bottom of the surface. Set this property to a scalar to draw the bottom with the same color as the top. Setting a bottom color is only supported when the destination device uses RGB color mode..

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Bottom color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CLIP_PLANES

A 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects..

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

The color to be used as the foreground color for this model. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0]..

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Bottom color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DATA

An array of any type that specifies the surface data..

| **Property Type** | Array of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** | **Init:** | **Registered:** No |

## DATAX

A floating-point vector or a two-dimensional array specifying the X coordinates of the surface grid. This property is the same as the X argument described above. This property is stored as double precision floating point values if the property is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point..

| **Property Type** | Floating-point vector or array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATAY

A floating-point vector or a two-dimensional array specifying the Y coordinates of the surface grid. This property is the same as the Y argument described above. This property is stored as double precision floating point values if the property is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point..

| **Property Type** | Floating-point vector or array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATAZ

A two-dimensional floating-point array to display as a surface. This property is the same as the Z argument described above. This property is stored as double precision

floating point values if the property is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point..

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point array | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_OFFSET

An integer value that specifies an offset in depth to be used when rendering filled primitives. This offset is applied along the viewing axis, with positive values moving the primitive away from the viewer.

The units are “Z-Buffer units,” where a value of 1 is used to specify a distance that corresponds to a single step in the device’s Z-Buffer.

Use DEPTH_OFFSET to always cause a filled primitive to be rendered slightly deeper than other primitives, independent of model transforms. This is useful for avoiding stitching artifacts caused by rendering lines or polygons on top of other polygons at the same depth.

**Note**

RSI suggests using this feature to remove stitching artifacts and not as a means for “layering” complex scenes with multiple DEPTH_OFFSET values. It is safest to use only a DEPTH_OFFSET value of 0, the default, and one other non-zero value, such as 1. Many system-level graphics drivers are not consistent in their handling of DEPTH_OFFSET values, particularly when multiple non-zero values are used. This can lead to portability problems because a set of DEPTH_OFFSET values may produce better results on one machine than on another. Using IDL’s software renderer will help improve the cross-platform consistency of scenes that use DEPTH_OFFSET.

**Note**

DEPTH_OFFEST has no effect unless the value of the STYLE property is 2 or 6 (Filled or LegoFilled)..

| | | | |
|---|---|---|---|
| **Property Type** | INTEGER | | |
| **Name String** | Depth offset | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.

- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DOUBLE

A Boolean value that indicates whether data provided by any of the input arguments will be stored in this object as using double-precision floating-point format.

- Set this property equal to 1 to convert input data to double-precision floating-point format.
- Set this property equal to 0 to convert input data to single-precision floating-point format.
- If you do not specify a value for this property, no data type conversion will be performed, and the data will be stored with its original precision.

Setting this property may be desirable if the data consists of large integers that cannot be accurately represented in single-precision floating-point arithmetic. This property is also automatically set to 1 if any of the input arguments are stored using a variable of type DOUBLE..

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## EXTENDED_LEGO

A Boolean value that determines whether to force the IDLgrSurface object to display the last row and column of data when lego display styles are selected..

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Show last lego row/column | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDDEN_LINES

A Boolean value that determines whether to draw point and wireframe surfaces using hidden line (point) removal. By default, hidden line removal is disabled..

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Remove hidden lines | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LINESTYLE

An integer value that indicates the line style to use to draw the surface lines. The value can be either an integer value specifying a pre-defined line style, or a two-element vector specifying a stippling pattern.

To use a pre-defined line style, set the LINESTYLE property equal to one of the following integer values:

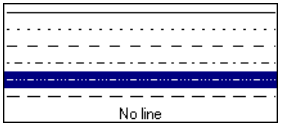
- 0 = Solid line (the default)
- 1 = dotted
- 2 = dashed
- 3 = dash dot
- 4 = dash dot dot dot
- 5 = long dash
- 6 = no line drawn

To define your own stippling pattern, specify a two-element vector [*repeat*, *bitmask*], where *repeat* indicates the number of times consecutive runs of 1’s or 0’s in the *bitmask* should be repeated. (That is, if three consecutive 0’s appear in the *bitmask* and the value of *repeat* is 2, then the line that is drawn will have six consecutive bits turned off.) The value of *repeat* must be in the range $1 \leq repeat \leq 255$.

The *bitmask* indicates which pixels are drawn and which are not along the length of the line. *Bitmask* is most conveniently specified as a 16-bit hexadecimal value.

For example, `LINESTYLE = [2, 'F0F0'X]` describes a dashed line (8 bits on, 8 bits off, 8 bits on, 8 bits off)..

In a property sheet, this property appears as follows:




| **Property Type** | LINESTYLE | | |
|---|---|---|---|
| **Name String** | Line style | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MAX_VALUE

A double-precision floating-point value that determines the maximum value to be plotted. If this property is present, data values greater than the value of MAX_VALUE are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Maximum value | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## MIN_VALUE

A double-precision floating-point value that determines the minimum value to be plotted. If this property is present, data values less than the value of MIN_VALUE are treated as missing data and are not plotted. Note that the IEEE floating-point value NaN is also treated as missing data. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Minimum value | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that defines the color palette of this object. This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp)..

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object..

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESET_DATA

A Boolean value that determines whether to treat the data provided via one of the DATA[XYZ] properties as a new data set unique to this object, rather than

overwriting data that is shared by other objects. There is no reason to use this property if the object on which the property is being set does not currently share data with another object (that is, if the SHARE_DATA property is not in use). This property has no effect if no new data is provided via a DATA property. .

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHADE_RANGE

A two-element integer array that specifies the range of pixel values (color indices) to use for shading. The first element is the color index for the darkest pixel. The second element is the color element for the brightest pixel. This value is ignored when the polygons are drawn to a graphics destination that uses the RGB color model..

| **Property Type** | Integer array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHADING

An integer representing the type of shading to use if STYLE is set to 2 (Filled).

- 0 = Flat (default): The color has a constant intensity for each face of the surface, based on the normal vector.
- 1 = Gouraud: The colors are interpolated between vertices, and then along scanlines from each of the edge intensities.

Gouraud shading may be slower than flat shading, but results in a smoother appearance.

In a property sheet, this property appears as an enumerated list with the following options:

- Flat

- Gouraud

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Fill shading | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## SHARE_DATA

An object reference to an object whose data is to be shared by this surface. A surface may only share data with another surface. The SHARE_DATA property is intended for use when data values are not set via an argument to the object's Init method or by setting the object's DATA property..

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SHOW_SKIRT

A Boolean value that determines whether to enable skirt drawing. The default is to disable skirt drawing. .

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Show skirt | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## SKIRT

A floating-point value that determines the *Z* value at which a skirt is to be defined around the array. The *Z* value is expressed in data units; the default is 0.0. If a skirt is defined, each point on the four edges of the surface is connected to a point on the skirt which has the given *Z* value, and the same *X* and *Y* values as the edge point. In addition, each point on the skirt is connected to its neighbor. The skirt value is

ignored if skirt drawing is disabled (see SHOW_SKIRT above). IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Skirt bottom height | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## STYLE

An integer value that indicates the style to be used to draw the surface. Valid values are:

- 0 = Points
- 1 = Wire mesh (the default)
- 2 = Filled
- 3 = RuledXZ
- 4 = RuledYZ
- 5 = Lego
- 6 = LegoFilled: for outline or shaded and stacked histogram-style plots..

In a property sheet, this property appears as an enumerated list with the following options:

- Points
- Wire mesh
- Filled
- Ruled XZ
- Ruled YZ
- Lego
- Lego filled

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Surface style | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TEXTURE_COORD

A 2-by-*n* floating-point array of surface coordinate-texture map coordinate pairs [*s*, *t*] at each vertex., containing the fill pattern array subscripts of each of the *n* polygon vertices. Use this property in conjunction with the TEXTURE_MAP property to warp images over the surface. To stretch (or shrink) the texture map to cover the surface mesh completely, set TEXTURE_COORD to a scalar. By default, IDL stretches (or shrinks) the texture map to cover the surface mesh completely, and sets TEXTURE_COORD to a scalar (-1).

Texture coordinates are normalized. This means that the *m* x *n* image object specified via the TEXTURE_MAP property is mapped into the range [0.0, 0.0] to [1.0, 1.0]. If texture coordinates outside the range [0.0, 0.0] to [1.0, 1.0] are specified, the image object is tiled into the larger range.

For example, suppose the image object specified via TEXTURE_MAP is a 256 x 256 array, and we want to map the image into a square two units on each side. To completely fill the square with a single copy of the image:

```
TEXTURE_COORD = [[0,0], [1,0], [1,1], [0,1]]
```

To fill the square with four tiled copies of the image:

```
TEXTURE_COORD = [[0,0], [2,0], [2,2], [0,2]]
```

Because of the way in which high-resolution textures require modified texture coordinates, if the TEXTURE_COORD property is used, TEXTURE_HIGHRES will be disabled..

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TEXTURE_HIGHRES

A Boolean value that determines whether texture tiling will be used when necessary to maintain the full pixel resolution of the original texture image. This is recommended if IDL is running on modern 3-D hardware and resolution loss due to downscaling becomes problematic. If not set, and the texture map is larger than the maximum resolution supported by the 3-D hardware, the texture is scaled down to the maximum resolution supported by the 3-D hardware on your system. The default value is 0.

**Note**

Because of the way in which high-resolution textures require modified texture coordinates, if you specify the TEXTURE_COORD property, high resolution textures (TEXTURE_HIGHRES) will be disabled..

In a property sheet, this property appears as an enumerated list with the following options:

- No tiling
- LOD tiling
- Tiling

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Texture hires | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TEXTURE_INTERP

A Boolean value that indicates whether bilinear sampling is to be used with texture mapping. The default method is nearest-neighbor sampling..

In a property sheet, this property appears as an enumerated list with the following options:

- Nearest neighbor
- Bilinear

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Texture interpolation | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## TEXTURE_MAP

An object reference to an instance of the IDLgrImage object class to be texture mapped onto the surface. If this property is omitted or set to a null object reference, no texture map is applied and the surface is filled with the color specified by the COLOR or VERT_COLORS property. If both TEXTURE_MAP and COLORS or VERT_COLORS properties exist, the color of the texture is modulated by the base color of the object. (This means that for the clearest display of the texture image, the

COLOR property should be set equal to [255,255,255].) By default, the texture map will be stretched (or shrunk) to cover the surface mesh completely.

Setting TEXTURE_MAP to the object reference of an IDLgrImage that contains an alpha channel allows you to create a transparent IDLgrSurface object. If an alpha channel is present in the IDLgrImage object, IDL blends the texture using the blend function src = alpha and dst = 1 - alpha, which corresponds to a BLEND_FUNCTION of (3,4) as described for the IDLgrImage object.

If a texture is provided without texture coordinates, IDLgrSurface generates its own texture mapping coordinates to map the texture onto the surface without resampling artifacts, even if the provided texture image does not have dimensions that are an exact power of two. If texture coordinates are provided, the image is resampled to the nearest larger dimensions that are exact powers of two.

**Note**

Texture mapping is disabled when rendering to a destination object that uses Indexed color mode.

**Note**

Texture mapping is applied to all styles that are set by the STYLE property except Lego and LegoFilled..

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Texture map | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## THICK

A floating-point value between 1.0 and 10.0, specifying the line thickness to use to draw surface lines, in points. The default is 1.0 points..

In a property sheet, this property appears as follows:


| **Property Type** | THICKNESS | | |
|---|---|---|---|
| **Name String** | Line thickness | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## USE_TRIANGLES

A Boolean value that determines whether to force the IDLgrSurface object to use triangles instead of quads to draw the surface and skirt..

In a property sheet, this property appears as an enumerated list with the following options:

- Quads
- Triangles

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Draw method | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VERT_COLORS

A vector of colors to be used to draw at each vertex. Color is interpolated between vertices if SHADING is set to 1 (Gouraud). If there are more vertices than elements in VERT_COLORS, the elements of VERT_COLORS are cyclically repeated. By default, the polygons are all drawn in the single color provided by the COLOR property. If this property is omitted or set to a scalar, vertex colors are removed and the surface is drawn in the color specified by the COLOR property.

**Note**

If the surface object is being rendered on a destination device that uses the Indexed color model, and the view that contains the surface also contains one or more light

objects, the VERT_COLORS property is ignored and the SHADE_RANGE property is used instead..

---

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Vertex colors | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert *X* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, [$s_0$, $s_1$], of scaling factors used to convert *Y* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, [$s_0$, $s_1$], of scaling factors used to convert *Z* coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZERO_OPACITY_SKIP

A Boolean value that determines whether to gain finer control over the rendering of textured surface pixels (texels) by setting an opacity of 0 in the texture map. Texels with zero opacity do not affect the color of a screen pixel since they have no opacity. If this property is set to 1, any texels are “skipped” and not rendered at all. If this property is set to zero, the Z-buffer is updated for these pixels and the display image is not affected as noted above. By updating the Z-buffer without updating the display image, the surface can be used as a *clipping* surface for other graphics primitives drawn after the current graphics object. The default value for this property is 1.

**Note**

This property has no effect if no texture map is used or if the texture map in use does not contain an opacity channel..

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Skip zero opacity | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ZRANGE

A two-element floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrSurface::Cleanup

The IDLgrSurface::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrSurface::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrSurface::GetCTM

The IDLgrSurface::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrSurface::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the surface object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrSurface::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrSurface::GetProperty

The IDLgrSurface::GetProperty procedure method retrieves the value of a property or group of properties for the surface.

## Syntax

*Obj* -> [IDLgrSurface::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrSurface Properties” on page 3555 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrSurface::Init

The IDLgrSurface::Init function method initializes the surface object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrSurface' [, *Z* [, *X*, *Y*]] [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrSurface::]Init([*Z* [, *X*, *Y*]] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### X

A vector or two-dimensional array specifying the X coordinates of the grid. If this argument is a vector, each element of X specifies the X coordinates for a column of Z (e.g., X[0] specifies the X coordinate for Z[0, *]). If X is a two-dimensional array, each element of X specifies the X coordinate of the corresponding point in Z ($X_{ij}$ specifies the X coordinate of $Z_{ij}$). This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

### Y

A vector or two-dimensional array specifying the Y coordinates of the grid. If this argument is a vector, each element of Y specifies the Y coordinates for a column of Z (e.g., Y[0] specifies the Y coordinate for Z[*, 0]). If Y is a two-dimensional array, each element of Y specifies the Y coordinate of the corresponding point in Z ($Y_{ij}$ specifies the Y coordinate of $Z_{ij}$). This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

### Z

The two-dimensional array to be displayed. If X and Y are provided, the surface is defined as a function of the (X, Y) locations specified by their contents. Otherwise, the surface is generated as a function of the array indices of each element of Z. This argument is stored as double precision floating point values if the argument variable is of type DOUBLE or if the DOUBLE property is non-zero, otherwise it is stored as single precision floating point.

## Keywords

Any property listed under “IDLgrSurface Properties” on page 3555 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrSurface::SetProperty

The IDLgrSurface::SetProperty procedure method sets the value of a property or group of properties for the surface.

## Syntax

*Obj* -> [IDLgrSurface::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrSurface Properties” on page 3555 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrSymbol

A symbol object represents a graphical element that is plotted relative to a particular position.

**Note**

Seven predefined symbols are provided by IDL.

## Superclasses

IDLitComponent

## Creation

See "IDLgrSymbol::Init" on page 3588.

## Properties

Objects of this class have the following properties. See "IDLgrSymbol Properties" on page 3584 for details on individual properties.

- ALL
- COLOR
- DATA
- SIZE
- THICK

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrSymbol::Cleanup
- IDLgrSymbol::GetProperty
- IDLgrSymbol::Init
- IDLgrSymbol::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrSymbol Properties

IDLgrSymbol objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrSymbol::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrSymbol::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrSymbol::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR

The color used to draw the symbol. The color may be specified as a color lookup table index or as an RGB vector. The default color is the color of the object for which this symbol is being used.

| **Property Type** | Color | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATA

A Boolean value that determines whether to specify a symbol. This property is equivalent to the *Data* argument.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## SIZE

A one-, two-, or three-element floating-point vector describing the X, Y, and Z scaling factors to be applied to the symbol. The default is [1.0, 1.0, 1.0].

- If SIZE is specified as a scalar, then the X, Y, and Z scale factors are all equal to the scalar value.
- If SIZE is specified as a 2-element vector, then the X and Y scale factors are as specified by the vector, and the Z scale factor is 1.0.
- If SIZE is specified as a 3-element vector, then the X, Y, and Z scale factors are as specified by the vector.

IDL converts, maintains, and returns this data as double-precision floating-point.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## THICK

A floating-point value between 1.0 and 10.0, specifying the line thickness to used to draw any lines that make up the symbol, in points. The default is 1.0 points.

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

# IDLgrSymbol::Cleanup

The IDLgrSymbol::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrSymbol::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrSymbol::GetProperty

The IDLgrSymbol::GetProperty procedure method retrieves the value of a property or group of properties for the symbol.

## Syntax

*Obj* -> [IDLgrSymbol::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrSymbol Properties" on page 3584 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.0

# IDLgrSymbol::Init

The IDLgrSymbol::Init function method initializes the plot symbol.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrSymbol' [, *Data*] [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLgrSymbol::]Init([*Data*] [, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### Data

Either an integer value from the list shown below, or an object reference to either an IDLgrModel object or atomic graphic object.

Use one of the following scalar-represented internal default symbols:

- 0 = No symbol
- 1 = Plus sign, '+' (default)
- 2 = Asterisk
- 3 = Period (Dot)
- 4 = Diamond

- 5 = Triangle
- 6 = Square
- 7 = X
- 8 = “Greater-than” Arrow Head (>)
- 9 = “Less-than” Arrow Head (<)

If an instance of the IDLgrModel object class or an atomic graphic object is used, the object tree is used as the symbol. For best results, the object should fill the domain from -1 to +1 in all dimensions. The pre-defined symbols listed above are all defined in the domain -1 to +1.

## Keywords

Any property listed under “IDLgrSymbol Properties” on page 3584 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

Data argument: 5.6

# IDLgrSymbol::SetProperty

The IDLgrSymbol::SetProperty procedure method sets the value of a property or group of properties for the symbol.

## Syntax

*Obj* -> [IDLgrSymbol::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrSymbol Properties” on page 3584 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrTessellator

A tessellator object decomposes a polygon description into a set of triangles. Use the tessellator object to convert complex and/or concave polygons into a form suitable for drawing with the IDLgrPolygon object. IDLgrPolygon can draw only convex polygons correctly.

The polygon contours may intersect each other and may be self-intersecting. The contours may be disjoint, overlapping, or contained within other contours. The contours may also be degenerate, may contain repeated points, and may or may not be closed. The order of the vertices may be either counter-clockwise or clockwise. For best results, the polygon contours should be coplanar.

The tessellator object uses the "odd-winding rule" to determine if a point is in the interior of the polygon and therefore contained in a triangle output by the tessellator. With this rule, a point is in the interior if it is circled an odd number of times as we travel around each of the contours.

**Note**

The INTERIOR keyword for the AddPolygon method is no longer needed to inform the tessellator that the polygon defines an exterior or interior boundary. This keyword is ignored by the tessellator because it now performs the interior testing using the odd-winding rule.

Specify polygon contours with calls to the IDLgrTessellator::AddPolygon method. After adding all the contours, use the IDLgrTessellator::Tessellate method to perform the tessellation and retrieve the resulting list of vertices and connectivity array.

If the polygon contours contain intersecting or self-intersecting contours, the tessellator may return vertices that were not in the original set of vertices specified with the IDLgrTessellator::AddPolygon method. These vertices are created by the intersecting contours.

If your vertex data also includes other information, such as a color for each vertex, then you may wish for this extra information to be created for any new vertices generated by the tessellator. Use the AUXDATA keywords for IDLgrTessellator::AddPolygon and IDLgrTessellator::Tessellate to pass in and retrieve your per-vertex data. The tessellator object interpolates the per-vertex data from neighboring vertices to create new per-vertex data for the new vertices it generates.

In the following example of handling per-vertex data with generated vertices, the polygon is a simple self-intersecting "bow-tie" polygon. It is submitted to the

tessellator with four vertices, but the tessellator returns a fifth at the point of self-intersection. Color data for the four original vertices is also supplied, and the tessellator returns a fifth color.

```
PRO tessaux
    oTess = OBJ_NEW('IDLgrTessellator')
    colors = [[0,255,0],[0,255,0],[0,64,0],[0,64,0]]
    oTess->AddPolygon, [0,1,0,1], [0,0,1,1], AUXDATA=colors
    result = oTess->Tessellate(v, c, AUXDATA=aux)
    PRINT, v[*,4]
    PRINT, aux[*,4]
    oPoly = OBJ_NEW('IDLgrPolygon', v, POLYGONS=c, $
VERT_COLORS=aux, SHADING=1)
    XOBJVIEW, oPoly, /BLOCK
    OBJ_DESTROY, [oTess, oPoly]
END
```

The generated output will be:

```
0.500000     0.500000
  0    159      0
```

## Superclasses

IDLitComponent

## Creation

See “IDLgrTessellator::Init” on page 3598.

## Properties

Objects of this class have no properties of their own.

## Methods

This class has the following methods:

- IDLgrTessellator::AddPolygon
- IDLgrTessellator::Cleanup
- IDLgrTessellator::Init
- IDLgrTessellator::Reset
- IDLgrTessellator::Tessellate

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrTessellator Properties

Objects of this class have no properties of their own.

# IDLgrTessellator::AddPolygon

The IDLgrTessellator::AddPolygon procedure method adds a polygon to the tessellator object.

## Syntax

*Obj* -> [IDLgrTessellator::]AddPolygon, *X* [, *Y*[, *Z*]] [, AUXDATA=*array of auxiliary data*] [, /INTERIOR] [, POLYGON=*array of polygon descriptions*]

## Arguments

### X

A 1 x *n*, 2 x *n*, or 3 x *n* array of polygon vertices.

### Y

A vector of Y values. If *X* and *Y* are both specified, they must be one-dimensional vectors of the same length.

### Z

A vector of Z values. If *X*, *Y*, and *Z* are all specified, they must all three be one-dimensional vectors of the same length. If no *Z* values are specified, the *Z* value for the polygon is set to 0.

## Keywords

### AUXDATA

Set this keyword to an array of auxiliary per-vertex data. This array must have dimensions [*m*,*n*] where m is the number of auxiliary data items per vertex and *n* is the number of vertices specified in the *X*, *Y*, and *Z* arguments. If you specify AUXDATA in any invocation of the AddPolygon method, you must specify it on all invocations of the method for the polygons to be tessellated together with the Tessellate method. Further, the value of m in the dimensions must be the same for all polygons. That is, all polygons must have the same number of auxiliary data items for each vertex.

### POLYGON

Set this keyword to an array of polygon descriptions. A polygon description is an integer or long word array of the form: [*n*, $i_0$, $i_1$, ..., $i_{n-1}$], where *n* is the number of vertices that define the polygon, and $i_0..i_{n-1}$ are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices. To ignore an entry in the POLYGON array, set the vertex count, *n*, to 0. To end the drawing list, even if additional array space is available, set *n* to -1. If this keyword is not specified, a single polygon will be generated.

**Note**

The connectivity array described by POLYGONS allows you to add multiple polygons to the tessellator object with a single AddPolygon operation.

### INTERIOR

Set this keyword to set a polygon to be an interior polygon, which is treated as a hole in the exterior polygons.

**Note**

The INTERIOR keyword for the AddPolygon method is no longer needed to inform the tessellator that the polygon defines an exterior or interior boundary. This keyword is ignored by the tessellator because it now performs the interior testing using the odd-winding rule.

## Version History

Introduced: 5.0

AUXDATA keyword: 5.6

# IDLgrTessellator::Cleanup

The IDLgrTessellator::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY,*Obj*

or

*Obj* -> [IDLgrTessellator::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrTessellator::Init

The IDLgrTessellator::Init function method initializes the tessellator object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrTessellator')

or

*Result* = *Obj* -> [IDLgrTessellator::]Init() (*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrTessellator::Reset

The IDLgrTessellator::Reset procedure method resets the object's internal state. All previously added polygons are removed from memory and the object is prepared for a new tessellation task.

## Syntax

*Obj* -> [IDLgrTessellator::]Reset

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrTessellator::Tessellate

The IDLgrTessellator::Tessellate function method performs the actual tessellation.

## Syntax

*Result* = *Obj* -> [IDLgrTessellator::]Tessellate( *Vertices*, *Poly* [, AUXDATA=*variable*] [, /QUIET] )

## Return Value

Returns 1, and the contents of Vertices and Poly are set to the results of the tessellation. Returns 0 if tessellation fails.

## Arguments

If the tessellation succeeds, IDLgrTessellator::Tessellate returns 1 and the contents of Vertices and Poly are set to the results of the tessellation. If the tessellation fails, the function returns 0.

### Vertices

A 2 x *n* array if all the input polygons were 2-D. A 3 x *n* array if all the input polygons were 3-D.

### Poly

An array of polygon descriptions. A polygon description is an integer or long word array of the form: [*n*, $i_0$, $i_1$, ..., $i_{n-1}$], where *n* is the number of vertices that define the polygon, and $i_0$..$i_{n-1}$ are indices into the *X*, *Y*, and *Z* arguments that represent the polygon vertices.

**Note**

On output, the *Vertices* array can be used as the value of the DATA property, and the *Poly* array can be used as the value of the POLYGON property, of an IDLgrPolygon object.

# Keywords

## AUXDATA

Set this keyword to a named variable that receives the auxiliary data associated with each vertex returned in the Vertices argument. The data is an [*m*, *n*] array where m is the number of per-vertex auxiliary data items specified in the call(s) to the AddPolygon method, and n is the number of vertices returned in the Vertices argument. The type of the returned auxiliary data is the same as the type of the data supplied with the AUXDATA keyword in the last call to AddPolygon.

## QUIET

Set this keyword to suppress warning and error message generation due to tessellation errors. !ERROR_STATE is not updated in the case of the return value being ‘0’ when the QUIET keyword is specified.

# Version History

Introduced: 5.0

AUXDATA keywords: 5.6

# IDLgrText

A text object represents one or more text strings that share common rendering attributes. An IDLgrText object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrText::Init" on page 3623.

## Properties

Objects of this class have the following properties. See "IDLgrText Properties" on page 3604 for details on individual properties.

- ALIGNMENT
- ALL
- ALPHA_CHANNEL
- BASELINE
- CHAR_DIMENSIONS
- CLIP_PLANES
- COLOR
- ENABLE_FORMATTING
- FONT
- HIDE
- KERNING
- LOCATIONS
- ONGLASS
- ONGLASS
- PALETTE
- PARENT
- RECOMPUTE_DIMENSIONS
- REGISTER_PROPERTIES
- RENDER_METHOD
- STRINGS
- UPDIR
- VERTICAL_ALIGNMENT
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZCOORD_CONV
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrText::Cleanup
- IDLgrText::GetCTM
- IDLgrText::GetProperty
- IDLgrText::Init
- IDLgrText::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrText Properties

IDLgrText objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrText::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrText::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrText::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALIGNMENT

A floating-point value between 0.0 and 1.0 to indicate the requested horizontal alignment of the text baseline. An alignment of 0.0 (the default) left-justifies the text at the given position; an alignment of 1.0 right-justifies the text, and an alignment of 0.5 centers the text over the given position..

| | | | |
|---|---|---|---|
| **Property Type** | FLOAT | | |
| **Name String** | Horizontal alignment | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ALPHA_CHANNEL

A floating-point value that determines the opacity of the text with respect to the background. Set this property to a value in the range [0.0, 1.0] (1.0 is the default) to draw the text foreground and background with the specified blending factor. A value of 1.0 draws the text opaquely without blending the text with objects already drawn on the destination. Edges of the glyphs are always blended. A value of 0.0 draws no text at all. A value in the middle of the range draws the text semi-transparently, which provides a way of creating labels that are visible while allowing features blocked by the labels to still be seen. This property is used only when the RENDER_METHOD in effect is 0 (Texture).

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Opacity | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## BASELINE

A two- or three-element floating-point vector describing the direction in which the baseline is to be oriented. Use this property in conjunction with the UPDIR property to specify the plane on which the text lies. The default BASELINE is [1.0,0,0] (i.e., parallel to the x-axis).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Baseline direction | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CHAR_DIMENSIONS

A two-element floating-point vector [*width*, *height*] indicating the dimensions (measured in data units) of a bounding box for each character, to be used when scaling text projected in three dimensions. If either *width* or *height* is zero, the text will be scaled such that if it were positioned halfway between the near and far clipping planes, it will appear at the point size associated with this text object's font. The default value is [0, 0]. IDL converts, maintains, and returns this data as double-precision floating-point.

**Note**

If you set the CHAR_DIMENSIONS property to [0,0] (using the SetProperty method), indicating that IDL should calculate the text size, the value (returned by the GetProperty method) will not be updated to reflect the calculated size until you call either the Draw method or the GetTextDimensions method.

For example, if the VIEWPLANE_RECT of the view the text object is being rendered in is set equal to [0,0,10,10] (that is, it spans ten data units in each of the X and Y directions), setting the CHAR_DIMENSIONS property equal to [2, 3] will scale the text such that each character fills 20% of the X range and 30% of the Y range.

This property has no effect if the ONGLASS property is set equal to one..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## CLIP_PLANES

A 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A$x$ + B$y$ + C$z$ + D = 0. Portions of this object that fall in the half space A$x$ + B$y$ + C$z$ + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects..

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COLOR

The color to be used as the foreground color for the text. The color may be specified as a color lookup table index or as an RGB vector. The default is [0, 0, 0]..

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ENABLE_FORMATTING

A Boolean value that determines whether the text object should honor embedded Hershey-style formatting codes within the strings. (Formatting codes are described in Appendix H, “Fonts”.) The default is not to honor the formatting codes..

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FILL_BACKGROUND

Set this property to zero (the default) to render the text with a transparent bitmap background, allowing graphics behind the text to show through between the glyphs. Set this property to non-zero to draw the text bitmap background with the color specified by the FILL_COLOR property. This property can only be used when RENDER_METHOD is set to 0 (Texture)..

| | | | |
|---|---|---|---|
| **Property Type** | BOOLEAN | | |
| **Name String** | Fill background | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## FILL_COLOR

An integer vector that determines whether to use a text background color other than the view color. Set this property to -1 (the default) to specify that the text background should be drawn using the view color. Set this property to an RGB color vector or color index value to specify that the text bitmap background should be drawn using the specified color. This property is used only when the FILL_BACKGROUND property has a non-zero value and the RENDER_METHOD in effect is 0 (Texture).

In a property sheet, this property appears as a color property

| | | | |
|---|---|---|---|
| **Property Type** | COLOR | | |
| **Name String** | Fill background | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## FONT

An object reference to an instance of an IDLgrFont object class to describe the font to use to draw this string. The default is 12 point Helvetica. See IDLgrFont for details.

**Note**

If the default font is in use, retrieving the value of the FONT property (using the GetProperty method) will return a null object..

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## HIDE

A Boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## KERNING

A Boolean value that determines whether to enable kerning while rendering characters. Kerning reduces the amount of space between glyphs if the shape of each glyph allows it, according to the font information stored in the font's file (e.g., AV). Set this property to a non-zero value (the default is zero) to enable kerning. Enabling kerning may not necessarily result in rendering glyphs more closely together because some fonts do not contain the required kerning information. This property is used only when the RENDER_METHOD in effect is 0 (Texture)..

| | | | |
|---|---|---|---|
| **Property Type** | BOOLEAN | | |
| **Name String** | Kerning | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LOCATIONS

A floating-point array of one or more two- or three-element vectors specifying the coordinates (measured in data units) used to position the string(s). The default location for each string is [0,0,0]. Each vector is of the form [*x*, *y*] or [*x*, *y*, *z*]; if *z* is not provided, it is assumed to be zero. Each location corresponds to a string in the *String* argument; the number of locations should be equal the number of strings. IDL converts, maintains, and returns this data as double-precision floating-point..

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Text locations | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ONGLASS

A Boolean value that indicates whether the text should be displayed “on the glass”. The default is projected 3-D text..

| | | | |
|---|---|---|---|
| **Property Type** | BOOLEAN | | |
| **Name String** | On glass | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that defines the color palette of this object. This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp)..

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object..

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## RECOMPUTE_DIMENSIONS

An integer value that indicates when this text object's character dimensions (refer to the CHAR_DIMENSIONS property) are to be recomputed automatically:

- 0 = The physical size of the text is affected by model and view transforms. The size of the text in terms of data units is obtained from CHAR_DIMENSIONS. Since the character dimensions are specified in data units, the text will maintain the data space size specified by CHAR_DIMENSIONS as the transforms change. In other words, the physical text size changes along with other primitives. If the value of this property is [0, 0], the text font's point size is used to compute the physical size of the text in terms of data units using the transforms in effect for the first draw. This setting is the default value for this property.
- 1 = The physical size of the text is only affected by model transforms. The CHAR_DIMENSIONS property is ignored. The size of the text is computed from the font's point size the first time it is drawn, and IDL does not try to keep the size of the text constant with respect to changes in the model transforms.
- 2 = The physical size of the text is held constant, even as the model and view change. The CHAR_DIMENSIONS property is ignored and the text is always drawn with a physical size equal to the text font's point size. IDL adjusts its internal text transforms to maintain the physical size of the text.

In a property sheet, this property appears as an enumerated list with the following options:

- Never
- Previous

- Always

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Recompute dimensions | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RENDER_METHOD

A Boolean value that determines how the text object will be rendered. Set this property to one of the following values:

- 0 = TEXTURE. IDL renders the text by placing a bitmap representation of a glyph into a texture map and then rendering a polygon with the texture map. The FILL_BACKGROUND, ALPHA_CHANNEL, and FILL_COLOR properties control the drawing of the background portions of the texture map and how the entire texture map is blended into the scene. Leaving these three properties set to their default values produces a result that closely approximates the TRIANGLES rendering method. One important difference is that the glyph bitmaps are generated by the FreeType font rendering library, producing glyphs that are more accurately rendered and anti-aliased than those drawn with the TRIANGLES method. The TEXTURE method cannot be used on indexed color destinations. The text is rendered with the TRIANGLES method if the destination color model is indexed.
- 1 = TRIANGLES. IDL renders the text by tessellating the glyph outline into a set of small triangles that are then drawn to produce the solid glyph. IDL also draws a blended line around the edge of the glyph to approximate anti-aliasing. This setting forces IDL to use the process it used as the default before IDL 6.0.

In a property sheet, this property appears as an enumerated list with the following options:

- Texture
- Triangles

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Render method | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## STRINGS

The string (or vector of strings) associated with the text object. This property is the same as the *String* argument described above.

If the number of strings matches the number of locations (as specified by the LOCATIONS property), the existing locations are used.

**Note**

If the number of strings *does not* match the number of locations, the number of locations is modified to match the number of strings, and the location value for each string is reset to [0,0,0]..

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Text strings | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## UPDIR

A two- (or three-) element floating-point vector describing the vertical direction for the string. The *upward direction* is the direction defined by a vector pointing from the origin to the point specified. Use this property in conjunction with the BASELINE property to specify the plane on which the text lies; the direction specified by UPDIR should be orthogonal to the direction specified by BASELINE. The default UPDIR is [0.0, 1.0, 0.0] (i.e., parallel to the *Y* axis).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Up direction | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VERTICAL_ALIGNMENT

A floating-point value between 0.0 and 1.0 to indicate the requested vertical alignment of the text. An alignment of 0.0 (the default) bottom-justifies the text at the given location; an alignment of 1.0 top-justifies the text at the given location..

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Vertical alignment | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZCOORD_CONV

A floating-point vector, [$s_0$, $s_1$], of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{NormalizedZ} = s_0 + s_1 * \text{DataZ}$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZRANGE

A two-element floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object. IDL maintains and returns this property in double-precision floating-point.

**Note**

Until the text is drawn to the destination object, the [XYZ]RANGE properties will only report the locations of the text. Use the GetTextDimensions method of the destination object to get the data dimensions of the text prior to a draw operation..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrText::Cleanup

The IDLgrText::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrText::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrText::GetCTM

The IDLgrText::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrText::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the text object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrText::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrText::GetProperty

The IDLgrText::GetProperty procedure method retrieves the value of a property or group of properties for the text.

## Syntax

*Obj* -> [IDLgrText::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrText Properties” on page 3604 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrText::Init

The IDLgrText::Init function method initializes the text object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrText' [, *String or vector of strings*] [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrText::]Init([*String or vector of strings*] [, *PROPERTY=value*]) (*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### String

The string (or vector of strings) to be created. If this argument is not a string, it is converted prior to creation of the text object using the default formatting rules.

**Note**

Strings have a default location of [0,0,0]. Use the LOCATIONS property to provide a different location for each string.

## Keywords

Any property listed under “IDLgrText Properties” on page 3604 that contains the word “Yes” in the “Init” column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrText::SetProperty

The IDLgrText::SetProperty procedure method sets the value of a property or group of properties for the text.

## Syntax

*Obj* -> [IDLgrText::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrText Properties” on page 3604 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrView

A view object represents a rectangular area in which graphics objects are drawn. It is a container for objects of the IDLgrModel class.

## Superclasses

IDL_Container

IDLitComponent

TrackBall

## Creation

See "IDLgrView::Init" on page 3640.

## Properties

Objects of this class have the following properties. See "IDLgrView Properties" on page 3628 for details on individual properties.

- ALL
- COLOR
- DEPTH_CUE
- DIMENSIONS
- DOUBLE
- EYE
- HIDE
- LOCATION
- PARENT
- PROJECTION
- REGISTER_PROPERTIES
- TRANSPARENT
- UNITS
- VIEWPLANE_RECT

- ZCLIP

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrView::Add
- IDLgrView::Cleanup
- IDLgrView::GetByName
- IDLgrView::GetProperty
- IDLgrView::Init
- IDLgrView::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrView Properties

IDLgrView objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrView::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrView::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrView::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR

The color for the view. This is the color to which the view area will be erased before its contents are drawn. The color may be specified as a color lookup table index or as an RGB vector. The default is [255, 255, 255] (white)..

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_CUE

A two-element floating-point array [*zbright*, *zdim*] specifying the near and far Z planes between which depth cueing is in effect. Depth cueing is only honored when drawing to a destination object that uses the RGB color model.

Depth cueing causes an object to appear to fade into the background color of the view object with changes in depth. If the depth of an object is further than *zdim* (that is, if the object's location in the Z direction is farther from the origin than the value specified by *zdim*), the object will be painted in the background color. Similarly, if the object is closer than the value of *zbright*, the object will appear in its "normal" color. Anywhere in-between, the object will be a blend of the background color and the object color. For example, if the DEPTH_CUE property is set to [-1,1], an object at the depth of 0.0 will appear as a 50% blend of the object color and the view color.

The relationship between $Z_{bright}$ and $Z_{dim}$ determines the result of the rendering:

- $Z_{bright} < Z_{dim}$: Rendering darkens with depth.
- $Z_{bright} > Z_{dim}$: Rendering brightens with depth.
- $Z_{bright} = Z_{dim}$: Disables depth cueing.

You can disable depth cueing by setting $z_{bright} = z_{dim}$. The default is [0.0, 0.0]..

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Depth cue | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DIMENSIONS

A two-element integer vector of the form [*width*, *height*] specifying the dimensions of the viewport (the rectangle in which models are displayed on a graphics destination). By default, the viewport dimensions are set to [0, 0], which indicates that it will match the dimensions of the graphics destination to which it is drawn. The dimensions are measured in the units specified by the UNITS property..

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DOUBLE

A Boolean value that controls the precision used for rendering the entire contents of the view. If set, IDL calculates the transformations used for the modeling and view transforms using double-precision floating-point arithmetic. This allows the values specified for the VIEWPLANE_RECT, modeling transforms in IDLgrModel objects, and coordinate data in atomic graphic objects to be used as double-precision before mapping to device coordinates.

**Note**

If this property is set to 0, IDL uses single-precision floating-point arithmetic for these values, which can cause loss of significance and incorrect rendering of data. Setting this property to 1 may impact graphics performance and should only be used when handling data requiring double precision..

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Double precision | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## EYE

A floating-point value that specifies the distance from the eyepoint to the viewplane (Z=0). The default is 4.0. The eyepoint is always centered within the viewplane rectangle. (That is, if the VIEWPLANE_RECT property is set equal to [0,0,1,1], the eyepoint will be at X=0.5, Y=0.5.) IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Eye distance | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LOCATION

A two-element floating-point vector of the form [*x*, *y*] specifying the position of the lower left corner of the view. The default is [0, 0], measured in device units.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Viewport location | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object..

| **Property Type** | Object reference | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** | **Init:** | **Registered:** No |

## PROJECTION

An integer value indicating the type of projection to use within this view. All models displayed within this view will be projected using this type of projection. Valid values are described below.

- 1 = Orthogonal projection (default).
- 2 = Perspective: Indicates that all models are projected toward the eye (located at the origin), which is the apex of the viewing frustum. With a perspective projection, models that are farther away from the eye will appear smaller in the view than models that are nearer to the eye..

In a property sheet, this property appears as an enumerated list with the following options:

- None
- Orthogonal
- Perspective

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Projection | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## TRANSPARENT

A Boolean value that determines whether to disable the viewport erase, making the viewport transparent..

| | | | |
|---|---|---|---|
| **Property Type** | BOOLEAN | | |
| **Name String** | Transparent | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## UNITS

An integer value that specifies the units of measure for this view. Valid values are:

- 0 = Device (default)
- 1 = Inches

- 2 = Centimeters
- 3 = Normalized: relative to the graphics destination's *rect*.

**Note**

If you set the UNITS property (using the SetProperty method) of a view without also setting the LOCATION and DIMENSIONS properties, IDL will use the existing size and location values in the new units, *without conversion*. This means that if your view's location and dimensions were previously measured in centimeters, and you change the value of UNITS to 1 (measurement in inches), the actual size of the view object will change..

In a property sheet, this property appears as an enumerated list with the following options:

- Device
- Inches
- Centimeters
- Normalization

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Units | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VIEWPLANE_RECT

A four-element floating-point vector of the form [*x, y, width, height*] to describe the bounds in x and y of the view volume. Objects within the view volume are projected into the viewport. These values are measured in normalized space. The default is [-1.0, -1.0, 2.0, 2.0] IDL converts, maintains, and returns this data as double-precision floating-point.

**Note**

The z bounds of the view volume are set via the ZCLIP property. The viewplane rectangle is always located at Z=0.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Viewplane rectangle | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ZCLIP

A two element floating-point vector representing the near and far clipping planes to be applied to the objects in this view. The vector should take the form [*near*, *far*]. By default, these values are [1, -1]. IDL converts, maintains, and returns this data as double-precision floating-point.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Z clipping | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

# IDLgrView::Add

The IDLgrView::Add procedure method adds a child to this view.

## Syntax

*Obj* -> [IDLgrView::]Add, *Model* [, POSITION=*index*]

## Arguments

### Model

An instance of the IDLgrModel object class.

## Keywords

### POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

## Version History

Introduced 5.0

# IDLgrView::Cleanup

The IDLgrView::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrView::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced 5.0

# IDLgrView::GetByName

The IDLgrView::GetByName function method finds contained objects by name. If the named object is not found, the GetByName function returns a null object reference.

**Note**

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

## Syntax

*Result* = *Obj* -> [IDLgrView::]GetByName(*Name*)

## Return Value

Returns contained objects by name. If the named object is not found, the GetByName function returns a null object reference.

## Arguments

### Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX filesystem. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

## Keywords

None

## Version History

Introduced 5.0

# IDLgrView::GetProperty

The IDLgrView::GetProperty procedure method retrieves the value of the property or group of properties for the view.

## Syntax

*Obj* -> [IDLgrView::]GetProperty[, *PROPERTY=variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrView Properties” on page 3628 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced 5.0

# IDLgrView::Init

The IDLgrView::Init function method initializes the view object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrView' [, *PROPERTY=value*])

or

*Result* = *Obj* -> [IDLgrView::]Init([*PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrView Properties" on page 3628 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced 5.0

# IDLgrView::SetProperty

The IDLgrView::SetProperty procedure method sets the value of the property or group of properties for the view.

## Syntax

*Obj* -> [IDLgrView::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrView Properties” on page 3628 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced 5.0

# IDLgrViewgroup

The IDLgrViewgroup object is a simple container object, very similar to the IDLgrScene object. It contains one or more IDLgrView objects and an IDLgrScene can contain one or more of these objects. This object is special in that it can also contain objects which do not have a Draw method (e.g. IDLgrPattern and IDLgrFont). An IDLgrViewgroup object cannot be returned by a call to the IDLgrWindow::Select method.

## Superclasses

IDL_Container

IDLitComponent

## Creation

See "IDLgrViewgroup::Init" on page 3652.

## Properties

Objects of this class have the following properties. See "IDLgrViewgroup Properties" on page 3645 for details on individual properties.

- ALL
- HIDE
- PARENT
- REGISTER_PROPERTIES

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrViewgroup::Add
- IDLgrViewgroup::Cleanup
- IDLgrViewgroup::GetByName
- IDLgrViewgroup::GetProperty

- IDLgrViewgroup::Init
- IDLgrViewgroup::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.1

# IDLgrViewgroup Properties

IDLgrViewgroup objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrViewgroup::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrViewgroup::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrViewgroup::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the retrievable properties associated with this object.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## HIDE

A Boolean value to indicate whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)
- False = Do not draw graphic..

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this viewgroup.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLgrViewgroup::Add

The IDLgrViewgroup::Add function method verifies that the added item is not an instance of the IDLgrScene or IDLgrViewgroup object. If it is not, IDLgrViewgroup:Add adds the object to the specified viewgroup.

## Syntax

*Obj* -> [IDLgrViewgroup::]Add, *Object* [, POSITION=*index*]

## Arguments

### Object

An instance of an object or a list of objects. Objects which subclass IDLgrScene or IDLgrViewgroup can not be added (avoiding circularity constraints). All other objects are allowed.

## Keywords

### POSITION

Set this keyword equal to the zero-based index of the position within the container at which the new object should be placed.

## Version History

Introduced: 5.1

# IDLgrViewgroup::Cleanup

The IDLgrViewgroup::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY,*Obj*

or

*Obj* -> [IDLgrViewgroup::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrViewgroup::GetByName

The IDLgrViewgroup::GetByName function method finds contained objects by name. If the named object is not found, the GetByName function returns a null object reference.

**Note**

The GetByName function does *not* perform a recursive search through the object hierarchy. If a fully qualified object name is not specified, only the contents of the current container object are inspected for the named object.

## Syntax

*Result* = *Obj* -> [IDLgrViewgroup::]GetByName(*Name*)

## Return Value

Returns contained objects by name. If the named object is not found, the GetByName function returns a null object reference.

## Arguments

### Name

A string containing the name of the object to be returned.

Object naming syntax is very much like the syntax of a UNIX filesystem. Objects contained by other objects can include the name of their parent object; this allows you to create a fully qualified name specification. For example, if `object1` contains `object2`, which in turn contains `object3`, the string specifying the fully qualified object name of object3 would be `'object1/object2/object3'`.

Object names are specified relative to the object on which the GetByName method is called. If used at the beginning of the name string, the `/` character represents the top of an object hierarchy. The string `'..'` represents the object one level “up” in the hierarchy.

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrViewgroup::GetProperty

The IDLgrViewgroup::GetProperty procedure method retrieves the value of a property or group of properties for the viewgroup object.

## Syntax

*Obj* -> [IDLgrViewgroup::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrViewgroup Properties" on page 3645 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.1

# IDLgrViewgroup::Init

The IDLgrViewgroup::Init function method initializes the viewgroup object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrViewgroup' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrViewgroup::]Init([, *PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrViewgroup Properties" on page 3645 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.1

# IDLgrViewgroup::SetProperty

The IDLgrViewgroup::SetProperty procedure method sets the value of a property or group of properties for the viewgroup.

## Syntax

*Obj* -> [IDLgrViewgroup::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrViewgroup Properties” on page 3645 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.1

# IDLgrVolume

A volume object represents a mapping from a three-dimensional array of data to a three-dimensional array of voxel colors, which, when drawn, are projected to two dimensions.

An IDLgrVolume object is an *atomic graphic object*; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

## Superclasses

IDLitComponent

## Creation

See "IDLgrVolume::Init" on page 3679.

## Properties

Objects of this class have the following properties. See "IDLgrVolume Properties" on page 3657 for details on individual properties.

- ALL
- AMBIENT
- BOUNDS
- CLIP_PLANES
- COMPOSITE_FUNCTION
- CUTTING_PLANES
- DATA0
- DATA1
- DATA2
- DATA3
- DEPTH_CUE
- DEPTH_TEST_DISABLE
- DEPTH_TEST_FUNCTION
- DEPTH_WRITE_DISABLE
- HIDE
- HINTS
- INTERPOLATE
- LIGHTING_MODEL
- NO_COPY
- OPACITY_TABLE0
- OPACITY_TABLE1
- PALETTE
- PARENT
- REGISTER_PROPERTIES

- RENDER_STEP
- RGB_TABLE0
- RGB_TABLE1
- TWO_SIDED
- VALID_DATA
- VOLUME_SELECT
- XCOORD_CONV
- XRANGE
- YCOORD_CONV
- YRANGE
- ZBUFFER
- ZCOORD_CONV
- ZERO_OPACITY_SKIP
- ZRANGE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrVolume::Cleanup
- IDLgrVolume::ComputeBounds
- IDLgrVolume::GetCTM
- IDLgrVolume::GetProperty
- IDLgrVolume::Init
- IDLgrVolume::PickVoxel
- IDLgrVolume::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrVolume Properties

IDLgrVolume objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrVolume::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrVolume::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrVolume::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## AMBIENT

The color and intensity of the volume’s base ambient lighting. Color is specified as an RGB vector. The default is [255, 255, 255]. AMBIENT is applicable only when LIGHTING_MODEL is set..

In a property sheet, this property appears as a color property.

| **Property Type** | COLOR | | |
|---|---|---|---|
| **Name String** | Ambient color | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## BOUNDS

A six-element floating-point vector of the form [$x_{min}$, $y_{min}$, $z_{min}$, $x_{max}$, $y_{max}$, $z_{max}$], which represents the sub-volume to be rendered. .

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Subvolume bounds | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CLIP_PLANES

A 4-by-*N* floating-point array that specifies the coefficients of the clipping planes to be applied to this object. The four coefficients for each clipping plane are of the form [A, B, C, D], where A*x* + B*y* + C*z* + D = 0. Portions of this object that fall in the half space A*x* + B*y* + C*z* + D > 0 will be clipped. By default, the value of this property is a scalar (-1) indicating that no clipping planes are to be applied.

**Note**

The clipping planes specified via this property are applied in addition to the near and far clipping planes associated with the IDLgrView in which this object appears.

**Note**

Clipping planes are applied in the data space of this object (prior to the application of any *x*, *y*, or *z* coordinate conversion).

**Note**

To determine the maximum number of clipping planes supported by the device, use the MAX_NUM_CLIP_PLANES property of the GetDeviceInfo method for the IDLgrBuffer, IDLgrClipboard, IDLgrWindow, and IDLgrVRML objects.

**Note**

Clipping planes are equivalent to cutting planes (refer to the CUTTING_PLANES property). The CUTTING_PLANES will be applied first, then the CLIP_PLANES (until a maximum number of planes is reached)..

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## COMPOSITE_FUNCTION

An integer value that determines the composite function to be used to measure the value of a pixel on the viewing plane by analyzing the voxels falling along the corresponding ray. Specify one of the following compositing functions:

- 0 = Alpha (default): Alpha-blending. The recursive equation

  ```
  dest' = src * srcalpha + dest * (1 - srcalpha)
  ```

  is used to compute the final pixel color.
- 1 = MIP: Maximum intensity projection. The value of each pixel on the viewing plane is set to the brightest voxel, as determined by its opacity. The most opaque voxel's color appropriation is then reflected by the pixel on the viewing plane.
- 2 = Alpha sum: Alpha-blending. The recursive equation

  ```
  dest' = src + dest * ( 1 - srcalpha)
  ```

  is used to compute the final pixel color. This equation assumes that the color tables have been pre-multiplied by the opacity tables. The accumulated values can be no greater than 255.
- 3 = Average: Average-intensity projection. The resulting image is the average of all voxels along the corresponding ray. Disables lighting and only works with grey scale palettes. Will not work with four-channel volumes..

In a property sheet, this property appears as an enumerated list with the following options:

- Alpha blending
- Maximum intensity projection
- Alpha sum

- Average intensity

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Composite function | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## CUTTING_PLANES

A floating-point array with dimensions (4, *n*) specifying the coefficients of *n* cutting planes. The cutting plane coefficients are in the form {{$n_x$, $n_y$, $n_z$, $D$}, ...} where $(n_x)X+(n_y)Y+(n_z)Z+ D > 0$, and (*X, Y, Z*) are the voxel coordinates. To clear the cutting planes, set this property to any scalar value (e.g. CUTTING_PLANES = 0). By default, no cutting planes are defined.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Cutting planes | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DATA0

A three-element array of any type of the format ($d_x$, $d_y$, $d_z$), which specifies a data volume. Setting this property is the same as including the $vol_0$ argument at creation time. If the data volume dimensions do not match those of any pre-existing data in DATA1, DATA2, or DATA3, all existing data is removed from the object..

| **Property Type** | Array of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATA1

A three-element array of any type of the format ($d_x$, $d_y$, $d_z$), which specifies a data volume. Setting this property is the same as including the $vol_1$ argument at creation

time. If the data volume dimensions do not match those of any pre-existing data in DATA0, DATA2, or DATA3, all existing data is removed from the object..

| **Property Type** | Array of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATA2

A three-element array of any type of the format ($d_x$, $d_y$, $d_z$), which specifies a data volume. Setting this property is the same as including the $vol_2$ argument at creation time. If the data volume dimensions do not match those of any pre-existing data in DATA0, DATA1, or DATA3, all existing data is removed from the object..

| **Property Type** | Array of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DATA3

A three-element array of any type of the format ($d_x$, $d_y$, $d_z$), which specifies a data volume. Setting this property is the same as including the $vol_3$ argument at creation time. If the data volume dimensions do not match those of any pre-existing data in DATA0, DATA1, or DATA2, all existing data is removed from the object.

**Note**

DATA0, DATA1, DATA2, and DATA3 sizes are dynamic..

| **Property Type** | Array of any type | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## DEPTH_CUE

A two-element floating-point array [*zbright, zdim*] specifying the near and far Z planes between which depth cueing is in effect. Depth cueing is only honored when drawing to a destination object that uses the RGB color model.

Depth cueing causes an object to appear to fade into the background color of the view object with changes in depth. If the depth of an object is further than *zdim* (that is, if the object's location in the Z direction is farther from the origin than the value specified by *zdim*), the object will be painted in the background color.

Similarly, if the object is closer than the value of *zbright*, the object will appear in its "normal" color. Anywhere in-between, the object will be a blend of the background color and the object color. For example, if the DEPTH_CUE property is set to [-1,1], an object at the depth of 0.0 will appear as a 50% blend of the object color and the view color.

The relationship between $Z_{bright}$ and $Z_{dim}$ determines the result of the rendering:

- $Z_{bright} < Z_{dim}$: Rendering darkens with depth.
- $Z_{bright} > Z_{dim}$: Rendering brightens with depth.
- $Z_{bright} = Z_{dim}$: Disables depth cueing.

You can disable depth cueing by setting $z_{bright} = z_{dim}$. The default is [0.0, 0.0]..

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Depth cue range | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_DISABLE

An integer value that determines whether depth testing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth testing. A model may also enable or disable depth testing.
- Set this property to 1 to explicitly disable depth buffer testing while drawing this object.
- Set this property to 2 to explicitly enable depth testing for this object.

Disabling depth testing allows an object to draw itself on top of other objects already on the screen, even if the object is located behind them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_TEST_FUNCTION

An integer value that determines the depth test function. Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always sets a depth test function of LESS. A model may also set a depth test function value. The graphics device compares the object's depth at a particular pixel location with the depth stored in the depth buffer at that same pixel location. If the comparison test passes, the object's pixel is drawn at that location on the screen and the depth buffer is updated (if depth writing is enabled).

Set this property to any of the following values to use the desired function while rendering this object.

- 0 = INHERIT - use value from parent model or view.
- 1 = NEVER - never passes.
- 2 = LESS - passes if the object's depth is less than the depth buffer's value.
- 3 = EQUAL - passes if the object's depth is equal to the depth buffer's value.
- 4 = LESS OR EQUAL - passes if the object's depth is less than or equal to the depth buffer's value.
- 5 = GREATER - passes if the object's depth is greater than or equal to the depth buffer's value.
- 6 = NOT EQUAL - passes if the object's depth is not equal to the depth buffer's value.
- 7 = GREATER OR EQUAL - passes if the object's depth is greater than or equal to the depth buffer's value.
- 8 = ALWAYS - always passes

Less means closer to the viewer.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Test Enable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DEPTH_WRITE_DISABLE

An integer value that determines whether depth writing is disabled.

- Set this property to 0 (the default) to inherit the value set by the parent model or view. The parent view always enables depth writing. A model may also enable or disable depth writing.
- Set this property to 1 to explicitly disable depth buffer writing while rendering this object.
- Set this property to 2 to explicitly enable depth writing for this object.

Disabling depth writing allows an object to be overdrawn by other objects, even if the object is located in front of them.

This property is registered as an enumerated list, but it is hidden by default.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Depth Write Disable | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HIDE

A Boolean value indicating whether this object should be drawn:

- 0 = Draw graphic (the default)
- 1 = Do not draw graphic

In a property sheet, this property appears as an enumerated list with the following options:

- True = Draw graphic (the default)

- False = Do not draw graphic..

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Show | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## HINTS

An integer value that specifies one of the following acceleration hints:

- 0 = Disables all acceleration hints (default).
- 1 = Enables Euclidean distance map (EDM) acceleration. This option generates a volume map containing the distance from any voxel to the nearest non-zero opacity voxel. The map is used to speed ray casting by allowing the ray to jump over open spaces. It is most useful with sparse volumes. After setting the EDM hint, the draw operation generates the volume map; this process can take some time. Subsequent draw operations will reuse the generated map and may be much faster, depending on the volume's sparseness. A new map is not automatically generated to match changes in opacity tables or volume data (for performance reasons). The user may force recomputation of the EDM map by setting the HINTS property to 1 again.
- 2 = Enables the use of multiple CPUs for volume rendering if the platforms used support such use. If HINTS is set to 2, IDL will use all the available (up to 8) CPUs to render portions of the volume in parallel.
- 3 = Selects the two acceleration options described above..

In a property sheet, this property appears as an enumerated list with the following options:

- Disable
- Euclidean distance map (EDM)
- Multiple CPU
- EDM and Multiple CPU

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Acceleration hints | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## INTERPOLATE

A Boolean value that determines whether to use Trilinear interpolation to determine the data value for each step on a ray. Setting this property improves the quality of images produced, at the cost of more computing time, especially when the volume has low resolution with respect to the size of the viewing plane. Nearest neighbor sampling is used by default..

In a property sheet, this property appears as an enumerated list with the following options:

- Nearest neighbor
- Trilinear

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Interpolation | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## LIGHTING_MODEL

A Boolean value that determines whether to use the current lighting model during rendering in conjunction with a local gradient evaluation.

**Note**

Only DIRECTIONAL light sources are honored by the volume object. Because normals must be computed for all voxels in a lighted view, enabling light sources increases the rendering time..

| | | | |
|---|---|---|---|
| **Property Type** | BOOLEAN | | |
| **Name String** | Use lighting | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## NO_COPY

A Boolean value that determines whether to relocate volume data from the input variables to the volume object, leaving the input variables undefined. Only the

DATA0 property and the *vol0* argument are affected. If this property is omitted, the input volume data will be duplicated and a copy will be stored in the object..

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## OPACITY_TABLE0

A 256-element byte array that specifies the opacity table for DATA0. The default table is the linear ramp..

| | | | |
|---|---|---|---|
| **Property Type** | Byte array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## OPACITY_TABLE1

A 256-element byte array that specifies the opacity table for DATA1. The default table is the linear ramp. This table is used only when VOLUME_SELECT is set equal to 1..

| | | | |
|---|---|---|---|
| **Property Type** | Byte array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that defines the color palette of this object. This property is only used if the destination device is using the RGB color model. If so, and a color value for the object is specified as a color index value, the palette set by this property is used to translate the color to RGB space. If the PALETTE property on this object is not set, the destination object PALETTE property is used (which defaults to a grayscale ramp)..

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## PARENT

An object reference to the object that contains this object..

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RENDER_STEP

A three-element floating-point vector of the form [*x*, *y*, *z*] that specifies the stepping factor through the voxel matrix..

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | XYZ render step | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## RGB_TABLE0

A 256 x 3-element byte array that specifies the RGB color table for DATA0. The default table is the linear ramp. .

| | | | |
|---|---|---|---|
| **Property Type** | Byte array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## RGB_TABLE1

A 256 x 3-element byte array that specifies the RGB color table for DATA1. The default table is the linear ramp. This table is used only when VOLUME_SELECT is set equal to 1..

| | | | |
|---|---|---|---|
| **Property Type** | Byte array | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## TWO_SIDED

A Boolean value that determines whether the lighting model uses a two-sided voxel gradient. The two-sided gradient is different from the one-sided gradient (default) in that the absolute value of the inner product of the light direction and the surface gradient is used instead of clamping to 0.0 for negative values. .

In a property sheet, this property appears as an enumerated list with the following options:

- One-sided
- Two-sided

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Voxel gradient | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VALID_DATA

An integer array (one per volume, DATA0, DATA1, etc.) which have the value 1 if volume data has been loaded for that volume and 0 if that volume data is currently undefined..

| **Property Type** | Integer array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## VOLUME_SELECT

An integer value that selects the form of the volume to be rendered. The VOLUME_SELECT property is used to modify the `src` and `srcalpha` parameters for the COMPOSITE_FUNCTION property.

- 0 = render voxels from the 8bit DATA0 volume (the default)

```
src = RGB_TABLE0[DATA0]
srcalpha = OPACITY_TABLE0[DATA0]
```

- 1 = render voxels formed by modulating the RGBA components from DATA0 and DATA1 (after RGB and OPACITY table lookups).

```
src = (RGB_TABLE0[DATA0]*RGB_TABLE1[DATA1])/256
srcalpha=(OPACITY_TABLE0[DATA0]*OPACITY_TABLE1[DATA1])/256
```

- 2 = render voxels formed using a byte from DATA0 (red), DATA1 (green), DATA2(blue) and DATA3(alpha). The keywords OPACITY_TABLE0 and RGB_TABLE0, described above, are used to indirect the data from each volume before forming the RGBA pixel.

```
src=(RGB_TABLE[DATA0,0],RGB_TABLE[DATA1,1],RGB_TABLE[DATA2,2])/256
srcalpha = (OPACITY_TABLE0[DATA3])/256.
```

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert X coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}X = s_0 + s_1 * \text{Data}X$$

Recommended values are:

$$[(-X_{min})/(X_{max}-X_{min}),\ 1/(X_{max}-X_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## XRANGE

A two-element double-precision floating-point vector of the form [*xmin*, *xmax*] that specifies the range of *x* data coordinates covered by the graphic object..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## YCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Y coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Y = s_0 + s_1 * \text{Data}Y$$

Recommended values are:

$$[(-Y_{min})/(Y_{max}-Y_{min}),\ 1/(Y_{max}-Y_{min})]$$

The default is [0.0, 1.0]. IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## YRANGE

A two-element double-precision floating-point vector of the form [*ymin*, *ymax*] that specifies the range of *y* data coordinates covered by the graphic object..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## ZBUFFER

A Boolean value that determines whether to clip the rendering to the current Z-buffer and then update the buffer. The default is to not modify the current Z-buffer..

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Update Z buffer | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ZCOORD_CONV

A floating-point vector, $[s_0, s_1]$, of scaling factors used to convert Z coordinates from data units to normalized units. The formula for the conversion is as follows:

$$\text{Normalized}Z = s_0 + s_1 * \text{Data}Z$$

Recommended values are:

$$[(-Z_{min})/(Z_{max}-Z_{min}),\ 1/(Z_{max}-Z_{min})]$$

The default is [0.0, 1.0]IDL converts, maintains, and returns this data as double-precision floating-point..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## ZERO_OPACITY_SKIP

A Boolean value that determines whether to skip voxels with an opacity of 0. This property can increase the output contrast of MIP (MAXIMUM_INTENSITY) projections by allowing the background to show through. If this property is set,

voxels with an opacity of zero will not modify the Z-buffer. The default (not setting the property) continues to render voxels with an opacity of zero..

| **Property Type** | BOOLEAN | | |
|---|---|---|---|
| **Name String** | Skip zero opacity | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ZRANGE

A two-element double-precision floating-point vector of the form [*zmin*, *zmax*] that specifies the range of *z* data coordinates covered by the graphic object..

| **Property Type** | Floating-point vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## Obsolete Properties

The following properties are obsolete:

- CUTTING_PLANES

# IDLgrVolume::Cleanup

The IDLgrVolume::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrVolume::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrVolume::ComputeBounds

The IDLgrVolume::ComputeBounds procedure method computes the smallest bounding box that contains all voxels whose opacity lookup is greater than a given opacity value. The BOUNDS property is updated to the computed bounding box.

## Syntax

*Obj* -> [IDLgrVolume::]ComputeBounds [, OPACITY=*value*] [, /RESET] [, VOLUMES=*int array*]

## Arguments

None

## Keywords

### OPACITY

Set this keyword to the opacity value to be used to determine which voxels are included within the bounding box. All voxels whose opacity lookup is greater than this value will be included. The default value is zero.

### RESET

Set this keyword to cause the BOUNDS keyword of IDLgrVolume::Init to be reset to contain the entire volume.

### VOLUMES

Set this keyword to an array of integers which select which volumes to consider when computing the bounding box. A non-zero value selects a volume to be searched. The default is to search all loaded volumes. For example: VOLUMES=[0,1] will cause ComputeBounds to search only the volume loaded in DATA1.

## Version History

Introduced: 5.0

# IDLgrVolume::GetCTM

The IDLgrVolume::GetCTM function method returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Syntax

*Result* = *Obj* -> [IDLgrVolume::]GetCTM( [, DESTINATION=*objref*] [, PATH=*objref(s)*] [, TOP=*objref to IDLgrModel object*] )

## Return Value

Returns the 4-by-4 double-precision floating-point graphics transform matrix from the current object upward through the graphics tree.

## Arguments

None

## Keywords

### DESTINATION

Set this keyword to the object reference of a destination object to specify that the projection matrix for the View object in the current tree be included in the returned transformation matrix. The resulting matrix will transform a point in the data space of the object on which the GetCTM method is called into a normalized coordinate system (-1 to +1 in X, Y, and Z), relative to the View object that contains the volume object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the transformation matrix. Each path object reference specified with this keyword must contain an alias. The transformation matrix is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrVolume::GetCTM is called from within a Draw method, with the DESTINATION keyword set and the PATH keyword not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

### TOP

Set this keyword equal to the object reference to an IDLgrModel object to specify that the returned matrix accumulate from the object on which the GetCTM method is called up to but not including the specified model object.

## Version History

Introduced: 5.0

# IDLgrVolume::GetProperty

The IDLgrVolume::GetProperty procedure method retrieves the value of a property or group of properties for the volume.

## Syntax

*Obj* -> [IDLgrVolume::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under “IDLgrVolume Properties” on page 3657 that contains the word “Yes” in the “Get” column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object’s superclass.

## Version History

Introduced: 5.0

# IDLgrVolume::Init

The IDLgrVolume::Init function method initializes the volume object. At least one volume must be specified, via arguments or keywords.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrVolume' [, *vol0* [, *vol1* [, *vol2* [, *vol3*]]]]
[, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrVolume::]Init([*vol0* [, *vol1* [, *vol2* [, *vol3*]]]]
[, *PROPERTY=value*]) (*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

### $vol_0$

A three-dimensional array ($d_x$, $d_y$, $d_z$) which specifies a data volume.

### $vol_1$

A three-dimensional array ($d_x$, $d_y$, $d_z$) which specifies a data volume.

### $vol_2$

A three-dimensional array ($d_x$, $d_y$, $d_z$) which specifies a data volume.

### $vol_3$

A three-dimensional array ($d_x$, $d_y$, $d_z$) which specifies a data volume.

**Note**

If two or more of the above arguments are specified, they must have matching dimensions.

## Keywords

Any property listed under "IDLgrVolume Properties" on page 3657 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

CLIP_PLANES keyword: 5.6

# IDLgrVolume::PickVoxel

The IDLgrVolume::PickVoxel function method computes the coordinates of the voxel projected to a location specified by the 2-D device coordinates point, [$x_i$, $y_i$], and the current Z-buffer. The function returns the volume indices as a a vector of three long integers. If the selected point is not within the volume, this function returns [-1,-1,-1].

## Syntax

*Result* = *Obj* -> [IDLgrVolume::]PickVoxel ( *Win*, *View*, *Point* [, PATH=*objref(s)*] )

## Return Value

Returns the volume indices as a a vector of three long integers. If the selected point is not within the volume, this function returns [-1,-1,-1].

## Arguments

### Win

The IDLgrWindow object from which the Z-buffer is to be used.

### View

The IDLgrView object that contains the volume.

### Point

The [*x*, *y*] viewport coordinates of the point chosen.

## Keywords

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a voxel coordinate. Each path object reference specified with this keyword must contain an alias. The voxel coordinate is computed for the version of the object falling within the specified path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.0

# IDLgrVolume::SetProperty

The IDLgrVolume::SetProperty procedure method sets the value of a property or group of properties for the volume.

## Syntax

*Obj* -> [IDLgrVolume::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrVolume Properties” on page 3657 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrVRML

The IDLgrVRML object allows you to save the contents of an Object Graphics hierarchy into a VRML 2.0 format file. The graphics tree can only contain a single view due to limitations in the VRML specification. The resulting VRML file is interactive and allows you to explore the geometry interactively using a VRML browser.

**Note**

Objects or subclasses of this type can not be saved or restored.

Aspect ratios are difficult to duplicate as they can be browser dependent. The object is limited to the primitives supported by VRML. Texture maps (and images) will be inlined into the output file. While this will generate large VRML files, the files are fully self-contained.

Several entities cannot be translated perfectly. These include:

## IDLgrImage objects

Rotation and Z buffer behavior are not completely supported. Image objects will be converted into texture mapped polygons. BLEND_FUNCTION is not completely supported (only binary srcAlpha,1-srcAlpha) This function is applied automatically if an alpha channel is present. It is also very browser dependent. Channel masks are not supported.

## IDLgrPolygon and IDLgrSurface objects

Hidden line/hidden point display, color and vertex color blending with texture colors, and bottom color are not supported. Shading may be browser dependent. Front face culling is not supported and back face culling is only supported at the browser's discretion.

## IDLgrLight objects

Lighting scope and intensity may be browser dependent.

## IDLgrText objects

Text using the ONGLASS property is only supported for the initial view.

## IDLgrViewgroup, IDLgrScene, IDLgrVolume objects

These objects are not supported.

### IDLgrPalette objects

Palette objects are simulated using an RGB color model.

### IDLgrPattern objects

Only solid or clear patterns are supported.

### IDLgrFont, IDLgrSymbol objects

The THICK property is not supported.

### IDLgrPolyline, IDLgrSymbol, IDLgrSurface, IDLgrPolygon and IDLgrPlot objects

Line attributes (thickness, linestyle) are not supported.

### IDLgrView objects

Z-clipping control, aspect ratio preservation, the LOCATION property, and orthographic projections are not supported.

### Destination objects

The COLOR_MODEL property is not fully supported in Indexed Color mode, when using a SHADER_RANGE (an RGB model will be substituted instead). The QUALITY property is not supported.

## Superclasses

IDLitComponent

## Creation

See “IDLgrVRML::Init” on page 3702.

## Properties

Objects of this class have the following properties. See “IDLgrVRML Properties” on page 3687 for details on individual properties.

- ALL
- COLOR_MODEL

- DIMENSIONS
- FILENAME
- GRAPHICS_TREE
- N_COLORS
- PALETTE
- QUALITY
- REGISTER_PROPERTIES
- RESOLUTION
- SCREEN_DIMENSIONS
- UNITS
- WORLDINFO
- WORLDTITLE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrVRML::Cleanup
- IDLgrVRML::Draw
- IDLgrVRML::GetDeviceInfo
- IDLgrVRML::GetFontnames
- IDLgrVRML::GetProperty
- IDLgrVRML::GetTextDimensions
- IDLgrVRML::Init
- IDLgrVRML::SetProperty

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.1

# IDLgrVRML Properties

IDLgrVRML objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrVRML::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrVRML::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrVRML::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the retrievable properties associated with this object.

| | | | |
|---|---|---|---|
| **Property Type** | Structure | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR_MODEL

An integer value that determines whether to use the indexed color model for the buffer:

- 0 = RGB (the default)
- 1 = Color indexed.

In a property sheet, this property appears as an enumerated list with the following options:

- RGB
- Indexed

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Color model | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## DIMENSIONS

A two-element integer vector of the form [*width, height*] to specify the dimensions of the window in units specified by the UNITS property. The default is [640,480].

**Note**

The only use of this property is to support the use of normalized coordinates for the dimensions of the IDLgrView object passed to the IDLgrVRML::Draw method..

| | | | |
|---|---|---|---|
| **Property Type** | Integer vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## FILENAME

A string that specifies the name of a file into which the vector data will be saved. The default is `idl.wrl`..

| | | | |
|---|---|---|---|
| **Property Type** | String | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## GRAPHICS_TREE

An object reference of type IDLgrView. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object. .

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## N_COLORS

An integer that specifies the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to indexed.

| **Property Type** | INTEGER | | |
|---|---|---|---|
| **Name String** | Number of colors | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) that specifies the red, green, and blue values that are to be loaded into the buffer's color lookup table.

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## QUALITY

An integer indicating the rendering quality at which graphics are to be drawn to the buffer. Valid values are:

- 0=Low
- 1=Medium
- 2=High (the default).
- In a property sheet, this property appears as an enumerated list with the following options:
- Low
- Medium

- High

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Quality | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RESOLUTION

A two-element floating-point vector of the form [*xres*, *yres*] specifying the device resolution in centimeters per pixel.

**Note**

This property is used for text scaling and partial aspect ratio preservation only. The default value is [0.0352778, 0.0352778] (72 DPI).

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Resolution | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## SCREEN_DIMENSIONS

A two-element integer vector of the form [*width*, *height*] specifying the dimensions of the overall screen dimensions for the screen with which this object associated. The screen dimensions are measured in device units..

| **Property Type** | Integer vector | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## UNITS

An integer that indicates the units of measure for the DIMENSIONS property. Valid values are:

- 0 = Device (the default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized (relative to 1600 x 1200)..

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## WORLDINFO

A list of strings for the info field of the VRML WorldInfo node. The default is the null string, ''.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## WORLDTITLE

A string containing the title for the VRML WorldInfo node, TITLE field. The default is `'IDL VRML file'`.

| **Property Type** | String | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# IDLgrVRML::Cleanup

The IDLgrVRML::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrVRML::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrVRML::Draw

The IDLgrVRML::Draw procedure method draws the given picture to this graphics destination.

## Syntax

*Obj* -> [IDLgrVRML::]Draw [, *Picture*]

## Arguments

### Picture

The view (an instance of an IDLgrView object) to be drawn. If the view has a LOCATION property, it is ignored.

## Keywords

None

## Version History

Introduced: 5.1

# IDLgrVRML::GetDeviceInfo

The IDLgrVRML::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=1 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

## Syntax

*Obj* -> [IDLgrVRML::]GetDeviceInfo [, ALL=*variable*]
[, MAX_NUM_CLIP_PLANES=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

## Arguments

None

## Keywords

### ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

### MAX_NUM_CLIP_PLANES

Set this keyword to a named variable that upon return will contain an integer that specifies the maximum number of user-defined clipping planes supported by the device.

### MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, *MAX_TEXTURE_DIMENSIONS* contains a two element integer array that specifies the maximum texture size supported by the device.

### MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, *MAX_VIEWPORT_DIMENSIONS* contains a two element integer array that specifies the maximum size of a graphics display supported by the device.

### NAME

Set this keyword equal to a named variable. Upon return, *NAME* contains the name of the rendering device as a string.

### NUM_CPUS

Set this keyword equal to a named variable. Upon return, *NUM_CPUS* contains an integer that specifies the number of CPUs that are known to, and available to IDL.

**Note**

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI IRIX, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

### VENDOR

Set this keyword equal to a named variable. Upon return, *VENDOR* contains the name of the rendering device creator as a string.

### VERSION

Set this keyword equal to a named variable. Upon return, *VERSION* contains the version of the rendering device driver as a string.

## Version History

Introduced: 5.1

MAX_NUM_CLIP_PLANES keyword: 5.6

# IDLgrVRML::GetFontnames

The IDLgrVRML::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

## Syntax

*Result* = *Obj* ->[IDLgrVRML::]GetFontnames( *FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*] )

## Return Value

Returns the list of available fonts that can be used in IDLgrFont objects.

## Arguments

### FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name, such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

## Keywords

### IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

### STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is

the string, “*”, which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

## Version History

Introduced: 5.1

# IDLgrVRML::GetProperty

The IDLgrVRML::GetProperty procedure method retrieves the value of a property or group of properties for the VRML object.

## Syntax

*Obj* -> [IDLgrVRML::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrVRML Properties" on page 3687 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.1

# IDLgrVRML::GetTextDimensions

The IDLgrVRML::GetTextDimensions function method retrieves the dimensions of a text or axis object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units. If the object specified is an axis object, the result encompasses the tick labels and the title of the axis (if any).

## Syntax

*Result* = *Obj* ->[IDLgrVRML::]GetTextDimensions( *TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*] )

## Return Value

Returns a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units.

## Arguments

### TextObj

The object reference to a text or axis object for which the text dimensions are requested.

## Keywords

### DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values represent the distance to travel (parallel to the UPDIR vector) from the text baseline to reach the bottom of the lowest descender in the string. All values will be negative numbers, or zero. This keyword is valid only if *TextObj* is an IDLgrText object.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If

this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrVRML::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.1

# IDLgrVRML::Init

The IDLgrVRML::Init function method initializes the VRML object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrVRML' [, *PROPERTY*=*value*])

or

*Result* = *Obj* -> [IDLgrVRML::]Init([*PROPERTY*=*value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrVRML Properties" on page 3687 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.1

# IDLgrVRML::SetProperty

The IDLgrVRML::SetProperty procedure method sets the value of a property or group of properties for the VRML world.

## Syntax

*Obj* -> [IDLgrVRML::]SetProperty[, *PROPERTY*=*value*]

## Arguments

None

## Keywords

Any property listed under “IDLgrVRML Properties” on page 3687 that contains the word “Yes” in the “Set” column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.1

# IDLgrWindow

A window object is a representation of an on-screen area on a display device that serves as a graphics destination.

**Note**

Objects or subclasses of this type can not be saved or restored.

### Note on Window Size Limits

The OpenGL libraries IDL uses impose limits on the maximum size of a drawable area. The limits are device-dependent — they depend both on your graphics hardware and the setting of the RENDERER property. Currently, the smallest maximum drawable area on any IDL platform is 1280 x 1024 pixels; the limit on your system may be larger.

## Superclasses

IDLitComponent

## Creation

See “IDLgrWindow::Init” on page 3729.

## Properties

Objects of this class have the following properties. See “IDLgrWindow Properties” on page 3707 for details on individual properties.

- ALL
- CURRENT_ZOOM
- DISPLAY_NAME (X Only)
- IMAGE_DATA
- N_COLORS
- QUALITY
- RENDERER
- RETAIN
- COLOR_MODEL
- DIMENSIONS
- GRAPHICS_TREE
- LOCATION
- PALETTE
- REGISTER_PROPERTIES
- RESOLUTION
- SCREEN_DIMENSIONS

- TITLE
- VIRTUAL_DIMENSIONS
- ZBUFFER_DATA
- UNITS
- VISIBLE_LOCATION

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- IDLgrWindow::Cleanup
- IDLgrWindow::Draw
- IDLgrWindow::Erase
- IDLgrWindow::GetContiguousPixels
- IDLgrWindow::GetDeviceInfo
- IDLgrWindow::GetFontnames
- IDLgrWindow::GetProperty
- IDLgrWindow::GetTextDimensions
- IDLgrWindow::Iconify
- IDLgrWindow::Init
- IDLgrWindow::PickData
- IDLgrWindow::Read
- IDLgrWindow::Select
- IDLgrWindow::SetCurrentCursor
- IDLgrWindow::SetProperty
- IDLgrWindow::Show

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDLgrWindow Properties

IDLgrWindow objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via IDLgrWindow::GetProperty. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via IDLgrWindow::Init. Properties with the word “Yes” in the “Set” column in the property table can be set via IDLgrWindow::SetProperty.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## ALL

An anonymous structure containing the values of all of the properties associated with the *state* of this object. State information about the object includes things like color, range, tick direction, etc., but not image, vertex, or connectivity data, or user values.

**Note**

The fields of this structure may change in subsequent releases of IDL.

| **Property Type** | Structure | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## COLOR_MODEL

An integer value that determines whether to use indexed color as the color model for the window:

- 0 = RGB (default)
- 1 = Color Index

**Note**

For some X11 display situations, IDL may not be able to support a color index model destination object in object graphics. We do, however, guarantee that an RGB color model destination will be available for all display situations..

In a property sheet, this property appears as an enumerated list with the following options:

- RGB
- Indexed color

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Color model | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## CURRENT_ZOOM

A floating-point value that represents the current zoom factor associated with this window.

| | | | |
|---|---|---|---|
| **Property Type** | FLOAT | | |
| **Name String** | Zoom factor | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** Yes |

## DIMENSIONS

A two-element integer vector of the form [*width*, *height*] to specify the dimensions of the window in units specified by the UNITS property. By default, if no value is specified for DIMENSIONS, IDL uses the value of the “Default Window Width” and “Default Window Height” preferences set in the IDL Development Environment’s (IDLDE) Preferences dialog. If there is no preference file for the IDLDE, the DIMENSIONS property is set equal to one quarter of the screen size. There are limits on the maximum size of an IDLgrWindow object; see “Note on Window Size Limits” on page 3705 for details.

**Note**

Changing DIMENSIONS properties is merely a request and may be ignored for various reasons. .

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Dimensions | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## DISPLAY_NAME (X Only)

A string that specifies the name of the X Windows display on which the window is to appear.

| | | | |
|---|---|---|---|
| **Property Type** | STRING | | |
| **Name String** | Display name | | |
| **Get:** Yes | **Set:** Yes | **Init:** No | **Registered:** Yes |

## GRAPHICS_TREE

An object reference of type IDLgrScene, IDLgrViewgroup, or IDLgrView. If this property is set to a valid object reference, calling the Draw method on the destination object with no arguments will cause the object reference associated with this property to be drawn. If this object is valid and the destination object is destroyed, this object reference will be destroyed as well. By default the GRAPHICS_TREE property is set equal to the null-object.

| | | | |
|---|---|---|---|
| **Property Type** | Object reference | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** No |

## IMAGE_DATA

A byte array representing the image that is currently displayed in the window. If the window object uses an RGB color model, the returned array will have dimensions (3, *winXSize*, *winYSize*), or (4, *winXSize*, *winYSize*) if an alpha channel is included. If the window object uses an Indexed color model, the returned array will have dimensions

(*winXSize*, *winYSize*). See "IDLgrWindow::Read" on page 3734 for more information.

| **Property Type** | Byte array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## LOCATION

A two-element floating-point vector of the form [*x*, *y*] to specify the location of the upper lefthand corner of the window relative to the display screen, in units specified by the UNITS property. By default, the window is positioned at one of four quadrants on the display screen, and the location is measured in device units.

**Note**

Changing LOCATION properties is merely a request and may be ignored for various reasons. LOCATION may be adjusted to take into account window decorations..

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Location | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## N_COLORS

An integer value that specifies the number of colors (between 2 and 256) to be used if COLOR_MODEL is set to Indexed (1). This property is ignored if COLOR_MODEL is set to RGB (0).

**Note**

If COLOR_MODEL is set to Color Index (1), setting N_COLORS is treated as a request to your operating system. You should always check the actual number of available colors for any Color Indexed destination with the

IDLgrWindow::GetProperty method. The actual number of available colors depends on your system and also on how you have used IDL..

| | | | |
|---|---|---|---|
| **Property Type** | INTEGER | | |
| **Name String** | Number of colors | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## PALETTE

An object reference to a palette object (an instance of the IDLgrPalette object class) to specify the red, green, and blue values that are to be loaded into the graphics destination's color lookup table, applicable if the Indexed color model is used..

This property is registered as a user-defined property, but it is hidden by default.

| | | | |
|---|---|---|---|
| **Property Type** | USERDEF | | |
| **Name String** | Color palette | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## QUALITY

An integer indicating the rendering quality at which graphics are to be drawn to this destination. Valid values are:

- 0 = Low
- 1 = Medium
- 2 = High (default)..

In a property sheet, this property appears as an enumerated list with the following options:

- Low
- Medium

- High

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Draw quality | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## REGISTER_PROPERTIES

A Boolean value that determines whether to register properties available for this object. Set this property to automatically register the following properties of the object for display in a property sheet. This property is useful mainly when creating iTools. By default, no properties are registered.

| | | | |
|---|---|---|---|
| **Property Type** | Boolean | | |
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## RENDERER

An integer value indicating which graphics renderer to use when drawing objects within the window. Valid values are:

- 0 = Platform native OpenGL
- 1 = IDL's software implementation

By default, your platform's native OpenGL implementation is used. If your platform does not have a native OpenGL implementation, IDL's software implementation is used regardless of the value of this property. See "Hardware vs. Software Rendering" in Chapter 34 of the *Using IDL* manual for details. Your choice of renderer may also affect the maximum size of an IDLgrWindow object; see "Note on Window Size Limits" on page 3705 for details.

In a property sheet, this property appears as an enumerated list with the following options:

- OpenGL

- Software.

| **Property Type** | ENUMLIST | | |
|---|---|---|---|
| **Name String** | Renderer | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## RESOLUTION

A floating-point vector of the form [*xres*, *yres*] reporting the pixel resolution, measured in centimeters per pixel. This value is stored in double precision.

| **Property Type** | FLOAT | | |
|---|---|---|---|
| **Name String** | Resolution | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** Yes |

## RETAIN

An integer value that specifies how backing store should be handled for the window. By default, if no value is specified for RETAIN, IDL uses the value of the “Backing Store” preference set in the IDL Development Environment’s (IDLDE) Preferences dialog. If there is no preference file for the IDLDE (that is, if you always use IDL in plain tty mode), the RETAIN property is set equal to 0 by default.

- 0 = No backing store.
- 1 = The server or window system is requested to provide the backing store. Note that requesting backing store from the server is only a request; backing store may not be provided in all situations.
- 2 = Requests that IDL provide the backing store directly. In some situations, IDL can not provide this backing store in Object Graphics. To see if IDL provided backing store, query the RETAIN property of IDLgrWindow::GetProperty. IDL may also alter the RENDERER property while attempting to provide backing store.

In IDL Object Graphics, it is almost always best to disable backing store (that is, set the RETAIN property equal to zero). This is because drawing to an off-screen pixmap (which is what happens when backing store is enabled) almost always bypasses any hardware graphics acceleration that may be available, causing all rendering to be done in software. To ensure that windows are redrawn properly,

enable the generation of expose events on the WIDGET_DRAW window and redraw the window explicitly when an expose event is received.

**Note**

If you are using software rendering (that is, the RENDERER property is set equal to one), IDL will refresh the window automatically regardless of the setting of the RETAIN property..

In a property sheet, this property appears as an enumerated list with the following options:

- No backing
- Server/Window
- IDL

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Retain | | |
| **Get:** Yes | **Set:** No | **Init:** Yes | **Registered:** Yes |

## SCREEN_DIMENSIONS

A two-element floating-point vector of the form [*width*, *height*] specifying the dimensions of the overall screen dimensions for the screen with which this window is associated. The screen dimensions are measured in device units.

**Note**

The maximum screen dimension size depends on the graphics device..

| | | | |
|---|---|---|---|
| **Property Type** | Floating-point vector | | |
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

## TITLE

A string that represents the title of the window..

| | | | |
|---|---|---|---|
| **Property Type** | STRING | | |
| **Name String** | Title | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## UNITS

An integer value that indicates the units of measure for the LOCATION and DIMENSIONS properties. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of the screen.

**Note**

If you set the value of the UNITS property (using the SetProperty method) without also setting the value of the LOCATION and DIMENSIONS properties, IDL will convert the current size and location values into the new units..

In a property sheet, this property appears as an enumerated list with the following options:

- Device
- Inches
- Centimeters
- Normalized

| | | | |
|---|---|---|---|
| **Property Type** | ENUMLIST | | |
| **Name String** | Units | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VIRTUAL_DIMENSIONS

A two-element integer vector, [width, height], specifying the dimensions of the virtual canvas for this window. The default is [0,0], indicating that the virtual canvas dimensions should match the visible dimensions (as specified via the DIMENSIONS keyword).

This property is registered as a user-defined property, but it is hidden by default.

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Virtual dimensions | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## VISIBLE_LOCATION

A two-element integer vector, [x,y], specifying the lower left location of the visible portion of the canvas (relative to the virtual canvas).

This property is registered as a user-defined property, but it is hidden by default..

| **Property Type** | USERDEF | | |
|---|---|---|---|
| **Name String** | Visible location | | |
| **Get:** Yes | **Set:** Yes | **Init:** Yes | **Registered:** Yes |

## ZBUFFER_DATA

A floating-point array representing the zbuffer that is currently within the buffer. The returned array will have dimensions (*xdim*, *ydim*).

| **Property Type** | Floating-point array | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** Yes | **Set:** No | **Init:** No | **Registered:** No |

# IDLgrWindow::Cleanup

The IDLgrWindow::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj* -> [IDLgrWindow::]Cleanup (*Only in subclass' Cleanup method*.)

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrWindow::Draw

The IDLgrWindow::Draw procedure method draws the specified scene or view object to this graphics destination.

**Note**

Objects are drawn to the destination device in the order that they are added to the model, view, viewgroup, or scene object that contains them.

# Syntax

*Obj* -> [IDLgrWindow::]Draw [, *Picture*] [, CREATE_INSTANCE={1 | 2}] [, /DRAW_INSTANCE]

# Arguments

## Picture

The view (an instance of an IDLgrView object), viewgroup (an instance of an IDLgrViewgroup object), or scene (an instance of an IDLgrScene object) to be drawn.

# Keywords

## CREATE_INSTANCE

Set this keyword equal to one specify that this scene or view is the unchanging part of a drawing. Some destinations can make an instance from the current window contents without having to perform a complete redraw. If the view or scene to be drawn is identical to the previously drawn view or scene, this keyword can be set equal to 2 to hint the destination to create the instance from the current window contents if it can.

## DRAW_INSTANCE

Set this keyword to specify that this scene or view is the changing part of a drawing. It is overlaid on the result of the most recent CREATE_INSTANCE draw.

# Version History

Introduced: 5.0

# IDLgrWindow::Erase

The IDLgrWindow::Erase procedure method erases the entire contents of the window.

## Syntax

*Obj* -> [IDLgrWindow::]Erase [, COLOR=*index or RGB vector*]

## Arguments

None

## Keywords

### COLOR

Set this keyword to the color to be used for the erase. The color may be specified as a color lookup table index or as an RGB vector. The default erase color is white.

## Version History

Introduced: 5.0

# IDLgrWindow::GetContiguousPixels

The IDLgrWindow::GetContiguousPixels function method returns an array of long integers whose length is equal to the number of colors available in the index color mode (that is, the value of the N_COLORS property).

The returned array marks contiguous pixels with the ranking of the range's size. This means that within the array, the elements in the largest available range are set to zero, the elements in the second-largest range are set to one, etc. Use this range to set an appropriate colormap for use with the SHADE_RANGE property of the IDLgrSurface and IDLgrPolygon object classes.

To get the largest contiguous range, you could use the following IDL command:

```
result = obj -> GetContiguousPixels()
Range0 = WHERE(result EQ 0)
```

A contiguous region in the colormap can be increasing or decreasing in values. The following would be considered contiguous:

```
[0,1,2,3,4]
[4,3,2,1,0]
```

## Syntax

*Result* = *Obj* -> [IDLgrWindow::]GetContiguousPixels()

## Return Value

Returns an array of long integers whose length is equal to the number of colors available in the index color mode.

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrWindow::GetDeviceInfo

The IDLgrWindow::GetDeviceInfo procedure method returns information which allows IDL applications to intelligently make decisions for optimal performance. For example, it allows an application to determine if RENDERER=0 is actually implemented in hardware. It also allows applications to make optimal quality decisions when dynamically building texture maps.

## Syntax

*Obj* -> [IDLgrWindow::]GetDeviceInfo [, ALL=*variable*]
[, MAX_NUM_CLIP_PLANES=*variable*]
[, MAX_TEXTURE_DIMENSIONS=*variable*]
[, MAX_VIEWPORT_DIMENSIONS=*variable*] [, NAME=*variable*]
[, NUM_CPUS=*variable*] [, VENDOR=*variable*] [, VERSION=*variable*]

## Arguments

None

## Keywords

### ALL

Set this keyword to a named variable which, upon return, contains a structure with the values of all the device information keywords as fields.

### MAX_NUM_CLIP_PLANES

Set this keyword to a named variable that upon return will contain an integer that specifies the maximum number of user-defined clipping planes supported by the device.

### MAX_TEXTURE_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_TEXTURE_DIMENSIONS contains a two element integer array that specifies the maximum texture size supported by the device.

### MAX_VIEWPORT_DIMENSIONS

Set this keyword equal to a named variable. Upon return, MAX_VIEWPORT_DIMENSIONS contains a two element integer array that specifies the maximum size of a graphics display supported by the device.

### NAME

Set this keyword equal to a named variable. Upon return, NAME contains the name of the rendering device as a string.

### NUM_CPUS

Set this keyword equal to a named variable. Upon return, NUM_CPUS contains an integer that specifies the number of CPUs that are known to, and available to IDL.

**Note**

The NUM_CPUS keyword accurately returns the number of CPUs for the SGI IRIX, SUN, and Microsoft Windows platforms. For platforms other than these, the number returned may not reflect the actual number of CPUs available to IDL in the current system.

### VENDOR

Set this keyword equal to a named variable. Upon return, VENDOR contains the name of the rendering device creator as a string.

### VERSION

Set this keyword equal to a named variable. Upon return, VERSION contains the version of the rendering device driver as a string.

## Version History

Introduced: 5.0

MAX_NUM_CLIP_PLANES keyword: 5.6

# IDLgrWindow::GetFontnames

The IDLgrWindow::GetFontnames function method returns the list of available fonts that can be used in IDLgrFont objects. This method will only return the names of the available TrueType fonts. Hershey fonts will not be returned; see Appendix H, "Fonts" for more information.

## Syntax

*Result* = *Obj* -> [IDLgrWindow::]GetFontnames(*FamilyName* [, IDL_FONTS={0 | 1 | 2}] [, STYLES=*string*] )

## Return Value

Returns the list of available fonts that can be used in IDLgrFont objects.

## Arguments

### FamilyName

A string representing the name of the font family to which all of the returned fonts must belong. The string may be a fully specified family name—such as "Helvetica". You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. To return all available family names, use "*".

## Keywords

### IDL_FONTS

Set this keyword to specify where to search for fonts that IDL may use. Set IDL_FONT to 1 to select only fonts installed by IDL and to 2 to select only fonts detected in the host operating system. The default value is 0, specifying that both IDL and operating system fonts should be returned.

### STYLES

Set this keyword to a string specifying the styles that are to be matched by the returned font names. You can set STYLES to a fully specified style string, such as "Bold Italic". If you set STYLES to the null string, ' ', only fontnames without style modifiers will be returned. You can use both "*" and "?" as wildcard characters, matching any number of characters or one character respectively. The default value is

the string, “*”, which returns all fontnames containing the *FamilyName* argument, with or without style modifiers.

## Version History

Introduced: 5.0

# IDLgrWindow::GetProperty

The IDLgrWindow::GetProperty procedure method retrieves the value of a property or group of properties for the window.

## Syntax

*Obj* -> [IDLgrWindow::]GetProperty[, *PROPERTY*=*variable*]

## Arguments

None

## Keywords

Any property listed under "IDLgrWindow Properties" on page 3707 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

Any keyword not recognized is passed to this object's superclass.

## Version History

Introduced: 5.0

# IDLgrWindow::GetTextDimensions

The IDLgrWindow::GetTextDimensions function method retrieves the dimensions of a text or axis object that will be rendered in a window. The result is a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units. If the object specified is an axis object, the result encompasses the tick labels and the title of the axis (if any).

## Syntax

*Result* = *Obj* -> [IDLgrWindow::]GetTextDimensions( *TextObj* [, DESCENT=*variable*] [, PATH=*objref(s)*] )

## Return Value

Returns a 3-element double-precision floating-point vector [*xDim*, *yDim*, *zDim*] representing the dimensions of the text or axis object, measured in data units.

## Arguments

### TextObj

The object reference to a text or axis object for which the text dimensions are requested.

## Keywords

### DESCENT

Set this keyword equal to a named variable that will contain an array of double-precision floating-point values (one for each string in the IDLgrText object). The values are the distance to travel (parallel to the UPDIR direction) from the baseline to reach the bottom of all the descenders for the string; the values will be negative or 0. This keyword is only valid if *TextObj* is of the class IDLgrText.

### PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to compute the text dimensions. Each path object reference specified with this keyword must contain an alias. The text dimensions are computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current

object to the top of the graphics hierarchy and no alias paths are pursued. If IDLgrWindow::GetTextDimensions is called from within a Draw method and the PATH keyword is not set, the alias path used to find the object during the draw is used, rather than the PARENT path.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## Version History

Introduced: 5.0

# IDLgrWindow::Iconify

The IDLgrWindow::Iconify procedure method iconifies or de-iconifies the window.

**Note**

Iconification under window systems is solely handled by the window manager; client applications, such as IDL, do not have the capability to manage icons. The Iconify method provides a hint to the window manager, which applies the information as it sees fit.

## Syntax

*Obj* -> [IDLgrWindow::]Iconify, *IconFlag*

## Arguments

### IconFlag

Set *IconFlag* to 1 (one) to iconify the window or to 0 (zero) to restore the window. If the window is already restored, it is brought to the front of the window stack.

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrWindow::Init

The IDLgrWindow::Init function method initializes the window object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDLgrWindow' [, *PROPERTY=value*])

or

*Result = Obj ->* [IDLgrWindow::]Init([, *PROPERTY=value*])
(*Only in a subclass' Init method*.)

## Return Value

When this method is called indirectly, as part of the call to the OBJ_NEW function, the return value is an object reference to the newly-created object.

When called directly within a subclass Init method, the return value is 1 if initialization was successful, or zero otherwise.

## Arguments

None

## Keywords

Any property listed under "IDLgrWindow Properties" on page 3707 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

All other keywords are passed to the superclass of this object.

## Version History

Introduced: 5.0

# IDLgrWindow::PickData

The IDLgrWindow::PickData function method maps a point in the two-dimensional device space of the window to a point in the three-dimensional data space of an object tree. The resulting 3-D data space coordinates are returned in a user-specified variable. The PickData function returns one if the specified location in the window's device space "hits" a graphic object, or zero if no object was "hit". PickData returns -1 if the point selected falls outside of the specified view or window.

## Syntax

*Result* = *Obj* -> [IDLgrWindow::]PickData( *View*, *Object*, *Location*, *XYZLocation* [, DIMENSIONS=*[w,h]*] [, PATH=*objref(s)*] [, PICK_STATUS=*variable*])

## Return Value

Returns 1 if the specified location in the window's device space "hits" a graphic object, or 0 if no object was hit. Returns -1 if the point selected falls outside the specified view or window.

## Arguments

### View

The object reference of an IDLgrView object that contains the object being picked.

### Object

The object reference of a model or atomic graphic object from which the data space coordinates are being requested.

### Location

A two-element vector [*x*, *y*] specifying the location in the window's device space of the point to pick data from.

### XYZLocation

A named variable that will contain the three-dimensional double-precision floating-point data space coordinates of the picked point. Note that the value returned in this variable is a location, not a data value.

**Note**

If the atomic graphic object specified as the target has been transformed using either the LOCATION or DIMENSIONS properties (this is only possible with IDLgrAxis, IDLgrImage, and IDLgrText objects), these transformations will *not* be included in the data coordinates returned by the PickData function. This means that you may need to re-apply the transformation accomplished by specifying LOCATION or DIMENSIONS once you have retrieved the data coordinates with PickData. This situation does not occur if you transform the axis, text, or image object using the [XYZ]COORD_CONV properties.

# Keywords

## DIMENSIONS

Set this keyword to a two-element array [*w, h*] to specify data picking should occur for all device locations that fall within a *pick box* of these dimensions. The pick box will be centered about the coordinates [*x, y*] specified in the *Location* argument, and will occupy the rectangle defined by:

```
(x-(w/2), y-(h/2)) - (x+(w/2), y+(h/2))
```

By default, the pick box covers a single pixel. The array returned via the *XYZLocation* argument will have dimensions [*3, w, h*].

## PATH

Set this keyword to a single object reference or a vector of object references. This keyword specifies the path in the graphics hierarchy to map the device position to a data space coordinate. Each path object reference specified with this keyword must contain an alias. The data space coordinate is computed for the version of the object falling within that path. If this keyword is not set, the PARENT properties determine the path from the current object to the top of the graphics hierarchy and no alias paths are pursued.

**Note**

For more information on aliases, refer to the ALIAS keyword in IDLgrModel::Add.

## PICK_STATUS

Set this keyword to a named variable that will contain “hit” information for each pixel in the pick box. If the DIMENSIONS keyword is not set, the PICK_STATUS will be a scalar value exactly matching the *Result* of the method call. If the

DIMENSIONS keyword is set, the PICK_STATUS variable will be an array matching the dimensions of the pick box. Each value in the PICK_STATUS array corresponds to a pixel in the pick box, and will be set to one of the following values:

| Value | Description |
|---|---|
| -1 | The pixel falls outside of the window's viewport. |
| 0 | No graphic object is "hit" at that pixel location. |
| 1 | A graphic object is "hit" at that pixel location. |

*Table 8-8: PICK_STATUS Keyword Values*

## Version History

Introduced: 5.0

PICK_STATUS keyword: 5.6

# IDLgrWindow::Read

The IDLgrWindow::Read function method reads an image from a window. The returned value is an instance of the IDLgrImage object class.

## Syntax

*Result* = *Obj* -> [IDLgrWindow::]Read()

## Arguments

None

## Keywords

None

## Version History

Introduced: 5.0

# IDLgrWindow::Select

The IDLgrWindow::Select function method returns a list of objects selected at a specified location. If no objects are selected, the Select function returns -1.

**Note**

IDL returns a maximum of 512 objects. This maximum may be smaller if any of the objects are contained in deep model hierarchies. Because of this limit, it is possible that not all objects eligible for selection will appear in the list.

## Syntax

*Result* = *Obj* -> [IDLgrWindow::]Select( *Picture, XY* [, DIMENSIONS=*[width, height]*] [, /ORDER] [, UNITS={0 | 1 | 2 | 3}] )

## Return Value

Returns a list of objects selected at a specified location. Returns -1 if no objects are selected.

## Arguments

### Picture

The view or scene (an instance of the IDLgrView, IDLgrViewgroup, or IDLgrScene class) whose children are among the candidates for selection.

If the first argument is a scene, then the returned object list will contain one or more views. If the first argument is a view, the list will contain atomic graphic objects (or model objects which have their SELECT_TARGET property set). Objects are returned in order, according to their distance from the viewer. The closer an object is to the viewer, the lower its index in the returned object list. If multiple objects are at the same distance from the viewer (views in a scene or 2-D geometry), the first object drawn will appear at a lower index in the list. (The ORDER keyword can be used to change this behavior.)

### XY

A two-element array defining the center of the selection box in device space. By default, the selection box is 3 pixels by 3 pixels.

# Keywords

## DIMENSIONS

Set this keyword to a two-element array [*w*, *h*] to specify that the selection box will have a width *w* and a height *h*, and will be centered about the coordinates [*x*, *y*] specified in the *XY* argument. The box occupies the rectangle defined by:

```
(x-(w/2), y-(h/2)) - (x+(w/1), y+(h/2))
```

Any object that intersects this box is considered to be selected. By default, the selection box is 3 pixels by 3 pixels.

## ORDER

Set this keyword to control how objects that are the same distance from the viewer are ordered in the selection list. If ORDER=0 (the default), the order of objects in the selection list will be the same as the order in which the objects are drawn. If ORDER=1, the order of objects in the selection list will be the reverse of the order in which they are drawn. This keyword has no affect on the ordering of objects that are not at the same distance from the viewer.

**Tip**

If you are using DEPTH_TEST_FUNCTION=4 (“less than or equal”) on your graphics objects, set ORDER=1 to return objects at the same depth in the order in which they appear visually.

## UNITS

Set this keyword to indicate the units of measure. Valid values are:

- 0 = Device (default)
- 1 = Inches
- 2 = Centimeters
- 3 = Normalized: relative to the dimensions of the graphics destination.

# Version History

Introduced: 5.0

# IDLgrWindow::SetCurrentCursor

The IDLgrWindow::SetCurrentCursor procedure method sets the current cursor image to be used while positioned over a drawing area.

## Syntax

*Obj*->[IDLgrWindow::]SetCurrentCursor [, *CursorName*] [, IMAGE=*16 x 16 bitmap*] [, MASK=*16 x 16 bitmap*] [, HOTSPOT=*[x, y]*]

**X Windows Keywords:** [, STANDARD=*index*]

## Arguments

### CursorName

A string that specifies which built-in cursor to use. This argument is ignored if any keywords to this routine are set. This string can either be a name provided to the REGISTER_CURSOR routine or one of the following:

- ARROW
- CROSSHAIR
- ICON
- IBEAM
- MOVE
- ORIGINAL
- SIZE_NE
- SIZE_NW
- SIZE_SE
- SIZE_SW
- SIZE_NS
- SIZE_EW
- UP_ARROW

## Keywords

### IMAGE

Set this keyword to a 16x16 column bitmap, contained in a 16-element short integer vector, specifying the cursor pattern. The offset from the upper-left pixel to the point that is considered the “hot spot” can be provided via the HOTSPOT keyword.

### MASK

When the IMAGE keyword is set, the MASK keyword can be used to simultaneously specify the mask that should be used. In the mask, bits that are set indicate bits in the IMAGE that should be seen and bits that are not are “masked out”.

### HOTSPOT

Set this keyword to a two-element vector specifying the [*x*, *y*] pixel offset of the cursor “hot spot”, the point which is considered to be the mouse position, from the upper left corner of the cursor image. This parameter is only applicable if IMAGE is provided. The cursor image is displayed top-down (the first row is displayed at the top).

### STANDARD (X Only)

Set this keyword to an X11 cursor font index to change the appearance of the cursor in the IDL graphics window to a glyph in this font. On non-X platforms, setting this keyword displays the crosshair cursor.

## Version History

Introduced: 5.0

CursorName argument: 5.6

# IDLgrWindow::SetProperty

The IDLgrWindow::SetProperty procedure method sets the value of a property or group of properties for the window.

## Syntax

*Obj* -> [IDLgrWindow::]SetProperty[, *PROPERTY=value*]

## Arguments

None

## Keywords

Any property listed under "IDLgrWindow Properties" on page 3707 that contains the word "Yes" in the "Set" column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.0

# IDLgrWindow::Show

The IDLgrWindow::Show procedure method exposes or hides a window.

## Syntax

*Obj* -> [IDLgrWindow::]Show, *Position*

## Arguments

### Position

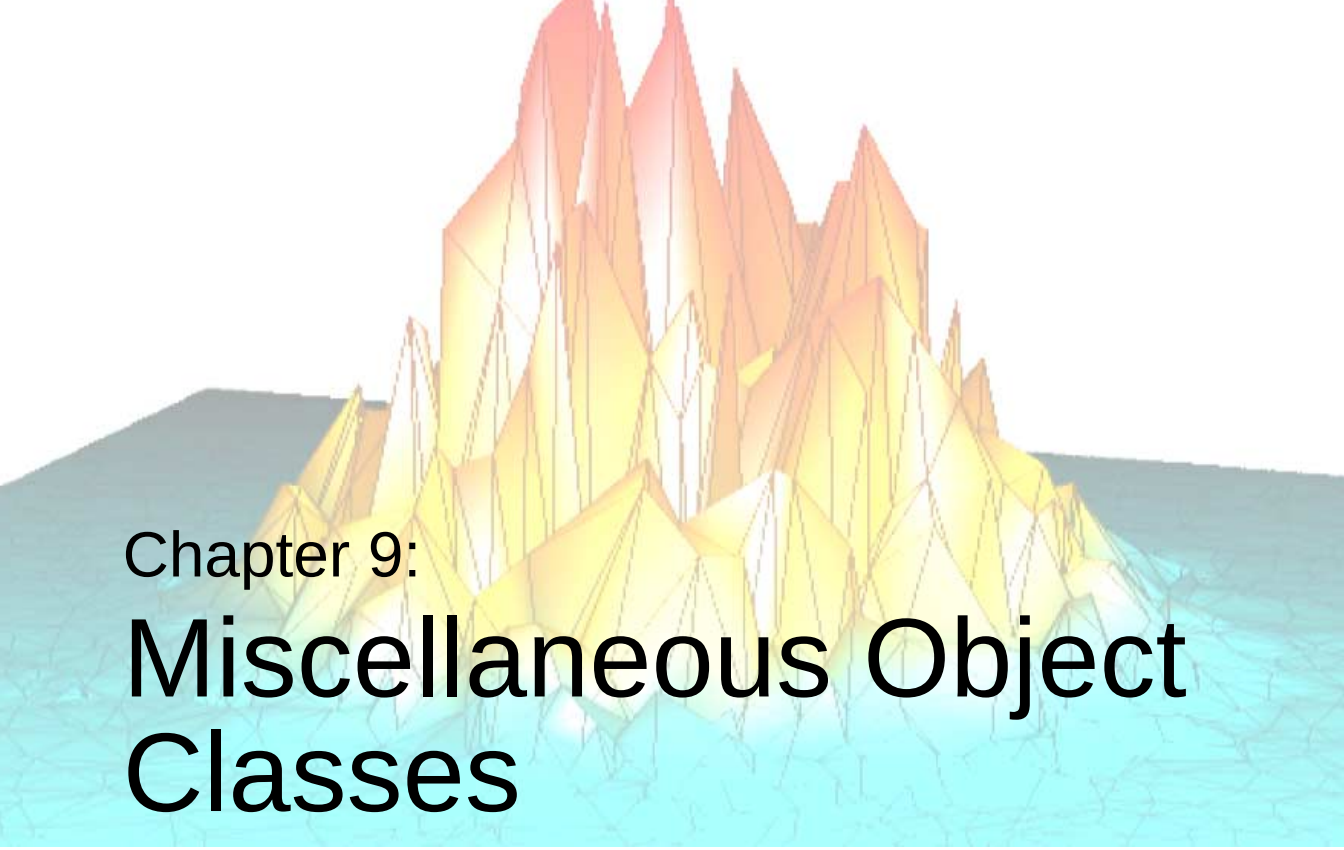
Set this argument equal to a non-zero value to expose the window, or to 0 to hide the window.

## Keywords

None

## Version History

Introduced: 5.0



# Chapter 9: Miscellaneous Object Classes

This chapter describes IDL's Container, COM, Java, and Trackball class libraries.

# IDL_Container

An IDL_Container object holds other objects. Destroying an IDL_Container object destroys any objects that have been added to the container via the Add method.

## Superclasses

This class has no superclasses.

## Creation

See “IDL_Container::Init” on page 3749.

## Properties

Objects of this class have no properties of their own.

## Methods

This class has the following methods:

- IDL_Container::Add
- IDL_Container::Cleanup
- IDL_Container::Count
- IDL_Container::Get
- IDL_Container::Init
- IDL_Container::IsContained
- IDL_Container::Move
- IDL_Container::Remove

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# IDL_Container Properties

Objects of this class have no properties of their own.

# IDL_Container::Add

The IDL_Container::Add procedure method adds one or more child objects to the container.

## Syntax

*Obj* -> [IDL_Container::]Add, *Objects* [POSITION=*index*]

## Arguments

### Objects

An object instance or array of object instances to be added to the container object.

## Keywords

### POSITION

Set this keyword equal to a scalar or array of zero-based index values. The number of elements specified must be equal to the number of object references specified by the *Objects* argument. Each index value specifies the position within the container at which a new object should be placed. The default is to add new objects at the end of the list of contained items.

## Examples

If the container has three objects, a new object will be placed at the fourth position. Since positions begin at zero, this would be equivalent to setting POSITION=3.

## Version History

Introduced: 5.0

# IDL_Container::Cleanup

The IDL_Container::Cleanup procedure method performs all cleanup on the object.

**Note**

Cleanup methods are special *lifecycle methods*, and as such cannot be called outside the context of object destruction. This means that in most cases, you cannot call the Cleanup method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Cleanup method from within the Cleanup method of the subclass.

## Syntax

OBJ_DESTROY, *Obj*

or

*Obj*`->` [IDL_Container::]Cleanup(*Only in subclass' Cleanup method*.)

## Arguments

None.

## Keywords

None.

## Version History

Introduced: 5.0

# IDL_Container::Count

The IDL_Container::Count function method returns the number of objects contained by the container object.

## Syntax

*Result* = *Obj* -> [IDL_Container::]Count()

## Arguments

None.

## Keywords

None.

## Version History

Introduced: 5.0

# IDL_Container::Get

The IDL_Container::Get function method returns an array of object references to objects in a container. Unless the ALL or POSITION keywords are specified, the first object in the container is returned. If no objects are found in the container, the Get function returns -1.

## Syntax

*Result* = *Obj* -> [IDL_Container::]Get ([, /ALL [, ISA=*class_name(s)*] | , POSITION=*index*] [COUNT=*variable*] )

## Arguments

None.

## Keywords

### ALL

Set this keyword to return an array of object references to all of the objects in the container.

### COUNT

Set this keyword equal to a named variable that will contain the number of objects selected by the function. If the ALL keyword is also specified, specifying this keyword is the same as calling the IDL_Container::Count method.

### ISA

Set this keyword equal to a class name or vector of class names. This keyword is used in conjunction with the ALL keyword. The ISA keyword filters the array returned by the ALL keyword, returning only the objects that inherit from the class or classes specified by the ISA keyword.

**Note**

This keyword is ignored if the ALL keyword is not provided.

### POSITION

Set this keyword equal to a scalar or array containing the zero-based indices of the positions of the objects to return.

## Version History

Introduced: 5.0

# IDL_Container::Init

The IDL_Container::Init function method initializes the container object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: If you write your own subclass of this class, you can call the Init method from within the Init method of the subclass.

## Syntax

*Obj* = OBJ_NEW('IDL_Container')

or

*Result* = *Obj* -> [IDL_Container::]Init( ) (*Only in a subclass' Init method*.)

## Arguments

None.

## Keywords

None.

## Version History

Introduced: 5.0

# IDL_Container::IsContained

The IDL_Container::IsContained function method returns true (1) if the specified object is in the container, or false (0) otherwise.

## Syntax

*Result* = *Obj* -> [IDL_Container::]IsContained( *Object* [, POSITION=*variable*] )

## Arguments

### Object

The object reference or vector of object references of the object(s) to search for in the container.

## Keywords

### POSITION

Set this keyword to a named variable that upon return will contain the position(s) at which (each of) the argument(s) is located within the container, or -1 if it is not contained.

## Version History

Introduced: 5.0

# IDL_Container::Move

The IDL_Container::Move procedure method moves an object from one position in a container to a new position. The order of the other objects in the container remains unchanged.

Positioning within a container controls the rendering order of the contained objects. The object whose location has the lowest index value is rendered first. If several objects are located at the same point in three-dimensional space, the object rendered first will occlude objects rendered later. Objects located “behind” other objects in three-dimensional space must be rendered before objects in front of them, even if the “front” objects are translucent.

## Syntax

*Obj* -> [IDL_Container::]Move, *Source*, *Destination*

## Arguments

### Source

The zero-based index of the current location of the object to be moved.

### Destination

The zero-based index of the location in the container where the object will reside after being moved.

## Keywords

None.

## Version History

Introduced: 5.0

# IDL_Container::Remove

The IDL_Container::Remove procedure method removes an object from the container.

## Syntax

*Obj* -> [IDL_Container::]Remove [, *Child_object* | , POSITION=*index* | , /ALL]

## Arguments

### Child_object

The object reference of the object to be removed from the container. If *Child_object* is not provided (and neither the ALL nor POSITION keyword are set), the first object in the container will be removed.

## Keywords

### ALL

Set this keyword to remove all objects from the container. If this keyword is set, the *Child_object* argument is not required.

### POSITION

Set this keyword equal to the zero-based index of the object to be removed. If the *Child_object* argument is supplied, this keyword is ignored.

## Version History

Introduced: 5.0

# IDLcomActiveX

The IDLcomActiveX object class creates an IDL object that encapsulates an ActiveX control. IDL provides data type and other translation services, allowing IDL programs to access the ActiveX control's methods and properties using standard IDL syntax.

For detailed information on using the IDLcomActiveX object, see "Using ActiveX Controls in IDL" in Chapter 5 of the *External Development Guide* manual.

## Superclasses

This class is a subclass of IDLcomIDispatch.

## Subclasses

When an ActiveX control is instantiated, IDL creates a dynamic subclass of the IDLcomActiveX class. The dynamic subclass is used to provide a unique name for each component type, based on the COM class or program identifier. See "ActiveX Control Naming Scheme" in Chapter 5 of the *External Development Guide* manual for details.

## Creation

IDLcomActiveX objects are always created automatically by IDL, as a result of a call to the WIDGET_ACTIVEX function. They should never be created manually.

## Properties

Objects of this class have no properties of their own.

## Methods

The IDLcomActiveX object class is a direct subclass of the IDLcomIDispatch class, and relies entirely on the superclass methods, providing none of its own.

## Version History

Introduced: 5.5

# IDLcomActiveX Properties

Objects of this class have no properties of their own.

# IDLcomIDispatch

The IDLcomIDispatch object class creates an IDL object that encapsulates a COM object. IDL provides data type and other translation services, allowing IDL programs to access the COM object's methods and properties using standard IDL syntax.

**Note**

COM objects encapsulated by IDLcomIDispatch objects must implement an IDispatch interface.

For detailed information on using the IDLcomIDispatch object, see Chapter 4, "Using COM Objects in IDL" in the *External Development Guide* manual.

## Superclasses

This class has no superclasses.

## Subclasses

When a COM object is instantiated, IDL creates a dynamic subclass of the IDLcomIDispatch class. The dynamic subclass is used to provide a unique name for each component type, based on the COM class or program identifier. See "IDLcomIDispatch Object Naming Scheme" in Chapter 4 of the *External Development Guide* manual for details.

ActiveX controls are instantiated within IDL as a special subclass of the IDLcomIDispatch class named IDLcomActiveX.

## Creation

See IDLcomIDispatch::Init

## Properties

Objects of this class have the following properties. See "IDLcomIDispatch Properties" on page 3757 for details on individual properties.

- *KEYWORD*

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

- IDLcomIDispatch::Init
- IDLcomIDispatch::GetProperty
- IDLcomIDispatch::SetProperty

In addition to these methods, you can call the underlying COM object's methods directly. See "Method Calls on IDLcomIDispatch Objects" in Chapter 4 of the *External Development Guide* manual for details.

**Note**

The IDL object system uses method names to identify and call object lifecycle methods (Init and Cleanup). If the COM object underlying an IDLcomIDispatch object implements Init or Cleanup methods, they will be overridden by IDL's lifecycle methods — the COM object's methods will be inaccessible from IDL. Similarly, IDL implements the GetProperty and SetProperty methods for the IDLcomIDispatch object, so any methods of the underlying COM object that use these names will be inaccessible from IDL.

## Version History

Introduced: 5.5

# IDLcomIDispatch Properties

IDLcomIDispatch objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Get” column of the property table can be retrieved via “IDLcomIDispatch::GetProperty” on page 3758. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via “IDLcomIDispatch::Init” on page 3759. Properties with the word “Yes” in the “Set” column in the property table can be set via “IDLcomIDispatch::SetProperty” on page 3760.

## *KEYWORD*

*KEYWORD* is a string containing the name of one of the underlying COM object’s properties, and *Variable* is the name of an IDL variable that will contain the retrieved property value. You can get multiple property values in a single statement by supplying multiple *KEYWORD=Variable* pairs.

**Note**

*KEYWORD* must map exactly to the full name of the underlying COM object’s property method. The partial keyword name functionality provided by IDL is not valid with IDLcomIDispatch objects.

# IDLcomIDispatch::GetProperty

The IDLcomIDispatch::GetProperty function method is used to get properties from the COM object that underlies an IDLcomIDispatch object. The COM object's property names are represented as IDL keywords to the GetProperty method, and property values are treated as IDL keyword values. See "Managing COM Object Properties" in Chapter 4 of the *External Development Guide* manual.

## Syntax

*Obj* -> [IDLcomIDispatch::]GetProperty, *KEYWORD=Variable*, [*arg0*, *arg1*, …]

## Arguments

Because some of the underlying COM object's property methods may require arguments, the GetProperty method will accept optional arguments. The values of the arguments themselves will depend on the COM object that underlies the IDLcomIDispatch object.

**Note**

If arguments are required, you can only specify one property to retrieve in a given call to the GetProperty method.

## Keywords

Any property listed under "IDLcomIDispatch Properties" on page 3757 that contains the word "Yes" in the "Get" column of the properties table can be retrieved using this method. To retrieve the value of a property, specify the property name as a keyword set equal to a named variable that will contain the value of the property.

## Version History

Introduced: 5.5

# IDLcomIDispatch::Init

The IDLcomIDispatch::Init function method is used to initialize a given COM object and establish a link between the resulting IDL object and the IDispatch interface of the underlying COM object.

## Syntax

*Obj* = OBJ_NEW('IDLcomIDispatch$*ID_type*$*ID*')

or

*Result* = *Obj* `->` [IDLcomIDispatch$*ID_type*$*ID*::]Init( ) (*Only in a subclass' Init method*)

where *ID_type* is one of the following:

- `CLSID` if the object is identified by its COM class ID, or
- `PROGID` if the object is identified by its COM program ID,

and *ID* is the COM object's actual class or program identifier string. If the COM object's class identifier string is used to create the IDLcomIDispatch object, the braces ( { } ) must be removed and the hyphens replaced by underscores. For details on constructing the class name, see "IDLcomIDispatch Object Naming Scheme" in Chapter 4 of the *External Development Guide* manual for details.

**Note**

While COM objects incorporated into IDL are instances of the dynamic subclass created when the COM object is instantiated, they still expose the functionality of the class IDLcomIDispatch, which is the direct superclass of the dynamic subclass. All IDLcomIDispatch methods are available to the dynamic subclass.

## Arguments

None.

## Keywords

None.

## Version History

Introduced: 5.5

# IDLcomIDispatch::SetProperty

The IDLcomIDispatch::SetProperty function method is used to set properties for the COM object that underlies an IDLcomIDispatch object. The COM object's property names are represented as IDL keywords to the SetProperty method, and property values are treated as IDL keyword values. See "Managing COM Object Properties" in Chapter 4 of the *External Development Guide* manual for details.

## Syntax

*Obj* -> [IDLcomIDispatch::]SetProperty, *KEYWORD=Expression*

## Arguments

None.

## Keywords

Any property listed under "IDLcomIDispatch Properties" on page 3757 that contains the word "Yes" in the "Set" column of the properties table can be set using this method. To set the value of a property, specify the property name as a keyword set equal to the appropriate property value.

## Version History

Introduced: 5.5

# IDLjavaObject

The IDLjavaObject class creates an IDL object that encapsulates a Java object. IDL provides data type and other translation services, allowing IDL programs to access the Java object's methods and properties using standard IDL syntax.

For detailed information on using the IDLjavaObject class, see Chapter 8, "Using Java Objects in IDL" in the *External Development Guide* manual.

## Superclasses

This class has no superclasses.

## Creation

See "IDLjavaObject::Init" on page 3765.

## Properties

The properties of this object depends on which Java object the IDLjavaObject class encapsulates. See "IDLjavaObject Properties" on page 3763 for more details.

## Methods

This class has the following methods:

- IDLjavaObject::GetProperty
- IDLjavaObject::Init
- IDLjavaObject::SetProperty

In addition to these methods, you can call the underlying Java object's methods directly. See "Method Calls on IDL-Java Objects" in Chapter 8 of the *External Development Guide* manual for details.

**Note**

The IDL object system uses method names to identify and call object *lifecycle methods* (Init and Cleanup). If the Java object underlying IDLjavaObject implements Init or Cleanup methods, they will be overridden by IDL's lifecycle methods — the Java object's methods will be inaccessible from IDL. Similarly, IDL implements the GetProperty and SetProperty methods for IDLjavaObject, so any methods of the underlying Java object that use these names will be inaccessible

from IDL. In Java, you can wrap these methods with different named methods to work around this limitation.

## Examples

See Chapter 8, “Using Java Objects in IDL” in the *External Development Guide* manual.

## Version History

Introduced: 6.0

# IDLjavaObject Properties

The property name of an instance of IDLjavaObject is passed to the IDL Java subsystem and is used in conjunction with the Java reflection API to access the related data member on the underlying object. The data member (property) is identified through the arguments to the IDLjavaObject::GetProperty and IDLjavaObject::SetProperty methods.

# IDLjavaObject::GetProperty

The IDLjavaObject::GetProperty procedure method retrieves properties (known as data members in Java) from the Java object that underlies the IDLjavaObject. The Java object's property names are represented as IDL keywords to the GetProperty method, and property values are treated as IDL keyword values. See "Managing IDL-Java Object Properties" in Chapter 8 of the *External Development Guide* manual.

## Syntax

*Obj* -> [IDLjavaObject::]GetProperty [, *PROPERTY=variable*]

## Arguments

None

## Keywords

### *PROPERTY*

The Java object property names are mapped to IDL keywords. The underlying property values are treated as IDL keyword values, which is the same convention for other IDL objects.

**Note**

The provided keywords must map directly to a property name or IDL issues an error. Any keyword passed into either of the property routines is assumed to be a fully-qualified Java property name. As such, the partial keyword name functionality provided by IDL is not valid with IDL Java based objects.

The *variable* may be an IDL primitive type, an instance of IDLJavaObject, or an array of IDL primitive types. See "IDL-Java Bridge Data Type Mapping" in Chapter 8 of the *External Development Guide* manual for more information.

**Note**

Besides other Java based objects, no complex types (structures, pointers, etc.) are supported as parameters to method calls.

## Version History

Introduced: 6.0

# IDLjavaObject::Init

The IDLjavaObject::Init function method instantiates the given Java object and establishes a link between the resulting IDL object with the underlying Java object.

**Note**

Init methods are special *lifecycle methods*, and as such cannot be called outside the context of object creation. This means that in most cases, you cannot call the Init method directly. There is one exception to this rule: the Init method can be called from within the Init method of a subclass.

## Syntax

*Obj* = OBJ_NEW('IDLjavaObject$*JAVACLASSNAME*', *JavaClassName*[, *Arg1*, ...])

where *JAVACLASSNAME* is a case-insensitive string representing the Java class to be instantiated, see "IDL-Java Bridge Architecture" in Chapter 8 of the *External Development Guide* manual for more information. All periods in *JAVACLASSNAME* must be converted to underscores.

## Return Value

Returns an object reference to the newly-created object if initialization is successful, or a null object if initialization fails.

## Arguments

### JavaClassName

A string representing the Java class to be instantiated. See "Java Class Names in IDL" in Chapter 8 of the *External Development Guide* manual for more details.

### Arg1, ...

Additional arguments as required by the contructor. These arguments are passed to the underlying Java constructor. Arguments may be IDL primitive types, IDL strings, IDLJavaObjects, and arrays of the previous types. See "IDL-Java Bridge Data Type Mapping" in Chapter 8 of the *External Development Guide* manual for more information.

## Keywords

None

## Version History

Introduced: 6.0

# IDLjavaObject::SetProperty

The IDLjavaObject::SetProperty procedure method sets properties (known as data members in Java) for the Java object that underlies an instance of IDLjavaObject. The Java object's property names are represented as IDL keywords to the SetProperty method, and property values are treated as IDL keyword values. See "Managing IDL-Java Object Properties" in Chapter 8 of the *External Development Guide* manual for more details.

## Syntax

*Obj* -> [IDLjavaObject::]SetProperty [, *PROPERTY=value*]

## Arguments

None

## Keywords

### *PROPERTY*

The Java object property names are mapped to IDL keywords. The underlying property values are treated as IDL keyword values, which is the same convention for other IDL objects.

**Note**

The provided keywords must map directly to a property name or IDL issues an error. Any keyword passed into either of the property routines is assumed to be a fully-qualified Java property name. As such, the partial keyword name functionality provided by IDL is not valid with IDL Java based objects.

The *value* may be an IDL primitive type, an instance of IDLJavaObject, or an array of IDL primitive types. See "IDL-Java Bridge Data Type Mapping" in Chapter 8 of the *External Development Guide* manual for more information.

**Note**

Besides other Java based objects, no complex types (structures, pointers, etc.) are supported as parameters to method calls.

## Version History

Introduced: 6.0

# TrackBall

A TrackBall object translates widget events from a draw widget (created with the WIDGET_DRAW function) into transformations that emulate a virtual trackball (for transforming object graphics in three dimensions).

This object class is implemented in the IDL language. Its source code can be found in the file `trackball__define.pro` in the `lib` subdirectory of the IDL distribution.

## Superclasses

This class has no superclasses.

## Creation

See "TrackBall::Init" on page 3772.

## Properties

Objects of this class have the following properties. See "TrackBall Properties" on page 3770 for details on individual properties.

- AXIS
- CONSTRAIN
- MOUSE

In addition, objects of this class inherit the properties of all superclasses of this class.

## Methods

This class has the following methods:

- TrackBall::Init
- TrackBall::Reset
- TrackBall::Update

In addition, this class inherits the methods of its superclasses (if any).

## Version History

Introduced: 5.0

# TrackBall Properties

TrackBall objects have the following properties in addition to properties inherited from any superclasses. Properties with the word “Yes” in the “Init” column of the property table can be retrieved via “TrackBall::Init” on page 3772.

**Note**

For a discussion of the property description tables shown below, see “About Object Property Descriptions” on page 2505.

## AXIS

An integer value that indicates the axis about which rotations are to be constrained if the CONSTRAIN keyword is set. Valid values include:

- 0 = Rotate only around the *X* axis.
- 1 = Rotate only around the *Y* axis.
- 2 = Rotate only around the *Z* axis (this is the default).

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## CONSTRAIN

A boolean value that indicates whether the trackball transformations are to be constrained about the axis specified by the AXIS keyword. The default is not to constrain the transformations.

| **Property Type** | Boolean | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

## MOUSE

An integer value that indicates which mouse button to honor for trackball events. Valid values include:

- 1 = Left mouse button (the default)

- 2 = Middle mouse button
- 4 = Right mouse button

| **Property Type** | Integer | | |
|---|---|---|---|
| **Name String** | *not displayed* | | |
| **Get:** No | **Set:** No | **Init:** Yes | **Registered:** No |

# TrackBall::Init

The TrackBall::Init function method initializes the TrackBall object.

# Syntax

*Obj* = OBJ_NEW('TrackBall', *Center*, *Radius* [, AXIS={0 | 1 | 2}] [, /CONSTRAIN] [, MOUSE={1 | 2 | 4}] )

or

*Result* = *Obj* -> [TrackBall::]Init( *Center*, *Radius* ) (*Only in a subclass' Init method*.)

**Note**

Keywords can be used in either form. They are omitted in the second form for brevity.

# Arguments

## Center

A two-element vector, [*X*, *Y*], specifying the center coordinates of the trackball. *X* and *Y* should be specified in device units.

## Radius

The radius of the trackball, specified in device units.

# Keywords

Any property listed under "TrackBall Properties" on page 3770 that contains the word "Yes" in the "Init" column of the properties table can be initialized during object creation using this method. To initialize the value of a property, specify the property name as a keyword set equal to the appropriate property value.

# Version History

Introduced: 5.0

# TrackBall::Reset

The TrackBall::Reset procedure method resets the state of the TrackBall object.

# Syntax

*Obj* -> [TrackBall::]Reset, *Center*, *Radius* [, AXIS={0 | 1 | 2}] [, /CONSTRAIN] [, MOUSE={1 | 2 | 4}]

# Arguments

## Center

A two-element vector, [*X*, *Y*], specifying the center coordinates of the trackball. *X* and *Y* should be specified in device units.

## Radius

The radius of the trackball, specified in device units.

# Keywords

## AXIS

Set this keyword to an integer value to indicate the axis about which rotations are to be constrained if the CONSTRAIN keyword is set. Valid values include:

- 0 = Rotate only around the *X* axis.
- 1 = Rotate only around the *Y* axis.s
- 2 = Rotate only around the *Z* axis (this is the default).

## CONSTRAIN

Set this keyword to indicate that the trackball transformations are to be constrained about the axis specified by the AXIS keyword. The default is not to constrain the transformations.

### MOUSE

Set this keyword to an integer value to indicate which mouse button to honor for trackball events. Valid values include:

- 1 = Left mouse button (the default)
- 2 = Middle mouse button
- 4 = Right mouse button

## Version History

Introduced: 5.0

# TrackBall::Update

The TrackBall::Update function method updates the state of the TrackBall object based on the information contained in the input widget event structure. The return value is nonzero if a transformation matrix is calculated as a result of the event, or zero otherwise.

# Syntax

*Result* = *Obj* -> [TrackBall::]Update( *sEvent* [, MOUSE={1 | 2 | 4}] [, TRANSFORM=*variable*] [, /TRANSLATE] )

# Arguments

## sEvent

The widget event structure.

# Keywords

## MOUSE

Set this keyword to an integer value to indicate which mouse button to honor for trackball events. Valid values include:

- 1 = Left mouse button (the default)
- 2 = Middle mouse button
- 4 = Right mouse button

## TRANSFORM

Set this keyword to a named variable that will contain a 4 x 4 element floating-point array if a new transformations matrix is calculated as a result of the widget event.

## TRANSLATE

Set this keyword to indicate that the trackball movement should be constrained to translation in the *X*-*Y* plane rather than rotation about an axis.

# Example

The example code below provides a skeleton for a widget-based application that uses the TrackBall object to interactively change the orientation of graphics.

Create a trackball centered on a 512x512 pixel drawable area, and a view containing the model to be manipulated:

```
xdim = 512
ydim = 512
wBase = WIDGET_BASE()
wDraw = WIDGET_DRAW(wBase, XSIZE=xdim, YSIZE=ydim, $
    GRAPHICS_LEVEL=2, /BUTTON_EVENTS, $
    /MOTION_EVENTS, /EXPOSE_EVENTS, RETAIN=0 )
WIDGET_CONTROL, wBase, /REALIZE
WIDGET_CONTROL, wDraw, GET_VALUE=oWindow

oTrackball = OBJ_NEW('Trackball', [xdim/2.,ydim/2.], xdim/2.)
oView = OBJ_NEW('IDLgrView')
oModel = OBJ_NEW('IDLgrModel')
oView->Add, oModel
XMANAGER, 'TrackEx', wBase
```

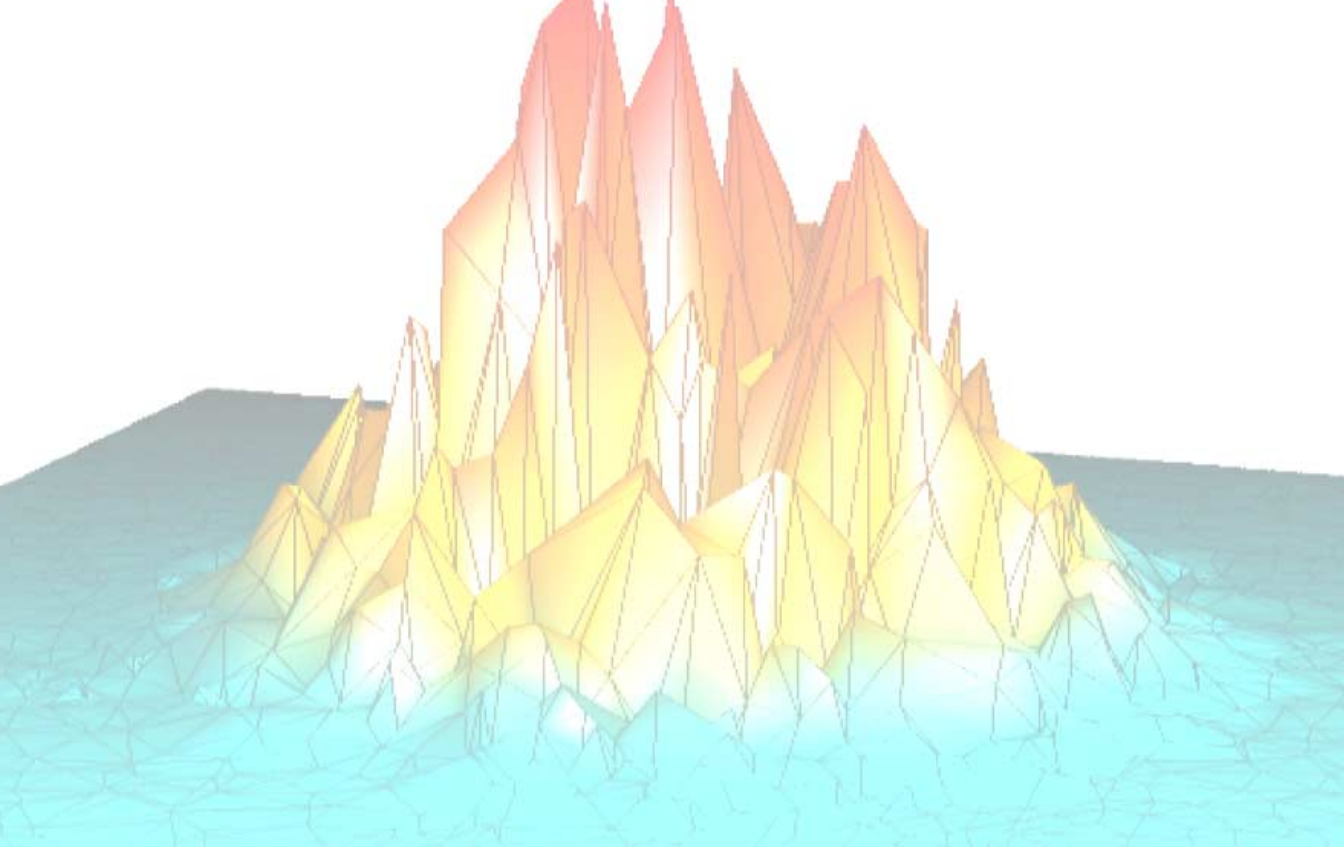
You must handle the trackball updates in the widget event-handling code. As the trackball transformation changes, update the transformation for the model object, and redraw the view:

```
PRO TrackEx_Event, sEvent
...
bHaveXform = oTrackball->Update( sEvent, TRANSFORM=TrackXform )
IF (bHaveXform) THEN BEGIN
oModel->GetProperty, TRANSFORM=ModelXform
oModel->SetProperty, TRANSFORM=ModelXform # TrackXform
oWindow->Draw, oView
ENDIF
...
END
```

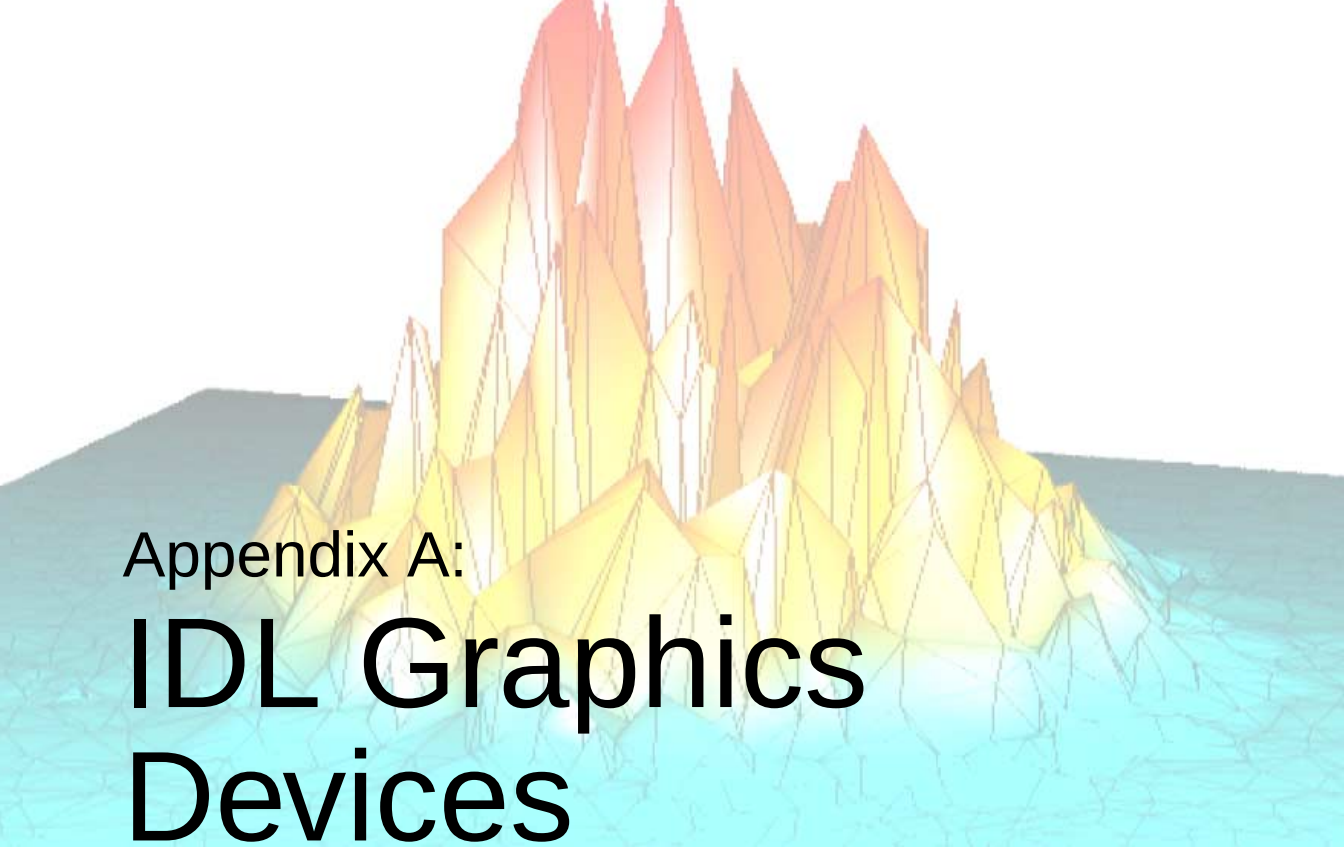
For a complete example, see the file `surf_track.pro`, located in the `examples/visual` subdirectory of the IDL distribution. The SURF_TRACK procedure uses IDL widgets to create a graphical user interface to an object tree, creates a surface object from user-specified data (or from default data, if none is specified), and places the surface object in an IDL draw widget. The SURF_TRACK interface allows the user to specify several attributes of the object hierarchy via pulldown menus.

## Version History

Introduced: 5.0



# *Part III: Appendices*



# Appendix A: IDL Graphics Devices

The following topics are covered in this appendix:

# Supported Devices

IDL Direct Graphics support graphic output to the devices listed below:

| Device Name | Description |
|---|---|
| CGM | Computer Graphics Metafile |
| HP | Hewlett-Packard Graphics Language (HP-GL) |
| METAFILE | Windows Metafile Format (WMF) |
| NULL | No graphics output |
| PCL | Hewlett-Packard Printer Control Language (PCL) |
| PRINTER | System printer |
| PS | PostScript |
| REGIS | Regis graphics protocol (DEC systems only) |
| TEK | Tektronix compatible terminal |
| WIN | Microsoft Windows |
| X | X Window System |
| Z | Z-buffer pseudo device |

*Table A-1: IDL Graphics Output Devices*

Each of these devices is described in a section of this chapter. The SET_PLOT procedure can be used to select the graphic device to which IDL directs its output. IDL Object Graphics does not rely on the concept of a current graphics device; see *Using IDL* for details about IDL Object Graphics.

The DEVICE procedure controls the graphic device-specific functions. An attempt has been made to isolate all device-specific functions in this procedure. DEVICE controls the graphics device currently selected by SET_PLOT. When using DEVICE, it is important to make sure that the current graphics device is the one you intend to use. This is because most of the devices have different keywords—you will most likely get a ‘‘`Keyword ... ... not allowed in call to: Device`’’ error if you call DEVICE when the wrong device is selected.

# Obsolete Graphics Devices and Device Keywords

The following graphics devices are obsolete:

- LJ
- MAC

For information on obsolete graphics devices, See Appendix I, “Obsolete Features”.

The following graphics device keywords are obsolete:

- DEPTH
- FONT

For information on obsolete keywords, See Appendix I, “Obsolete Features”.

# Keywords Accepted by the IDL Devices

The following table indicates which keywords are accepted by the DEVICE procedure. The NULL device is not listed as it accepts no keywords. Details of the various keywords can be found on the page indicated in the table.

**Note**

Most keywords to the DEVICE procedure are sticky — that is, once you set them, they remain in effect until you explicitly change them again, or end your IDL session. The exceptions are keywords used to return a value from the system (GET_FONTNAMES, for example) and those that perform a one-time-only operation (CLOSE_FILE, for example).

| Keywords | Devices | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CGM | HP | METAFILE | PCL | PRINTER | PS | REGIS | TEK | WIN | X | Z |
| AVANTGARDE | | | | | | • | | | | | |
| AVERAGE_LINES | | | | | | | • | | | | |
| BINARY | • | | | | | | | | | | |
| BITS_PER_PIXEL | | | | | | • | | | | | |
| BKMAN | | | | | | • | | | | | |
| BOLD | | | | | | • | | | | | |
| BOOK | | | | | | • | | | | | |
| BYPASS_TRANSLATION | | | | | | | | | • | • | |
| CLOSE | | | | | | | | | | | • |
| CLOSE_DOCUMENT | | | | | • | | | | | | |
| CLOSE_FILE | • | • | • | • | | • | • | • | | | |

*Table A-2: Keywords accepted by the IDL devices*

| Keywords | Devices | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CGM | HP | METAFILE | PCL | PRINTER | PS | REGIS | TEK | WIN | X | Z |
| COLOR | | | | • | | • | | | | | |
| COLORS | • | | | | | | | • | | | |
| COPY | | | | | | | | | • | • | |
| COURIER | | | | | | • | | | | | |
| CURSOR_CROSSHAIR | | | | | | | | | • | • | |
| CURSOR_IMAGE | | | | | | | | | • | • | |
| CURSOR_MASK | | | | | | | | | • | • | |
| CURSOR_ORIGINAL | | | | | | | | | • | • | |
| CURSOR_STANDARD | | | | | | | | | • | • | |
| CURSOR_XY | | | | | | | | | • | • | |
| DECOMPOSED | | | | | | | | | • | • | |
| DEMI | | | | | | • | | | | | |
| DIRECT_COLOR | | | | | | | | | | • | |
| EJECT | | • | | | | | | | | | |
| ENCAPSULATED | | | | | | • | | | | | |
| ENCODING | • | | | | | | | | | | |
| FILENAME | • | • | • | • | | • | • | • | | | |
| FLOYD | | | | • | | | | | | • | |
| FONT_INDEX | | | | | | • | | | | | |
| FONT_SIZE | | | | | | • | | | | | |
| GET_CURRENT_FONT | | | • | | • | | | | • | • | |

*Table A-2: Keywords accepted by the IDL devices (Continued)*

| Keywords | Devices | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CGM | HP | METAFILE | PCL | PRINTER | PS | REGIS | TEK | WIN | X | Z |
| GET_DECOMPOSED | | | | | | | | | • | • | |
| GET_FONTNAMES | | | • | | • | | | | • | • | |
| GET_FONTNUM | | | • | | • | | | | • | • | |
| GET_GRAPHICS_FUNCTION | | | | | | | | | • | • | • |
| GET_PAGE_SIZE | | | | | • | | | | | | |
| GET_SCREEN_SIZE | | | | | | | | | • | • | |
| GET_VISUAL_DEPTH | | | | | | | | | • | • | |
| GET_VISUAL_NAME | | | | | | | | | • | • | |
| GET_WINDOW_POSITION | | | | | | | | | • | • | |
| GET_WRITE_MASK | | | | | | | | | | • | • |
| GIN_CHARS | | | | | | | | • | | | |
| GLYPH_CACHE | | | • | | • | • | | | • | | • |
| HELVETICA | | | | | | • | | | | | |
| INCHES | | • | • | • | • | • | | | | | |
| INDEX_COLOR | | | • | | • | | | | | | |
| ISOLATIN1 | | | | | | • | | | | | |
| ITALIC | | | | | | • | | | | | |
| LANDSCAPE | | • | | • | • | • | | | | | |
| LANGUAGE_LEVEL | | | | | | • | | | | | |
| LIGHT | | | | | | • | | | | | |
| MEDIUM | | | | | | • | | | | | |

*Table A-2: Keywords accepted by the IDL devices (Continued)*

| Keywords | Devices | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CGM | HP | METAFILE | PCL | PRINTER | PS | REGIS | TEK | WIN | X | Z |
| NARROW | | | | | | • | | | | | |
| NCAR | • | | | | | | | | | | |
| OBLIQUE | | | | | | • | | | | | |
| OPTIMIZE | | | | • | | | | | | | |
| ORDERED | | | | • | | | | | | • | |
| OUTPUT | | • | | | | • | | | | | |
| PALATINO | | | | | | • | | | | | |
| PIXELS | | | | • | | | | | | | |
| PLOT_TO | | | | | | | • | • | | | |
| PLOTTER_ON_OFF | | • | | | | | | | | | |
| POLYFILL | | • | | | | | | | | | |
| PORTRAIT | | • | | • | • | • | | | | | |
| PRE_DEPTH | | | | | | • | | | | | |
| PRE_XSIZE | | | | | | • | | | | | |
| PRE_YSIZE | | | | | | • | | | | | |
| PREVIEW | | | | | | • | | | | | |
| PRINT_FILE | | | | | | | | | • | | |
| PSEUDO_COLOR | | | | | | | | | | • | |
| RESET_STRING | | | | | | | | • | | | |
| RESOLUTION | | | | • | | | | | | | |
| RETAIN | | | | | | | | | • | • | |

*Table A-2: Keywords accepted by the IDL devices (Continued)*

| Keywords | Devices | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CGM | HP | METAFILE | PCL | PRINTER | PS | REGIS | TEK | WIN | X | Z |
| SCALE_FACTOR | | | | | • | • | | | | | |
| SCHOOLBOOK | | | | | | • | | | | | |
| SET_CHARACTER_SIZE | • | • | • | • | • | • | • | • | • | • | • |
| SET_COLORMAP | | | | • | | | | | | | |
| SET_COLORS | | | | | | | | | | | • |
| SET_FONT | | | • | | • | • | | | • | • | • |
| SET_GRAPHICS_FUNCTION | | | | | | | | | • | • | • |
| SET_RESOLUTION | | | | | | | | | | | • |
| SET_STRING | | | | | | | | • | | | |
| SET_TRANSLATION | | | | | | | | | | • | |
| SET_WRITE_MASK | | | | | | | | | | • | • |
| STATIC_COLOR | | | | | | | | | | • | |
| STATIC_GRAY | | | | | | | | | | • | |
| SYMBOL | | | | | | • | | | | | |
| TEK4014 | | | | | | | | • | | | |
| TEK4100 | | | | | | | | • | | | |
| TEXT | • | | | | | | | | | | |
| THRESHOLD | | | | • | | | | | | • | |
| TIMES | | | | | | • | | | | | |
| TRANSLATION | | | | | | | | | • | • | |
| TRUE_COLOR | | | • | | • | | | | | • | |

*Table A-2: Keywords accepted by the IDL devices (Continued)*

| Keywords | Devices | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CGM | HP | METAFILE | PCL | PRINTER | PS | REGIS | TEK | WIN | X | Z |
| TT_FONT | | | • | | • | | | | • | • | • |
| TTY | | | | | | | • | • | | | |
| USER_FONT | | | | | | • | | | | | |
| VT240, VT241 | | | | | | | • | | | | |
| VT340, VT341 | | | | | | | • | | | | |
| WINDOW_STATE | | | | | | | | | • | • | |
| XOFFSET | | • | | • | • | • | | | | | |
| XON_XOFF | | • | | | | | | | | | |
| XSIZE | | • | • | • | • | • | | | | | |
| YOFFSET | | • | | • | • | • | | | | | |
| YSIZE | | • | • | • | • | • | | | | | |
| ZAPFCHANCERY | | | | | | • | | | | | |
| ZAPFDINGBATS | | | | | | • | | | | | |
| Z_BUFFERING | | | | | | | | | | | • |

*Table A-2: Keywords accepted by the IDL devices (Continued)*

Keywords accepted by the DEVICE command are described below. A list of devices that accept the keyword is included in parentheses below the keyword name.

## AVANTGARDE

(PS)

Set this keyword to select the ITC Avant Garde PostScript font.

## AVERAGE_LINES

(REGIS)

Controls the method of writing images to the VT240. If this keyword is set, (default setting), even and odd pairs of image lines are averaged and written to a single line. If clear, each image line is written to the screen. See the discussion below. This keyword has no effect when using a VT300 series terminal.

## BINARY

(CGM)

Set this keyword to set the encoding type for the CGM output file to binary.

## BITS_PER_PIXEL

(PS)

IDL is capable of producing PostScript images with 1, 2, 4, or 8 bits per pixel. Using more bits per pixel gives higher resolution at the cost of generating larger files. BITS_PER_PIXEL is used to specify the number of bits to use. If you do not specify a value for BITS_PER_PIXEL, a default value of 4 is used.

It should be noted that many laser printers, including the original Apple Laserwriter are capable of only 32 different shades of gray (which can be represented by 5 bits). Thus, specifying 8 bits per pixel does not give 256 apparent shades of grey as might be expected, only 32, at a cost of sending twice the number of bits to the printer. Often, 4 bits (16 levels of gray) will give acceptable results with a large savings in file size.

## BKMAN

(PS)

Set this keyword to select the ITC Bookman PostScript font.

## BOLD

(PS)

Set this keyword to specify that the bold version of the current PostScript font should be used.

## BOOK

(PS)

Set this keyword to specify that the book version of the current PostScript font should be used.

## BYPASS_TRANSLATION

(WIN, X)

Set this keyword to bypass the translation tables, allowing direct specification of color indices. See “Color Translation” on page 3861 Pixel values read via the TVRD function are not translated if this keyword is set, and the result contains the byte value of the actual pixel values present in the display.

By default, the translation tables are used with shared and static color tables. When using displays with private color tables, the translation tables are bypassed.

This keyword is accepted by the WIN device (for compatibility with the X device), but has no effect when set.

## CLOSE

(Z)

Set this keyword to deallocate the memory used by the Z-buffer. The Z-buffer device is reinitialized if subsequent graphics operations are directed to the device.

## CLOSE_DOCUMENT

(PRINTER)

Set this keyword to have IDL send any buffered output to the currently selected printer. This keyword is applicable only when the printer device is selected. See “The Printer Device” on page 3839 for details.

## CLOSE_FILE

(CGM, HP, METAFILE, PCL, PS, REGIS, TEK)

Set this keyword to have IDL output any buffered commands and close the current graphics file.

Caution: If you close the output file and then cause IDL to produce more output (e.g., by executing a new PLOT command), IDL will open the file again, causing the contents of the recently closed file to be lost. To avoid this, use the FILENAME keyword to specify a different file name or use SET_PLOT to disable the graphics driver, or be sure to print the closed output file before creating more output.

See the discussion of printing output files in “Printing Graphics Output Files” on page 3827

## COLOR

(PCL, PS)

Set this keyword to enable color PCL or PostScript output. See "The PCL Device" on page 3837 or "The PostScript Device" on page 3840.

## COLORS

(CGM, TEK)

This keyword specifies the maximum number of colors and the size of the color table used for output. The value of the system variable fields !D.N_COLORS and !D.TABLE_SIZE are set to this value and !P.COLOR is set to one less than this value.

### For Tektronix Terminals Only

This keyword sets the number of colors supported by a 4100 series terminal. For example, if your terminal has 4-bit planes, the number of colors is $2^4 = 16$:

```
DEVICE, COLORS = 16
```

Valid values of this parameter are: 2, 4, 8, 16, or 64; other values will cause problems. Some Tektronix terminals will not operate properly if this parameter does not exactly match the number of colors available in the terminal hardware.

This parameter sets the field !D.N_COLORS, which affects the loading of color tables, the scaling used by the TVSCL procedure, and the number of bits output by the TV procedure to the terminal. It also changes the default color, !P.COLOR to the number of colors minus one.

## COPY

(WIN, X)

Use this keyword to copy a rectangular area of pixels from one region of a window to another. COPY should be set a six or seven element array: $[X_s, Y_s, N_x, N_y, X_d, Y_d, W]$, where: $(X_s, Y_s)$ is the lower left corner of the source rectangle, $(N_x, N_y)$ are the number of columns and rows in the rectangle, and $(X_d, Y_d)$ is the coordinate of the destination rectangle. Optionally, $W$ is the index of the window *from which the pixels should be copied to the current* window. If it is not supplied, the current window is used as both the source and destination.

## COURIER

(PS)

Set this keyword to select the Courier PostScript font.

## CURSOR_CROSSHAIR

(WIN, X)

Set this keyword to selects the crosshair cursor type. This is the IDL default.

## CURSOR_IMAGE

(WIN, X)

Specifies the cursor pattern. The value of this keyword must be a 16-line by 16-column bitmap, contained in a 16-element short integer vector. The offset from the upper left pixel to the point that is considered the hot spot can be provided via the CURSOR_XY keyword.

## CURSOR_MASK

(WIN, X)

When the CURSOR_IMAGE keyword is used to specify a cursor bitmap, the CURSOR_MASK keyword can be used to simultaneously specify the mask that should be used. In the mask, bits that are set indicate bits in the CURSOR_IMAGE that should be seen and bits that are not set are masked out.

By default, the CURSOR_IMAGE bitmap is used for both the image and the mask. This can cause the cursor to be invisible on a black background (because only black pixels are allowed to be displayed).

## CURSOR_ORIGINAL

(WIN, X)

Set this keyword to select the window system’s default cursor. Under X Windows, it is the cursor in use by the root window when IDL starts. For the Microsoft Windows device, it is the arrow pointer.

## CURSOR_STANDARD

(WIN, X)

This keyword can be used to change the cursor appearance in IDL graphics windows.

### For X Windows

This keyword selects one of the predefined cursors provided by the X Window system. The available cursors shapes are defined in the file `cursorfont.h` in the directory `/usr/include/X11`. In order to use one of these cursors, you select the number of the cursor and provide it as the value of the CURSOR_STANDARD keyword. For example, the file gives the value of XC_CROSS as being 30. In order to make that the current cursor, use the statement:

```
DEVICE, CURSOR_STANDARD=30
```

### For Microsoft Windows

The table below shows the values for CURSOR_STANDARD that result in different cursor shapes. For example, to change the cursor to an “I-beam” when the cursor is in an IDL graphics window, use the command:

```
DEVICE, CURSOR_STANDARD = 32513
```

| Value | Cursor Shape |
|---|---|
| 32512 | Arrow |
| 32513 | I-Beam |
| 32514 | Hourglass |
| 32515 | Black Crosshair |
| 32516 | Up Arrow |
| 32640 | Size (Windows NT only) |
| 32641 | Icon (Windows NT only) |
| 32642 | Size NW-SE |
| 32643 | Size NE-SW |
| 32644 | Size E-W |
| 32645 | Size N-S |

*Table A-3: Values for the WIN device CURSOR_STANDARD Keyword*

## CURSOR_XY

(WIN, X)

A two element integer vector giving the (X, Y) pixel offset of the cursor hot spot, the point which is considered to be the mouse position, from the lower left corner of the cursor image. This parameter is only applicable if CURSOR_IMAGE is provided. The cursor image is displayed top-down—the first row is displayed at the top.

## DECOMPOSED

(WIN, X)

This keyword is used to control the way in which graphics color index values are interpreted when using displays with decomposed color (TrueColor or DirectColor visuals). This keyword has no effect with other types of visuals.

Set this keyword to 1 to cause color indices to be interpreted as 3, 8-bit color indices where the least-significant 8 bits contain the red value, the next 8 bits contain the green value, and the most-significant 8 bits contain the blue value. This is the way IDL has always interpreted pixels when using visual classes with decomposed color.

Set this keyword to 0 to cause the least-significant 8 bits of the color index value to be interpreted as a PseudoColor index. This setting allows users with DirectColor and TrueColor displays to use IDL programs written for standard, PseudoColor displays without modification.

In older versions of IDL, color index values higher than !D.N_COLORS-1 were clipped to !D.N_COLORS-1 in the higher level graphics routines. In some cases, this clipping caused the exclusive-OR graphics mode to malfunction with raster displays. This clipping has been removed. Programs that incorrectly specified color indices higher than !D.N_COLORS-1 will now probably exhibit different behavior.

## DEMI

(PS)

Set this keyword to specify that the demi version of the current PostScript font should be used.

## DIRECT_COLOR

(X)

Set this keyword to select the DirectColor visual. The value of the keyword represents the number of bits per pixel. This keyword has effect only if no windows have been

created. Visual classes are discussed in more detail in “X Windows Visuals” on page 3856.

## EJECT

(HP)

In order to perform an erase operation on a plotter, it is necessary to remove the current sheet of paper and load a fresh sheet. The ability of various plotters to do this varies, so the EJECT keyword allows you to specify what should be done. The following table describes the possible values.

| Value | Meaning |
|---|---|
| 0 | Do nothing. Note that this is likely to cause one page to plot over the previous one, so you should limit yourself to one page of output per file. This is the default. |
| 1 | Use the sheet feeder to load the next page. |
| 2 | Put the plotter off-line at the beginning of each page after the first. |

*Table A-4: Values for the HP-GL Eject Keyword*

Many HP-GL plotters lack a sheet feeder, and require the user to load the next page manually. Therefore, the default action is for IDL to not issue any page eject instructions. In this case, you must restrict yourself to generating only a single plot at a time. If your plotter has a sheet feeder, you will want to issue the command:

```
DEVICE, /EJECT
```

to tell IDL that it should use the sheet feeder instead of placing the plotter off-line.

If your plotter does not have a sheet feeder, but it does understand the HP-GL NR command, use the command:

```
DEVICE, EJECT=2
```

to place the plotter off-line at the start of every plot except the first one. This causes the plotter to wait between plots for the user to replace the paper. When the user puts the plotter back on-line, the graphics commands for the new page are executed by the plotter. Consult the programming manual for your plotter to determine if this instruction is provided.

## ENCAPSULATED

(PS)

Set this keyword to create an encapsulated PostScript file, suitable for importing into another document (e.g., a LaTeX or FrameMaker document).

**Note**

You must explicitly set this keyword to zero to create “regular” PostScript output after creating encapsulated output. (That is, like most keyword settings to the DEVICE procedure, the setting “sticks” until you change it, or until you quit IDL.)

Normally, IDL assumes that its PostScript-generated output will be sent directly to a printer. It therefore includes PostScript commands to position the plot on the page and to eject the page from the printer. These commands are undesirable if the output is going to be inserted into the middle of another PostScript document. If ENCAPSULATED is present and non-zero, IDL does not generate these commands.

IDL follows the standard PostScript convention for encapsulated files. It assumes the standard PostScript scaling is in effect (72 points per inch), In addition, it declares the size, or *bounding box* of the plotting region at the top of the output file. This size is determined when the output file is opened (when the first graphics command is given), by multiplying the size of the plotting region (as specified with the XSIZE and YSIZE keywords) by the current scale factor (as specified by the SCALE_FACTOR keyword).

Changing the size of the plotting region or scale factor once graphics have been output will not be reflected in the declared bounding box, and will confuse programs that attempt to import the resulting graphics. Therefore, when generating encapsulated PostScript, do not change the plot region size or scaling factor once any graphics commands have been issued. If you need to change these parameters, use the FILENAME keyword to start a new file.

## ENCODING

(CGM)

Set this keyword to set the CGM encoding type for the output file. Valid values are:

| Value | Description |
|---|---|
| 1 | Binary encoding - the default. |

*Table A-5: CGM Encoding Values*

| Value | Description |
|---|---|
| 2 | Text encoding. |
| 3 | NCAR binary encoding. |

*Table A-5: CGM Encoding Values*

The encoding type can only be changed when no CGM file is open.

## FILENAME

(CGM, HP, METAFILE, PCL, PS, REGIS, TEK)

Normally, all generated output is sent to a file named `idl.xxx`, where `xxx` is the lowercase name of the device shown in the table under "Supported Devices" on page 3782. The FILENAME keyword can be used to change these defaults. If FILENAME is specified:

1. If the file is already open (as happens if plotting commands have been directed to the file since the call to SET_PLOT), then the file is completed and closed as if CLOSE_FILE had been specified.
2. The specified file is opened for subsequent graphics output.

### HP-GL Only

Under UNIX, if you wish to send HP-GL output directly to a plotter without generating an intermediate file, you should specify the device special file for the plotter as the argument to FILENAME. For example, if your plotter is connected to a serial input/output port known on your system as `/dev/ttya`, you would issue the command:

```
DEVICE, FILENAME='/dev/ttya'
```

All subsequent HP-GL output is sent directly to the plotter connected to serial port `/dev/ttya`.

## FLOYD

(PCL, X)

Set this keyword to select the Floyd-Steinberg method of dithering. This algorithm distributes the error, due to displaying intermediate shades in either black or white, to surrounding pixels. This method generally gives the most pleasing results but requires the most computer time.

## FONT_INDEX

(PS)

An integer representing the font index to be mapped to the current PostScript font.

Normally the font specification keywords (AVANTGARDE, etc.) take effect immediately to change the current font. The FONT_INDEX keyword alters this behavior. The current font is not changed. Instead, the specified font is mapped to the specified font index. This mapping can then be used within text strings to change the font in the middle of the string. See “Using PostScript Fonts” on page 3841

## FONT_SIZE

(PS)

The default height used for displayed text. FONT_SIZE is given in points (a common typesetting unit of measure). The default size is 12 point text.

## GET_CURRENT_FONT

(METAFILE, PRINTER, WIN, X)

Set this keyword to a named variable in which the name of the current font is returned as a scalar string. A null string is returned if the Windows font is the default font. If the current device is PRINTER or METAFILE, the current font is returned.

## GET_DECOMPOSED

(WIN, X)

Set this keyword to a named variable in which is returned the current state of the decomposed flag in the current direct graphics device.

## GET_FONTNAMES

(METAFILE, PRINTER, WIN, X)

Set this keyword to a named variable in which a string array containing the names of available fonts is returned. If no fonts are found, a null scalar string is returned. This keyword must be used in conjunction with the SET_FONT keyword. Set the SET_FONT keyword to a scalar string containing the name of the desired font or to a wildcard. For example, the following command will return in the variable `fnames` the names of all available fonts:

```
DEVICE, GET_FONTNAMES=fnames, SET_FONT='*'
```

## GET_FONTNUM

(METAFILE, PRINTER, WIN, X)

Set this keyword to a named variable in which the number of fonts available to your installation is returned. This keyword must be used in conjunction with the SET_FONT keyword. Set the SET_FONT keyword to a scalar string containing the name of the desired font or a wildcard. For example, the following command will return in the variable `numfonts` the number of available fonts:

```
DEVICE, GET_FONTNUM=numfonts, SET_FONT='*'
```

## GET_GRAPHICS_FUNCTION

(WIN, X, Z)

Set this keyword to a named variable that returns the value of the current graphics function (which is set with the SET_GRAPHICS_FUNCTION keyword). This can be used to remember the current graphics function, change it temporarily, and then restore it. See “SET_GRAPHICS_FUNCTION” on page 3815 keyword for an example.

## GET_PAGE_SIZE

(PRINTER)

Set this keyword to a named variable in which to return a two-element vector that contains the width and height of the page size in pixels.

## GET_SCREEN_SIZE

(WIN, X)

Set this keyword to a named variable in which to return a two-word array that contains the width and height of the server’s screen, in pixels.

## GET_VISUAL_DEPTH

(WIN, X)

Set this keyword to a named variable into which a long integer is returned containing the depth of the visual associated with this device. Under X, if the X server is not connected when you call the DEVICE procedure with this keyword set, a new connection is made.

## GET_VISUAL_NAME

(WIN, X)

Set this keyword equal to a named variable in which a string containing the name of the current visual class IDL is using is returned. Possible return values are:

- StaticGray (X only)
- GrayScale (X only)
- StaticColor (X only)
- PseudoColor
- TrueColor
- DirectColor (X only)

Under X, if no connection to the X server has been established when the DEVICE procedure is called with this keyword set, a new connection is made.

## GET_WINDOW_POSITION

(WIN, X)

Set this keyword to a named variable that returns a two-element array containing the (X,Y) position of the lower left corner of the current window on the screen. The origin is also in the lower left corner of the screen.

## GET_WRITE_MASK

(WIN, X)

Specifies the name of a variable to receive the current value of the write mask.

## GIN_CHARS

(TEK)

The number of characters IDL is to read when accepting a GIN (Graphics INput) report. The default is 5. If your terminal is configured to send a carriage return at the end of each GIN report, set this parameter to 6. If the number of GIN characters is too large, the IDL CURSOR procedure will not respond until two or more keys are struck. If it is too small, the extra characters sent by the terminal will appear as input to the next IDL prompt.

## GLYPH_CACHE

(METAFILE, PRINTER, PS, WIN, Z)

Set this keyword to a scalar specifying the maximum number of glyphs to cache at any given time. The first time a glyph from a TrueType font is used, it is tessellated into triangles. These triangles are cached so that the tessellation step is not repeated for each use of that glyph. If the glyph cache fills, the least used glyph will be released before a new glyph is generated and cached. The default is 256.

## HELVETICA

(PS)

Set this keyword to select the Helvetica PostScript font.

## INCHES

(HP, METAFILE, PCL, PRINTER, PS)

Normally, the XOFFSET, XSIZE, YOFFSET, and YSIZE keywords are specified in centimeters. However, if INCHES is present and non-zero, they are taken to be in inches instead.

## INDEX_COLOR

(METAFILE, PRINTER)

Set this keyword to place the printer or MetaFile device in index color mode. This is the default. This keyword is applicable only when the printer or MetaFile device is selected.

## ISOLATIN1

(PS)

Set this keyword to use Adobe ISO Latin 1 font encoding with any font that supports such coding. Use of this keyword allows access to many commonly-used foreign characters.

## ITALIC

(PS)

Set this keyword to specify that the italic version of the current PostScript font should be used.

## LANDSCAPE

(HP, PCL, PRINTER, PS)

IDL normally generates plots with portrait orientation (the abscissa is along the short dimension of the page). If the LANDSCAPE keyword is set, landscape orientation (abscissa along the long dimension of the page) is used instead. Note that explicitly setting LANDSCAPE=0 is the same as setting the PORTRAIT keyword.

If the current device is PRINTER, and a page is open in the printer, it is closed and a new page set to landscape layout is started.

**Note**

The ability to set a printer to landscape mode is printer-driver dependent. Your printer may not support this functionality; use the system native print setup dialog to set the orientation of the print job.

## LANGUAGE_LEVEL

(PS)

Set this keyword to indicate the language level of the PostScript output that is to be generated by the device. Valid values include 1 (the default) and 2 (required for some features, such as filled patterns for polygons).

## LIGHT

(PS)

Set this keyword to specify that the light version of the current PostScript font should be used.

## MEDIUM

(PS)

Set this keyword to specify that the medium version of the current PostScript font should be used.

## NARROW

(PS)

Set this keyword to specify that the narrow version of the current PostScript font should be used.

## NCAR

(CGM)

Set this keyword to set the encoding type for the CGM output file to NCAR binary.

### The NCAR Binary Encoding

The NCAR binary encoding is used exclusively by the NCAR graphics package. Version 3.01 of NCAR View (`ctrans`, `ictrans`, and `cgm2ncgm`) does not correctly handle the following graphic elements:

- Cell arrays (raster images) with an odd number of pixels in the X dimension. Solution: specify an even number of pixels for the X dimension or make the image one column wider and fill with zeros.
- Raster images drawn in top down order. Solution: invert the image prior to using TV or TVSCL and do not use the /ORDER keyword. For example:

```
TV, image
; Draw image top to bottom:
TV, ROTATE(image, 7)
```

## OBLIQUE

(PS)

Set this keyword to specify that the oblique version of the current PostScript font should be used.

## OPTIMIZE

(PCL)

It is desirable, though not always possible, to compress the size of the PCL output file. Such optimization reduces the size of the output file, and improves I/O speed to the printer. There are three levels of optimization:

| Value | Description |
|---|---|
| 0 | No optimization is performed. This is the default because it will work with any PCL device. However, users of devices which can support optimization should use one of the other optimization levels. |

*Table A-6: PCL Optimization Values*

| Value | Description |
|---|---|
| 1 | Optimization is performed using PCL optimization primitives. This gives the best output compression and printing speed. Unfortunately, not all PCL devices support it. On those that can't, the result will be garbage printed on the page. Consult the programmers manual for your printer to determine if it supports the required escape sequences. The required sequences are: <ESC>*b0M (select full graphics mode), <ESC>*b1M (select compacted graphics mode 1), and <ESC>*b2M (select compacted graphics mode 2). The HP LaserJet II does not support this optimization level. The DeskJet PLUS does. |
| 2 | IDL attempts to optimize the output by explicitly moving the left margin and then outputting non-blank sections of the page. This is primarily intended for use with the LaserJet II, which does not support optimization level 1. Note: This optimization can be very slow on some devices (such as the DeskJet PLUS). On such devices, it is best to avoid this optimization level. |

*Table A-6: PCL Optimization Values (Continued)*

## ORDERED

(PCL, X)

Set this keyword to select the ordered dither method. This introduces a pseudo-random error into the display by using a 4 by 4 "dither" matrix, yielding 16 apparent intensities. This is the default method.

## OUTPUT

(HP, PS)

Specifies a scalar string that is sent directly to the graphics output file without any processing, allowing the user to send arbitrary commands to the file. Since IDL does not examine the string, it is the user's responsibility to ensure that the string is correct for the target device.

## PALATINO

(PS)

Set this keyword to select the Palatino PostScript font.

## PIXELS

(PCL)

Normally, the XOFFSET, XSIZE, YOFFSET, and YSIZE keywords are specified in centimeters. However, if the PIXELS keyword is set, they are taken to be in pixels instead. Note that the selected resolution will determine how large a region is actually written on the page.

## PLOT_TO

(REGIS, TEK)

Directs the Tektronix graphic output that would normally go to the user's terminal to the specified I/O unit. The logical unit specified should be open with write access to a device or file. Graphic output may be saved in files for later playback, redirected to other terminals, or to devices that can accept Textronix graphic commands.

Do not use the interactive graphics cursor when graphic output is not directed to your terminal.

To direct the graphic data to both the terminal and the file, set the unit to the negative of the actual unit number. Alternatively, you can use the TTY keyword, described below.

If the specified unit number is zero then Tektronix output to the file is stopped.

## PLOTTER_ON_OFF

(HP)

There are some configurations in which a HP-GL plotter is connected between the computer and a terminal. In this mode (known as eavesdrop mode), the plotter ignores everything it is sent and passes it through to the terminal—the plotter is logically off. This state continues until an escape sequence is sent that turns the plotter logically on. At this point the plotter interprets and executes all input as HP-GL commands. Another escape sequence is sent at the end of the HP-GL commands to return the plotter to the logically off state.

Most configurations do not use eavesdrop mode, and the plotter is always logically on. However, if you are using this style of connection, you must use PLOTTER_ON_OFF to instruct IDL to generate the necessary on/off commands. If present and non-zero, PLOTTER_ON_OFF causes each output page to be bracketed by device control commands that turn the plotter logically on and off. Specifying a value of zero stops the issuing of such commands. You should only use this keyword before any output has been generated.

## POLYFILL

(HP)

Some plotters (e.g., HP7550A) can perform polygon filling in hardware, while others (e.g., HP7475) cannot. IDL therefore assumes that the plotter cannot, and generates all polygon operations in software using line drawing. Specifying a non-zero value for the POLYFILL keyword causes IDL to use the hardware polygon filling. Setting it to zero reverts to software filling.

Different implementations of HP-GL plotters may have different limits for the number of vertices that can be specified for a polygon region before the plotter runs out of internal memory. Since this limit can vary, the HP-GL driver cannot check for calls to POLYFILL that specify too many points. Therefore, it is possible for the user to produce HP-GL output that causes an error when sent to the plotter. To avoid this situation, minimize the number of points used. On the HP7550A, the limit is about 127 points. If you do generate output that exceeds the limit imposed by your plotter, you will have to break that polygon filling operation into multiple smaller operations.

## PORTRAIT

(HP, PCL, PRINTER, PS)

Set the PORTRAIT keyword to generate plots using portrait orientation. Portrait orientation is the default. Note that explicitly setting PORTRAIT=0 is the same as setting the LANDSCAPE keyword.

If the current device is PRINTER, and a page is open in the printer, it is closed and a new page set to portrait layout is started.

**Note**

The ability to set a printer to portrait mode is printer-driver dependent. Your printer may not support this functionality; use the system native print setup dialog to set the orientation of the print job.

## PRE_DEPTH

(PS)

Set this keyword to a value indicating the bit depth to be used for the preview in the PostScript file. Valid values are 1 (for black and white preview) and 8 (for 8-bit grayscale preview). This keyword applies only if the PREVIEW keyword is nonzero. The default depth is 8.

## PRE_XSIZE

(PS)

Set this keyword to the width to be used for the preview in the PostScript file. PRE_XSIZE is specified in centimeters, unless the INCHES keyword is set. This keyword applies only if the PREVIEW keyword value is nonzero. The default is 1.77778 inches (128 pixels at 72dpi).

Also see the note below, "A Note About Preview Dimensions".

## PRE_YSIZE

(PS)

Set this keyword to the height to be used for the preview in the PostScript file. PRE_YSIZE is specified in centimeters, unless the INCHES keyword is set. This keyword applies only if the PREVIEW keyword value is nonzero. The default is 1.77778 inches (128 pixels at 72dpi).

Also see the note below, "A Note About Preview Dimensions".

## PREVIEW

(PS)

Set this keyword to 1 to add a platform-independent preview to the PostScript output file in encapsulated PostScript interchange format (EPSI). EPSI is an ASCII format. Set this keyword to 2 to write the EPS file in EPSF format, including an on-screen preview that is supported by many Windows applications, e.g. MSWord. The default (0) is to not include a preview.

**Note**

EPSF is not an ASCII format and cannot be sent directly to a Postscript printer, unlike the EPSI format. It must be imported into an application for printing.

### A Note About Preview Dimensions

Different applications may utilize the information within a PostScript file in different ways when displaying a screen preview. Some applications will ignore the preview contents entirely, and simply use the primary PostScript contents to generate a screen preview. Other applications will use the preview data and its corresponding dimensions for screen display. Still others will use the preview data and stretch it to the dimensions of the primary PostScript contents. It is therefore recommended that the target application (into which the encapsulated PostScript file is to be loaded) be

considered when selecting an appropriate XSIZE, YSIZE, PRE_XSIZE, and PRE_YSIZE.

## PRINT_FILE

(WIN)

Set this keyword to the name of a file (e.g., PostScript or PCL) to be sent to the currently-selected Windows printer. IDL performs no type checking on this file before sending it to the printer. Therefore, if you have a PostScript printer selected and you send a file that contains no valid PostScript information, you'll simply get text output.

To send the file `myfile.ps` to the currently-selected Windows printer, enter:

```
DEVICE, PRINT_FILE='myfile.ps'
```

## PSEUDO_COLOR

(X)

If this keyword is present, the PseudoColor visual is used. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 3856.

## RESET_STRING

(TEK)

The string used to place the terminal back into the normal interactive mode after drawing graphics. Use this parameter, in conjunction with the SET_STRING keyword, to control the mode switching of your terminal.

For example, the GraphON 200 series terminals require the string `<ESC>2` to activate the alphanumeric window after drawing graphics. The call to set this is:

```
DEVICE, RESET = string(27b) + '2'
```

If the 4100 series mode switch is set, using the keyword TEK4100, the default mode resetting string is `<ESC>%!1`, which selects the ANSI code mode.

## RESOLUTION

(PCL)

### PCL Only

The resolution at which the PCL printer will work. PCL supports resolutions of 75, 100, 150, and 300 dots per inch. The default is 300 dpi. Lower resolution gives smaller output files, while higher resolution gives superior quality.

## RETAIN

(WIN, X)

Use this keyword to specify the default method used for backing store when creating new windows. This is the method used when the RETAIN keyword is not specified with the WINDOW procedure. Backing store is discussed in more detail under “Backing Store” on page 3824, along with the possible values for this keyword. If RETAIN is not used to specify the default method, method 1 (server-supplied backing store) is used.

### Microsoft Windows Only

The initial value of this parameter can be set by selecting File-Preferences from the menu bar. See “Backing Store” on page 3824.

### A Note on Reading Data from Windows

On some systems, when backing store is provided by the window system (RETAIN=1), reading data from a window using TVRD may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (RETAIN=2) ensures that the window contents will be read properly. These types of problems are described in more detail in the documentation for TVRD. See “Unexpected Results Using TVRD with X Windows” on page 2053.

## SCALE_FACTOR

(PRINTER, PS)

Specifies a scale factor applied to the entire plot. The default value is 1.0, allowing output to appear at its normal size. SCALE_FACTOR is used to magnify or shrink the resulting output.

The SCALE_FACTOR keyword behaves slightly differently in the context of the PRINTER device than it does in the context of the PS device.

When the current device is PRINTER, the SCALE_FACTOR keyword is designed to emulate a scalable resolution setting on the printer. For example, if you have a 300 x 300 pixel image—stored in the variable *image*—the following IDL commands will print *image* in a 0.5 inch square on a 600 dpi printer:

```
SET_PLOT, 'printer'
TV, image
```

Setting SCALE_FACTOR to 2 will scale the image to a 1 inch square on the same 600 dpi printer:

```
SET_PLOT, 'printer'
DEVICE, SCALE_FACTOR=2
TV, image
```

The output of IDL's Direct Graphics routines (CONTOUR, PLOT, SURFACE, etc.) is automatically scaled to fill the available drawing area. As a result, the following IDL commands will produce two identical copies of the same output on any printer:

```
SET_PLOT, 'printer'
PLOT, data
DEVICE, SCALE_FACTOR=2
PLOT, data
```

## SCHOOLBOOK

(PS)

Set this keyword to select the New Century Schoolbook PostScript font.

## SET_CHARACTER_SIZE

(CGM, HP, METAFILE, PCL, PRINTER, PS, REGIS, TEK, WIN, X, Z)

Set this keyword equal to a two-element vector to specify the font size and line spacing (leading) of vector and TrueType fonts, and the line spacing of device fonts. The way that the value of this vector determines character size is not completely intuitive.

The vector specified to the SET_CHARACTER_SIZE keyword sets the values of the X_CH_SIZE and Y_CH_SIZE fields in the !D System Variable structure. These values describe the size of the rectangle that contains the "average" character in the current font. (It is not important what the "average" character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The first element specifies the width of the rectangle in device units (usually pixels), and the second element specifies the height.

For vector and TrueType fonts, the height of the "average" character is determined by the *width* of the rectangle. The aspect ratio of the "average" character remains fixed;

the character is scaled so that its width fits in the specified rectangle. The resulting scale factor is then applied to all of the characters in the font. The amount of spacing between lines (baseline to baseline) is determined explicitly by the height of the rectangle.

For device fonts, the character size is fixed. When the device font system is in use, the first element of the vector specified to SET_CHARACTER_SIZE is silently ignored, and only the line-spacing value is used.

**Note**

Changing between font systems (and sometimes changing from one font to another within the same font system) can also change the !D structure, so do not assume that the character size you have set is preserved when you change fonts.

## SET_COLORMAP

(PCL)

Set this keyword to a 14,739 ($= 3 \cdot 17^3$) element byte vector containing the RGB-to-printer color translation table for a color PCL printer. The default table is for an HP Deskjet 500C printer.

The translation table is divided into red, green, and blue planes of 4913 ($=17^3$) elements each. For a given RGB triple, the offset into each plane is calculated as follows:

```
Offset = (Red/16)*289 + (Green/16)*17 + (Blue/16)
```

Thus, if the RGB triple is [16,32,160], the offset into each plane is 333. The printer will use the value at element 332 of the translation table as the red value, the value at element 5245 (=4913+332) as the green value, and the value at element 10158 (=9826+332) as the blue value.

The following example shows how to scale an existing colortable for use by a PCL printer.

```
; Set the plot window to the X device:
SET_PLOT, 'X'
; Create a window:
WINDOW,0,XS=300,YS=300
; Load a color table:
LOADCT,13
; Read color table values into variables:
TVLCT,r,g,b,/GET
; Re-size color table variables:
r2=CONGRID(r,4913)
g2=CONGRID(g,4913)
```

```
b2=CONGRID(b,4913)
; Create 14,739-element color map:
colormap=[r2,g2,b2]
; Change to the PCL device:
SET_PLOT, 'PCL'
; Set file name, resolution, color, and color map:
DEVICE, FILE = 'pcl.pcl', RESOLUTION = 300, $
    /COLOR, SET_COLORMAP = colormap
; Display an image:
TVSCL,DIST(900)
; Close the device:
DEVICE,/CLOSE
```

**Note**

The color table used need not be one of IDL's predefined tables.

## SET_COLORS

(Z)

Sets the number of pixel values, !D.N_COLORS and !D.TABLE_SIZE. This value is used by a number of IDL routines to determine the scaling of pixel data and the default drawing index. Allowable values range from 2 to 256, and the default value is 256. Use this parameter to make the Z-buffer device compatible with devices with fewer than 256 colors indices.

## SET_FONT

(METAFILE, PRINTER, PS, WIN, X, Z)

Set this keyword to a scalar string specifying the name of the font used when a hardware or TrueType font is selected. Note that hardware fonts cannot be rotated, scaled, or projected, and that the "!" commands for formatting may not work. When generating three-dimensional plots, it is best to use the vector-drawn or TrueType characters. Note that for the PS device, only one hardware font (other than the predefined fonts set via the fontname keywords, such as /AVANTEGARDE) may be loaded at a time.

### Note on the FONT Keyword

The SET_FONT keyword was introduced with IDL version 5.1 and replaces the FONT and USER_FONT keywords used in previous versions.

### Using TrueType Fonts

For TrueType fonts, the specified font name must exactly match one of the names in the first column of the `ttfont.map` file in the `resource/fonts/tt` directory or

(on Windows platforms) the name of an installed font. See "About TrueType Fonts" on page 3957 for details on the `ttfont.map` file and for a listing of TrueType fonts distributed with IDL. Note that you must include the TT_FONT keyword to indicate that the font specified is a TrueType font. For example, the following sets the font to the font to the TrueType font Helvetica Bold Italic:

```
DEVICE, SET_FONT='Helvetica-BoldItalic'
```

**Note**

You can append additional TrueType fonts to the `ttfont.map` file if desired; on Windows platforms, additional fonts can also be added via the normal font installation procedures for your system. RSI cannot guarantee that TrueType fonts you add will be satisfactorily tessellated or displayed. See "About TrueType Fonts" on page 3957 for details.

### Using Hardware Fonts

Because device fonts are specified differently on different platforms, the syntax of the *fontname* string depends on which platform you are using.

#### UNIX

Usually, the window system provides a directory of font files that can be used by all applications. List the contents of that directory to find the fonts available on your system. The size of the font selected also affects the size of vector drawn text. X Windows users can use the `xlsfonts` command to list available X Windows fonts.

On some machines, fonts are kept in subdirectories of `/usr/lib/X11/fonts`.

For example, to select the font 8X13:

```
!P.FONT = 0
DEVICE, SET_FONT = '8X13'
```

#### Microsoft Windows

The SET_FONT keyword should be set to a string with the following form:

```
DEVICE, SET_FONT='font*modifier1*modifier2*...modifiern'
```

where the asterisk (*) acts as a delimiter between the font's name (*font*) and any modifiers. The string is *not* case sensitive. Modifiers are simply "keywords" that change aspects of the selected font. Valid modifiers are:

- For font weight: THIN, LIGHT, BOLD, HEAVY
- For font quality: DRAFT, PROOF
- For font pitch: FIXED, VARIABLE

- For font angle: ITALIC
- For strikeout text: STRIKEOUT
- For underlined text: UNDERLINE
- For font size: Any number is interpreted as the font height in pixels.

For example, if you have Garamond installed as one of your Windows fonts, you could select 24-pixel cell height Garamond italic as the font to use in plotting. The following commands tell IDL to use hardware fonts, change the font, and then make a simple plot:

```
!P.FONT = 0
DEVICE, SET_FONT = 'GARAMOND*ITALIC*24'
PLOT, FINDGEN(10), TITLE = 'IDL Plot'
```

This feature is compatible with TrueType and Adobe Type Manager (and, possibly, other type scaling programs for Windows). If you have TrueType or ATM installed, the TrueType or PostScript outline fonts are used so that text looks good at any size.

## SET_GRAPHICS_FUNCTION

(WIN, X, Z)

Most window systems allow applications to specify the graphics function. This is a logical function which specifies how the source pixel values generated by a graphics operation are combined with the pixel values already present on the screen. The complete list of possible values is given in the following table:

| Logical Function | Code | Definition |
|---|---|---|
| GXclear | 0 | 0 |
| GXand | 1 | source AND destination |
| GXandReverse | 2 | source AND (NOT destination) |
| GXcopy | 3 | source |
| GXandInverted | 4 | (NOT source) AND destination |
| GXnoop | 5 | destination |
| GXxor | 6 | source XOR destination |
| GXor | 7 | source OR destination |

*Table A-7: Graphic Function Codes*

| Logical Function | Code | Definition |
|---|---|---|
| GXnor | 8 | (NOT source) AND (NOT destination) |
| GXequiv | 9 | (NOT source) XOR destination |
| GXinvert | 10 | (NOT destination) |
| GXorReverse | 11 | source OR (NOT destination) |
| GXcopyInverted | 12 | (NOT source) |
| GXorInverted | 13 | (NOT source) OR destination |
| GXnand | 14 | (NOT source) OR (NOT destination) |
| GXset | 15 | 1 |

*Table A-7: Graphic Function Codes (Continued)*

The default graphics function is GXcopy, which causes new pixels to completely overwrite any previous pixels. Not all functions are available on all window systems.

For example, the following code segment inverts the bottom bit in the rectangle defined by its diagonal corners $(x_0, y_0)$ and $(x_1, y_1)$:

```
; Set graphics function to exclusive or (GXor), and save the
; old function:
DEVICE, GET_GRAPHICS_FUNCTION = oldg, SET_GRAPHICS_FUNCTION = 6
; Use POLYFILL to select the area to be inverted. The source
; pixel value is 1:
POLYFILL, [[x0,y0], [x0,y1], [x1,y1], [x1,y0]], $
   /DEVICE, COLOR=1
; Restore the previous graphics function:
DEVICE, SET_GRAPHICS_FUNCTION=oldg
```

## SET_RESOLUTION

(Z)

Set this keyword to a two-element vector that specifies the width and height of the Z-buffers. The default size is 640 by 480. If this size is not the same as the existing buffers, the current buffers are destroyed and the device is reinitialized.

## SET_STRING

(TEK)

The string used to place the terminal into the graphics mode from the normal interactive terminal mode. If the 4100 series mode switch is set, using the keyword TEK4100, the default graphic mode setting string is `<ESC>%!0`, which selects the Tektronix code mode.

## SET_TRANSLATION

(X)

This keyword can be used to allow multiple, simultaneous IDL sessions to use the same colors from a shared colormap. Use this keyword before the X connection is established (i.e., before a window is created), IDL will use the shared color map without allocating any additional colors, and will not load a grayscale ramp as is usually done when the X server starts up. The following example shows two cooperating IDL processes sharing the same colormap:

Execute the following commands in the first IDL session:

```
WINDOW, GET_X_ID = a
DEVICE, TRANSLATION = t
OPENW, 1, 'junk.dat'
WRITEU, 1, a, !D.N_COLORS, t[0:!D.N_COLORS-1]
CLOSE, 1
LOADCT, 3
```

Execute the following commands in the second IDL session:

```
OPENR, 1, 'junk.dat'
a=0L
n=0L
READU,1, a, n
t = BYTARR(n)
READU, 1, t
CLOSE, 1
DEVICE, SET_TRANSLATION = t
WINDOW, COLORS=n, SET_X_ID=a
TV, DIST(256)
```

## SET_WRITE_MASK

(X, Z)

Sets the write mask to the specified value. For an *n*-bit system, the write mask can range from 0 to $2^n$-1.

## STATIC_COLOR

(X)

Use this keyword to select the X Windows StaticColor visual. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 3856.

## STATIC_GRAY

(X)

Use this keyword to select the X Windows StaticGray visual. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 3856.

## SYMBOL

(PS)

Set this keyword to select the Symbol PostScript font.

## TEK4014

(TEK)

Set this keyword to specify that coordinates are to be output with full 12-bit resolution. If this keyword is not present or is zero, 10-bit coordinates are output. Normally, IDL sends 10-bit coordinates. 12-bit coordinates are compatible with most terminals, even those without the full resolution, but require more characters to send.

**Note**

The 4014 and the 4100 modes can be used together. The coordinate system IDL uses for the Tektronix is 0 to 4095 in the X direction and 0 to 3120 in the Y direction, even when not in the 4014 mode. In the 10-bit case the internal coordinates are divided by 4 prior to output.

## TEK4100

(TEK)

Set this keyword to indicate that the terminal is a 4100 or 4200 series terminal. The use of color, ANSI and Tektronix mode switching, hardware line styles, and pixel

output with the TV procedure is supported with these terminals. Also, text is output differently.

## TEXT

(CGM)

Set this keyword to set the encoding type for the CGM output file to text.

## THRESHOLD

(PCL, X)

Set this keyword to select the threshold algorithm—the simplest dithering method. The value of this keyword is the threshold to be used. This algorithm simply compares each pixel against the given threshold, usually 128. If the pixel equals or exceeds the threshold the display pixel is set to white, otherwise it is black.

## TIMES

(PS)

Set this keyword to select the Times-Roman PostScript font.

## TRANSLATION

(WIN, X)

As discussed in “Shared Colormaps” on page 3859, using the shared colormap (normally recommended) causes IDL to translate between IDL color indices (which always start with zero and are contiguous) and the pixel values actually present in the display. The TRANSLATION keyword specifies the name of a variable to receive the translation vector. To read the translation table, use the command:

```
DEVICE, TRANSLATION=TRANSARR
```

where TRANSARR is a named variable into which the translation array is stored. The result is a 256-element byte vector. Element zero of the vector contains the pixel value allocated for the first color in the IDL colormap, and so forth.

### Microsoft Windows Only

This keyword is accepted by the WIN device, for compatibility with the X Windows driver, but simply returns a 256-element vector where each element has the value of its subscript (0 to 255).

## TRUE_COLOR

(METAFILE, PRINTER, X)

Use this keyword to select TrueColor visuals. The value of the keyword represents the number of bits per pixel to be used. This keyword has effect only if no windows have been created. Visual classes are discussed in more detail in "X Windows Visuals" on page 3856. If the current device is PRINTER or METAFILE, the printer is placed in RGB or TrueColor mode if the value of the TRUE_COLOR keyword is greater than zero (the number of bits per pixel specified is ignored.)

## TT_FONT

(METAFILE, PRINTER, WIN, X, Z)

Set this keyword to indicate that the font set via the SET_FONT keyword (either to set the fontname or to retrieve fontnames in conjunction with the GET_FONTNAMES or GET_FONTNUM keywords) should be treated as a TrueType font.

## TTY

(REGIS, TEK)

Set this keyword to specify that output should be sent to the terminal at the same time that it is being sent to a file due to the FILENAME or PLOT_TO keywords. A zero value causes output to go only to the file. If no output file is in use, this keyword has no effect.

## USER_FONT

(PS)

*This keyword is now obsolete and has been replaced by the SET_FONT keyword. Code that uses the USER_FONT keyword will continue to function as before, but we suggest that all new code use SET_FONT.*

## VT240, VT241

(REGIS)

Set this keyword to configure the REGIS device for VT240 series terminals.

## VT340, VT341

(REGIS)

Set this keyword to configure the REGIS device for VT340 series terminals.

## WINDOW_STATE

(WIN, X)

Set this keyword to a named variable that returns an array containing one element for each possible window. Array element *i* contains a 1 if window *i* is open, otherwise it contains a 0.

## XOFFSET

(HP, PCL, PRINTER, PS)

Specifies the X position, on the page, of the lower left corner of output generated by IDL. XOFFSET is specified in centimeters, unless INCHES is specified. See "Positioning Graphics Output" on page 3828.

### PostScript Only

SCALE does not affect the value of XOFFSET.

## XON_XOFF

(HP)

If present and non-zero, XON_XOFF causes each output page to start with device control commands that instruct the plotter to obey xon/xoff (^S/^Q) style flow control. Specifying a value of zero stops the issuing of such commands. You should only use this keyword before any output has been generated.

Such handshaking is the default. To turn it off, use the command

```
DEVICE, XON_XOFF=0
```

Often, it is not necessary to tell the plotter to obey flow control because the printing facilities on the system handle such details for you, but it is usually harmless.

## XSIZE

(HP, METAFILE, PCL, PRINTER, PS)

Specifies the width of output generated by IDL. XSIZE is specified in centimeters, unless INCHES is specified.

### PostScript Only

SCALE modifies the value of XSIZE. Hence, the following statement:

```
DEVICE,/INCHES,XSIZE=7.0,SCALE_FACTOR=0.5
```

results in a real width of 3.5 inches.

Also see "A Note About Preview Dimensions" on page 3808.

## YOFFSET

(HP, PCL, PRINTER, PS)

Specifies the Y position, on the page, of the lower left corner of output generated by IDL. YOFFSET is specified in centimeters, unless INCHES is specified. See "Positioning Graphics Output" on page 3828.

**Note**

The corner of the page from which the Y offset is measured (lower or upper left) differs on various devices. Read the device specific information in the following sections to determine how this is handled for your device.

### PostScript Only

SCALE does not affect the value of YOFFSET.

## YSIZE

(HP, METAFILE, PCL, PRINTER, PS)

Specifies the height of output generated by IDL. YSIZE is specified in centimeters, unless INCHES is specified.

### PostScript Only

SCALE modifies the value of YSIZE. Hence, the following statement:

```
DEVICE,/INCHES,YSIZE=5.0,SCALE_FACTOR=0.5
```

results in a real width of 2.5 inches.

Also see "A Note About Preview Dimensions" on page 3808.

## ZAPFCHANCERY

(PS)

Set this keyword to select the ITC Zapf Chancery PostScript font.

## ZAPFDINGBATS

(PS)

Set this keyword to select the ITC Zapf Dingbats PostScript font.

## Z_BUFFERING

(Z)

This keyword enables and disables the Z-buffering. If this keyword is specified with a zero value, the driver operates as a standard 2-D device, the Z-buffering is disabled, and the Z-buffer (if any) is deallocated. Setting this keyword to one (the default value), enables the Z-buffering.

To disable Z-buffering enter:

```
DEVICE, Z_BUFFERING = 0
```

# Window Systems

The different window systems supported by IDL have many features in common. This section describes those features. See the individual descriptions of each system later in this chapter for additional information about each one.

IDL utilizes the window system by creating and using one or more largely independent windows, each of which can be used for the display of graphics and/or images. One color map table is shared among all these windows. Multiple windows can be active simultaneously. Windows are referenced using their index which is a non-negative integer.

"Dithering" or halftoning techniques are used to display images with multiple shades of gray on monochrome displays—displays that can only display white or black. This topic is discussed in "Image Display On Monochrome Devices" on page 3826.

Graphic and image output is always directed to the current window. When a window system is selected as the current IDL graphics device, the index number of the current window is found in the !D.WINDOW system variable. This variable contains -1 if no window is open or selected. The WSET procedure is used to change the current window. WSHOW hides, displays, and iconifies windows. WDELETE deletes a window.

The WINDOW procedure creates a new window with a given index. If a window already exists with the same index, it is first deleted. The size, position, title, and number of colors, may also be specified. If you access the display before creating the first window, IDL automatically creates a window with an index number of 0 and with the default attributes.

## Backing Store

One of the features that distinguishes various window systems is how they handle the issue of backing store. When part of a window that was previously not visible is exposed, there are two basic approaches that a window system can take. Some keep track of the current contents of all windows and automatically repair any damage to their visible regions (retained windows). This saved information is known as the backing store. Others simply report the damage to the program that created the

window and leave repairing the visible region to the program (non-retained windows).

| Value | Description |
|---|---|
| 0 | No backing store. |
| 1 | Request the server or window system to perform backing store. |
| 2 | Make IDL perform backing store. |

*Table A-8: Allowed Values for the RETAIN Keyword*

There are convincing arguments for and against both approaches. It is generally more convenient for IDL if the window system handles this problem automatically, but this often comes at a performance penalty. The actual cost of retained windows varies between systems and depends partially on the application.

The X Window system does not by default keep track of window contents. Therefore, when a window on the display is obscured by another window, the contents of its obscured portion is lost. Re-exposing the window causes the X server to fill the missing data with the default background color for that window, and request the application to redraw the missing data. Applications can request a backing store for their windows, but servers are not required to provide it. Many X servers do not provide backing store, and even those that do cannot necessarily provide it for all requesting windows. Therefore, requesting backing store from the server might help, but there is no certainty.

The IDL window system drivers allow you to control the issue of backing store using the RETAIN keyword to the DEVICE and WINDOW procedures. Using it with DEVICE allows you to set the default action for all windows, while using it with WINDOW lets you override the default for the new window. The possible values for this keyword are summarized under "Backing Store" on page 3824, and are described below:

- Setting the RETAIN keyword to 0 specifies that no backing store is kept. In this case, exposing a previously obscured window leaves the missing portion of the window blank. Although this behavior can be inconvenient, it usually has the highest performance because there is no need to keep a copy of the window contents.
- Setting the RETAIN keyword to 1 causes IDL to request that a backing store be maintained. If the window system decides to accept the request, it will automatically repair the missing portions when the window is exposed. X

Windows may or may not provide backing store when requested, depending on the capabilities of the server and the resources available to it.

- Setting the RETAIN keyword to 2 specifies that IDL should keep a backing store for the window itself, and repair any window damage when the window system requests it. This option exists for X Windows. In this case, a pixmap (off-screen display memory) the same size as the window is created at the same time the window is created, and all graphics operations sent to the window are also sent to the pixmap. When the server requests IDL to repair freshly exposed windows, this pixmap is used to fill in the missing contents. Pixmaps are a precious resource in the X server, so backing pixmaps should only be requested for windows with contents that must absolutely be preserved.

If the type of backing store to use is not explicitly specified using the RETAIN keyword, IDL assumes option 1 and requests the window system to keep a backing store.

### A Note on Reading Data from Windows

On some systems, when backing store is provided by the window system (RETAIN=1), reading data from a window using TVRD may cause unexpected results. For example, data may be improperly read from the window even when the image displayed on screen is correct. Having IDL provide the backing store (RETAIN=2) ensures that the window contents will be read properly. These types of problems are described in more detail in the documentation for TVRD. See “Unexpected Results Using TVRD with X Windows” on page 2053.

## Image Display On Monochrome Devices

Images are automatically dithered when sent to some monochrome devices. Dithering is a technique which increases the number of apparent brightness levels at the expense of spatial resolution. Images with 256 gray levels are displayed on a display with only two colors, black and white, using halftoning techniques. PostScript handles dithering directly. IDL supports dithering for other devices if their DEVICE procedures accept the FLOYD, ORDERED, or THRESHOLD keywords.

# Printing Graphics Output Files

For printer and plotter devices (e.g., PCL, PostScript, and HP-GL), IDL creates a file containing output commands. This file can be sent to the printer via the normal methods provided by the local operating system. When attempting to output the file before exiting IDL, the user must be sure that the graphics output file is complete. For example, the following IDL commands (executed under UNIX) will not produce the desired result:

```
SET_PLOT,'PS'
PLOT,x,y
SPAWN,'lpr idl.ps'
```

These commands fail because the attempt to print the file is premature—the file is still open within IDL and is not yet complete.

The following lines of code are an IDL procedure called OUTPUT_PLOT which closes the current graphics file and sends it to the printer. This routine assumes that the graphics output file is named `idl.xxx`, where `xxx` represents the name of the graphics driver. For example, PostScript output file is assumed to be `idl.ps`. It also assumes that the graphics output to be printed is from the current graphics device, as selected with SET_PLOT.

```
; Close the current graphics file, and print it. If the
; New_file parameter is present, rename the file to the given
; name so it won't be overwritten:
Pro OUTPUT_PLOT, New_file
; Close current graphics file:
DEVICE,/CLOSE
; Build the default output file name by using the idl name for
; the current device (!D.NAME):
file = 'idl.' + STRLOWCASE(!D.NAME)
; Build shell commands to send file to the printer.
; You will probably have to change this command in accordance
; with local usage:
cmd = 'lpr ' + file
; Concatenate rename command if new file specified:
IF N_ELEMENTS(New_file) GT 0 THEN $
   cmd = cmd + '; mv' + file + ' ' + New_file
; Issue shell commands to print/rename file:
SPAWN, cmd
END
```

The call to DEVICE causes IDL to finish the file and close it, which makes it available for printing.

# Setting Up The Printer

In order for IDL generated output files to work properly with printers and plotters, it is necessary for the device to be configured properly. This usually involves configuring both the device hardware and the operating system printing software. When setting up your system, keep the following points in mind:

- The device and computer must use some form of flow control to prevent the computer from sending data faster than the printing device can handle it. The most common form of flow control is known as XON/XOFF, and involves the sending of Control-S (off) and Control-Q (on) characters from the device to the printer to manage the flow of data.

  Many printers have a large buffer into which they store incoming data they haven't yet processed. This reduces the need to invoke flow control. When testing your configuration to ensure flow control is actually enabled, you must be sure to print a document long enough to fill any such buffer, or flow control may never occur, giving a false impression that the setup is correct. A common source of problems stem from attempting to print long IDL generated output files without proper flow control.

- Some devices (such as PCL) require an eight-bit data path, while others (such as PostScript) do not. For devices that do, it is important to ensure that the printer port and system printing software provide such a connection.

  If you are having problems printing on a PostScript printer, the `ehandler.ps` file in the `resource/fonts/ps` subdirectory of the IDL distribution can help you to debug your problem. Sending this file to your PostScript Printer causes it to print any subsequent errors it encounters on a sheet of paper and eject it. The effect of this file lasts until the printer is reset.

## Setting Up Printers Under UNIX

Printers are configured in the `/etc/printcap` file. This file describes to the system which printers are connected to it, the characteristics of each printer, and how the printer port should be configured. Managing the printcap file is usually discussed in the system management documentation supplied with the system by the manufacturer.

# Positioning Graphics Output

The difference between the XOFFSET and YOFFSET keywords to the DEVICE procedure, and the higher level plot positioning keywords and system variables (discussed in Appendix B, "Graphics Keywords" and Chapter 17, "Direct Graphics

Plotting" in the *Using IDL* manual) can lead to confusion. A common misunderstanding is to attempt to use the DEVICE procedure "offset" and "size" keywords multiple times in an attempt to produce multiple plots on a single output page.

The DEVICE keywords are intended to specify the size and position of the entire output area on the page, not to move the plotting region for multiple plots. The driver does not monitor their values continuously, but only when initializing a new page or ejecting the current one.

The proper way to produce multiple plots is to use the high level positioning abilities. The !P.MULTI, !P.POSITION, and !P.REGION system variables can be used to position individual plots on the page. The plotting routines also accept the POSITION, MARGIN and REGION keywords.

## Image Background Color

Graphical output that is displayed with a black background on a monitor frequently look better if the background is changed to white when printed on white paper. This is easily done with the statement:

```
a(WHERE(a EQ 0B)) = 255B
```

# The CGM Device

### Device Keywords Accepted by the CGM Device:

BINARY, CLOSE_FILE, COLORS, ENCODING, FILENAME, NCAR, SET_CHARACTER_SIZE, TEXT

The CGM, Computer Graphics Metafile, standard describes a device independent file format used for the exchange of graphic information. The IDL CGM driver produces CGM files encoded in one of three methods: *Text*, *Binary* or *NCAR Binary*. To direct graphics output to a CGM file, issue the command:

```
SET_PLOT,'CGM'
```

This causes IDL to use the CGM driver for producing graphical output. Once the CGM driver is selected, the DEVICE procedure controls its actions, as described below. Typing `HELP, /DEVICE` displays the current state of the CGM driver. The CGM driver defaults to the binary encoding using 256 colors.

## Abilities and Limitations

This section describes details specific to IDL's CGM implementation:

- IDL uses the CGM default integer encoding for graphic primitives. Coordinate values range from 0 to 32767. It is advisable to use the values stored in !D.X_SIZE and !D.Y_SIZE instead of assuming a fixed coordinate range.
- Color information is output with a resolution of 8 bits (color indices and intensity values range from 0 to 255).
- The definition of background color in the CGM standard is somewhat ambiguous. According to the standard, color index 0 and the background color are the same. Because background color is specified in the metafile as a color value (RGB triple), not an index, it is possible to have the background color not correspond with the color value of index 0.
- The CGM BACKGROUND_COLOUR attribute is explicitly set by IDL only during an erase operation: changing the value of the color map at index 0 does not cause IDL to generate a BACKGROUND_COLOUR attribute until the next ERASE occurs. An ERASE command sets the background color to the value in the color map at index 0. The command `ERASE, INDEX` (where INDEX is not 0) generates the message "`Value of background color is out of allowed range.`" For consistent results, modify the color table before any graphics are output.

- The CGM standard uses scalable (variable size) pixels for raster images. By default, the TV and TVSCL procedures output images, regardless of size, using the entire graphics output area. To output an image smaller than the graphics output area, specify the XSIZE and YSIZE keywords with the TV and TVSCL procedures. For example:

```
; Select the CGM driver:
SET_PLOT, 'CGM'
; Create a 64 x 64 element array:
X = DIST(64)
; Display the image (fills entire screen):
TVSCL, X
; Now display 4 images on the screen:
ERASE
XS = !D.X_SIZE / 2 ; Size of each image, X dimension
YS = !D.Y_SIZE / 2 ; Size of each image, Y dimension
TVSCL, X, 0, XSIZE=XS, YSIZE=YS ; Upper left
TVSCL, X, 1, XSIZE=XS, YSIZE=YS ; Upper right
TVSCL, X, 2, XSIZE=XS, YSIZE=YS ; Lower left
TVSCL, X, 3, XSIZE=XS, YSIZE=YS ; Lower right
```

# The HP-GL Device

## Device Keywords Accepted by the HP-GL Device:

CLOSE_FILE, EJECT, FILENAME, INCHES, LANDSCAPE, OUTPUT, PLOTTER_ON_OFF, POLYFILL, PORTRAIT, SET_CHARACTER_SIZE, XOFFSET, XON_XOFF, XSIZE, YOFFSET, YSIZE

HP-GL (Hewlett-Packard Graphics Language) is a plotter control language used to produce graphics on a wide family of pen plotters. To use HP-GL as the current graphics device, issue the IDL command:

```
SET_PLOT,'HP'
```

This causes IDL to use HP-GL for producing graphical output. Once the HP-GL driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below. The default settings for the HP-GL driver are shown in the following table. Use the statement:

```
HELP, /DEVICE
```

to view the current state of the HP-GL driver.

| Feature | Value |
|---|---|
| File | idl.hp |
| Orientation | Portrait |
| Erase | No action |
| Polygon filling | Software |
| Turn plotter logically on/off | No |
| Specify xon/xoff flow control | Yes |
| Horizontal offset | 3/4 in. |
| Vertical offset | 5 in. |
| Width | 7 in. |
| Height | 5 in. |

*Table A-9: Default HP-GL Driver Settings*

## Abilities And Limitations

IDL is able to produce a wide variety of graphical output using HP-GL. The following is a list of what is and is not supported:

- All types of vector graphics can be generated, including line plots, contours, surfaces, etc.
- HP-GL plotters can draw lines in different colors selected from the pen carousel. It should be noted that color tables are not used with HP-GL. Instead, each color index refers directly to one of the pens in the carousel.
- Some HP-GL plotters can do polygon filling in hardware. Others can rely on the software polygon filling provided by IDL.
- It is possible to generate graphics using the hardware generated text characters, although such characters do not give much improvement over the standard vector fonts. To use hardware characters, set the !P.FONT system variable to zero, or set the FONT keyword to the plotting routines to zero.
- Since HP-GL is designed to drive pen plotters, it does not support the output of raster images. Therefore, TV and TVSCL do not work with HP-GL.
- Since pen plotters are not interactive devices, they cannot support such operations as cursors and windows.

## HP-GL Linestyles

The LINESTYLE graphics keyword allows specifying any of 6 linestyles. HP-GL does not support all of these linestyles, and styles 3 and 4 differ from the definition in Appendix B, “Graphics Keywords”. The following table summarizes the differences:

| Index | Normal Line Style | HP-GL Line Style |
|---|---|---|
| 0 | Solid | same |
| 1 | Dotted | same |
| 2 | Dashed | same |
| 3 | Dash Dot | Relative size of dash and dot are different. |
| 4 | Dash Dot Dot Dot | Dash Dot Dot |
| 5 | Long Dashes | same |

*Table A-10: Linestyles for the HP-GL Device*

# The Metafile Display Device

## Device Keywords Accepted by the Null Device:

CLOSE_FILE, FILENAME, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GLYPH_CACHE, INCHES, INDEX_COLOR, SET_CHARACTER_SIZE, SET_FONT, TRUE_COLOR, TT_FONT, XSIZE, YSIZE

The Windows Metafile Format (WMF) is used by Windows to store vector graphics in order to exchange graphics information between applications. This format is only available on the Windows platforms. To direct graphics to a file in the WMF format, use the SET_PLOT procedure:

```
SET_PLOT, 'METAFILE'
```

This causes IDL to use the Metafile driver for producing graphical output. Once the Metafile driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions. The default settings are given in the following table:

| Feature | Value |
|---|---|
| File | idl.emf |
| Mode | N/A |
| Horizontal offset | N/A |
| Vertical offset | N/A |
| Width | 7 in. |
| Height | 5 in. |
| Resolution | Screen |

*Table A-11: Default Metafile Driver Settings*

For example, the following will create a WMF file for a simple plot:

```
;Create X and Y Axis data
x=findgen(10)
y=findgen(10)

;Save current device name
mydevice=!D.NAME
```

```
;Set the device to Metafile
SET_PLOT, 'METAFILE'

;Name the file to be created
DEVICE, FILE='test.emf'

;Create the plot
PLOT, x, y

;Close the device which creates the Metafile
DEVICE, /CLOSE

;Set the device back to the original
SET_PLOT, mydevice
```

# The Null Display Device

## Device Keywords Accepted by the Null Device:

No keywords are accepted by the DEVICE procedure when the NULL device is selected.

To suppress graphics output entirely, use the null device:

```
SET_PLOT, 'NULL'
```

# The PCL Device

## Device Keywords Accepted by the PCL Device:

CLOSE_FILE, COLOR, FILENAME, FLOYD, INCHES, LANDSCAPE, OPTIMIZE, ORDERED, PIXELS, PORTRAIT, RESOLUTION, SET_CHARACTER_SIZE, SET_COLORMAP, THRESHOLD, XOFFSET, XSIZE, YOFFSET, YSIZE

PCL (Printer Control Language) is used by Hewlett-Packard laser and ink jet printers to produce graphics output. To direct graphics output to a PCL file, issue the command:

```
SET_PLOT,'PCL'
```

This causes IDL to use the PCL driver for producing graphical output. Once the PCL driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below. The default settings for the PCL driver are listed in the following table:

| Feature | Value |
|---|---|
| File | idl.pcl |
| Mode | Portrait |
| Optimization level | 0 (None) |
| Dither method | Floyd-Steinberg |
| Resolution | 300 dpi |
| Horizontal offset | 1/2 in. |
| Vertical offset | 1 in. |
| Width | 7 in. |
| Height | 5 in. |

*Table A-12: Default PCL Driver Settings*

The PCL device draws into a memory buffer of the specified size (or the default size, if the XSIZE and YSIZE keywords to DEVICE are not specified). Anything drawn outside this buffer will be silently discarded.

**Note**

Unlike monitors where white is the most visible color, PCL writes black on white paper. Setting the output color index to 0, the default when PCL output is selected, writes in black. A color index of 255 writes white which is invisible on white paper.

Color tables are not used with PCL unless the color mode has been enabled using the COLOR keyword to the DEVICE procedure. For images, color dithering produces realistic color image output even though PCL printers only produce eight output colors. In most cases, simply choosing an appropriate color table (using LOADCT or XLOADCT), or creating a color table from an image (via TVLCT) will work fine. If you need finer control over the colors used, see the SET_COLORMAP keyword for additional information. For vector graphics, only eight colors are supported—no line dithering is implemented. Any RGB component that is not zero is treated as 255. The correct RGB definitions for each color are shown in the following table. Use the `HELP, /DEVICE` command to view the current options for PCL output.

| Color | Red Value | Green Value | Blue Value |
|---|---|---|---|
| Red | 255 | 0 | 0 |
| Green | 0 | 255 | 0 |
| Blue | 0 | 0 | 255 |
| Cyan | 0 | 255 | 255 |
| Magenta | 255 | 0 | 255 |
| Yellow | 255 | 255 | 0 |
| Black | 0 | 0 | 0 |
| White | 255 | 255 | 255 |

*Table A-13: PCL RGB Color Definitions*

# The Printer Device

## Device Keywords Accepted by the PRINTER Device:

CLOSE_DOCUMENT, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GET_PAGE_SIZE, INDEX_COLOR, PORTRAIT, SCALE_FACTOR, SET_CHARACTER_SIZE, TRUE_COLOR, XOFFSET, XSIZE, YOFFSET, YSIZE

The PRINTER device allows IDL Direct Graphics to be output to a system printer. To direct graphics output to a printer, issue the command:

```
SET_PLOT, 'printer'
```

This causes IDL to use a printer driver to produce graphical output. By default, the default system printer is used for output. Use the DIALOG_PRINTERSETUP function to define the printing parameters for the printer device. Use the DIALOG_PRINTJOB function to control the print job itself.

Note that the printer device is an IDL Direct Graphics device. Like other Direct Graphics devices, you must change to the new device and then issue the IDL commands that send output to that device. With the printer device, you must use the CLOSE_DOCUMENT keyword to the DEVICE routine to actually initiate the print job and make something come out of your printer.

# The PostScript Device

## Device Keywords Accepted by the PS Device:

AVANTGARDE, BITS_PER_PIXEL, BKMAN, BOLD, BOOK, CLOSE_FILE, COLOR, COURIER, DEMI, ENCAPSULATED, FILENAME, FONT_INDEX, FONT_SIZE, HELVETICA, INCHES, ISOLATIN1, ITALIC, LANDSCAPE, LIGHT, MEDIUM, NARROW, OBLIQUE, OUTPUT, PALATINO, PORTRAIT, PRE_DEPTH, PRE_XSIZE, PRE_YSIZE, PREVIEW, SCALE_FACTOR, SCHOOLBOOK, SET_CHARACTER_SIZE, SET_FONT, SYMBOL, TIMES, TT_FONT, XOFFSET, XSIZE, YOFFSET, YSIZE, ZAPFCHANCERY, ZAPFDINGBATS

PostScript is a programming language designed to convey a description of a page containing text and graphics. Many laser printers and high-resolution, high-quality photo typesetters support PostScript. Color output or direct color separations can be produced with color PostScript. To direct graphics output to a PostScript file, issue the command:

```
SET_PLOT, 'PS'
```

This causes IDL to use the PostScript driver for producing graphical output. Once the PostScript driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below. The default settings are given in the following table:

| Feature | Value |
|---|---|
| File | idl.ps |
| Mode | Portrait, non-encapsulated, no color |
| Horizontal offset | 3/4 in. |
| Vertical offset | 5 in. |
| Width | 7 in. |
| Height | 5 in. |
| Scale factor | 1.0 |
| Font size | 12 points |

*Table A-14: Default PostScript Driver Settings*

| Feature | Value |
|---|---|
| Font | Helvetica |
| # Bits / Image Pixel | 4 |

*Table A-14: Default PostScript Driver Settings (Continued)*

**Note**

Unlike monitors where white is the most visible color, PostScript writes black on white paper. Setting the output color index to 0, the default when PostScript output is selected, writes black. A color index of 255 writes white which is invisible on white paper. Color tables are not used with PostScript unless the color mode has been enabled using the DEVICE procedure. See "Color Images" on page 3842

To obtain adequate resolution, the device coordinate system used for PostScript output is expressed in units of 0.001 centimeter (i.e., 1000 pixels/cm).

Use the `HELP, /DEVICE` call to view the current font, file, and other options set for PostScript output.

## Using PostScript Fonts

Information necessary for rendering a set of 35 standard PostScript fonts are included with IDL. (The standard 35 fonts are the fonts found on the Apple Laserwriter II PostScript printer; the same fonts are found on almost any PostScript printer made in the time since the LaserWriter II appeared.) Use of PostScript fonts is discussed in detail in "About Device Fonts" on page 3962.

## Color PostScript

If you have a color PostScript device you can enable the use of color with the statement:

```
DEVICE, /COLOR
```

Enabling color also enables the color tables. Text and graphic color indices are translated to RGB by dividing the red, green and blue color table values by 255. As with most display devices, color indices range from 0 to 255. Zero is normally black and white is normally represented by an index of 255. For example, to create and load a color table with four elements, black, red, green and blue:

```
TVLCT, [0,255,0,0], [0,0,255,0], [0,0,0,255]
```

Drawing text or graphics with a color index of 0 results in black, 1 in red, 2 in green, and 3 in blue.

## Color Images

As with black and white PostScript, images may be output with 1, 2, 4, or 8 bits, yielding 1, 2, 16, or 256 possible colors. In addition, images are either pseudo-color or TrueColor. A pseudo-color image is a two dimensional image, each pixel of which is used to index the color table, thereby obtaining an RGB value for each possible pixel value. Pseudo-color images are similar to those displayed using the workstation monitor.

**Note**

In the case of pseudo-color images of fewer than 8 bits, the number of columns in the image should be an exact multiple of the number of pixels per byte (i.e., when displaying 4 bit images the number of columns should be even, and 2 bit images should have a column size that is a multiple of 4). If the image column size is not an exact multiple, extra pixels with a value of 255 are output at the end of each row. This causes no problems if the color white is loaded into the last color table entry, otherwise a stripe of the last (index number 255) color is drawn to the right of the image.

## TrueColor Images

A TrueColor image consists of an array with three dimensions, one of which has a size of three, containing the three color components. It may be considered as three two dimensional images, one each for the red, green and blue components. For example a TrueColor *n* by *m* element image can be ordered in three ways: pixel interleaved (3, *n*, *m*), row interleaved (*n*, 3, *m*), or image interleaved (*n*, *m*, 3). By convention the first color is always red, the second green, and the last is blue.

TrueColor images are also routed through the color tables. The red color table array contains the intensity translation table for the red image, and so forth. Assuming that the color tables have been loaded with the vectors `R`, `G`, and `B`, a pixel with a color value of (*r*, *g*, *b*) is displayed with a color of ($R_r$, $G_g$, $B_b$). As with other devices, a color table value of 255 represents maximum intensity, while 0 indicates an absence of the color. To pass the RGB pixel values without change, load the red, green and blue color tables with a ramp with a slope of 1.0:

```
TVLCT, INDGEN(256), INDGEN(256), INDGEN(256)
```

or with the LOADCT procedure:

```
; Load standard black/white table:
```

```
LOADCT, 0
```

Use the TRUE keyword to the TV and TVSCL procedures to indicate that the image is a TrueColor image and to specify the dimension over which color is interleaved. A value of 1 specifies pixel interleaving, 2 is row interleaving, and 3 is image interleaving. The following example writes a 24-bit image, interleaved over the third dimension, to a PostScript file:

```
SET_PLOT, 'PS'
;Set the PostScript device to *8* bits per color, not 24:
DEVICE, FILE='24bit.ps', /COLOR, BITS=8
TV, [[[r]], [[g]], [[b]]], TRUE=3
DEVICE, /CLOSE
; Return plotting to X windows:
SET_PLOT, 'X'
```

**Note**

Currently, the PostScript device does not support TrueColor plots. Only TrueColor images are supported.

### Image Background Color

Images that are displayed with a black background on a monitor frequently look better if the background is changed to white when displayed with PostScript. This is easily done with the statement:

```
a(WHERE(a EQ 0B)) = 255B
```

## PostScript Positioning

### Using the XOFFSET and YOFFSET Keywords

Often, IDL users are confused by the use of the XOFFSET and YOFFSET keywords to the PostScript DEVICE routine. These keywords control the position of IDL plots on the page. XOFFSET specifies the “X” position of the lower left corner of the output generated by IDL. This offset is always taken relative to the lower left-hand corner of the page when viewed in portrait orientation. YOFFSET specifies the “Y” position of the lower left corner of the output generated by IDL. This offset is also taken relative to the lower left-hand corner of the page when viewed in portrait orientation.

The following figure shows how the XOFFSET and YOFFSET keywords are interpreted by the PostScript device in the Portrait (left) and Landscape (right) modes. Note that the landscape plot uses the same origin for determining the effect of the

XOFFSET and YOFFSET keywords, but that the output is rotated 270 degrees clockwise.

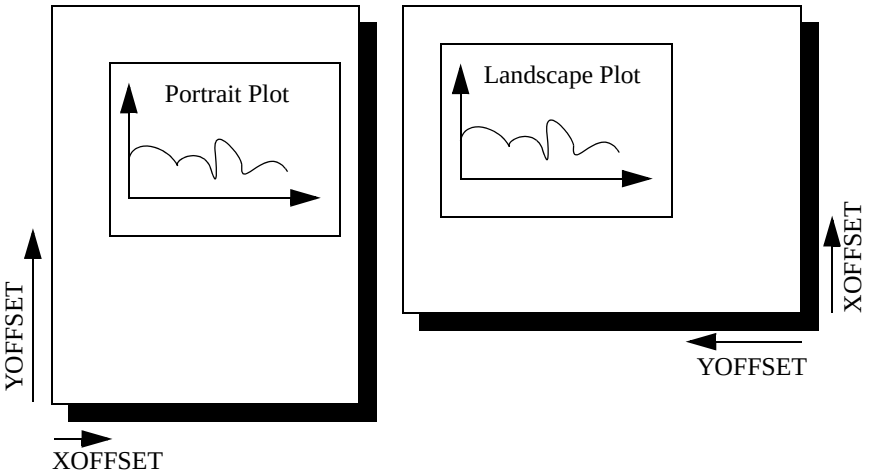



*Figure A-1: Interpretation of the XOFFSET and YOFFSET Keywords*

The page on the left shows an IDL plot printed in "portrait" orientation. Note that the X and Y offsets work just as we expect them to—increasing the XOFFSET moves the plot to the right and increasing the YOFFSET moves the plot up the page. The page on the right shows an IDL plot printed in "landscape" orientation. Here, the X and Y offsets are still taken relative to the same points even though the orientation of the plot has changed. This happens because IDL moves the origin of the plot *before* rotating the PostScript coordinate system 270 degrees clockwise for the landscape plot.

**Note**

The XOFFSET and YOFFSET keywords have no effect when you generate ENCAPSULATED PostScript output.

## Encapsulated PostScript Output

Another form of PostScript output is Encapsulated PostScript. This is the format used to import PostScript files into page layout and desktop publishing programs. An Encapsulated PostScript (EPS) file is similar to a regular PostScript file except that it contains only one page of PostScript output contained in a "bounding box" that is used to tell other programs about the size and aspect ratio of the encapsulated image.

Most of the time, output from IDL to an EPS file is properly scaled into the EPS bounding box because commands such as PLOT take full advantage of the plotting area made available to them. Sometimes, however, the default bounding box is inappropriate for the image being displayed.

As an example, suppose you have an image that is narrow and tall that, when TV'ed to an IDL window, fills only a small portion of the plotting window. Similarly, when output to an EPS file, this image will only fill a small portion of the bounding box. When the resulting EPS file is brought into a desktop publishing program, it becomes very hard to properly scale the image since the aspect ratio of the bounding box bears no relation to the aspect ratio of the image itself.

To solve this problem, use the XSIZE and YSIZE keywords to the DEVICE procedure to make the bounding box just large enough to contain the image. Since IDL uses a resolution of 1000 dots per centimeter with the PostScript device, the correct XSIZE and YSIZE (in centimeters) can be computed as:

- XSIZE = Width of image in pixels/1000.0 pixels per cm
- YSIZE = Height of image in pixels/1000.0 pixels per cm

The following IDL procedure demonstrates this technique. This procedure reads an X Windows Dump file and writes it back out as a properly-sized, 8-bit-color Encapsulated PostScript file:

```
PRO XWDTOEPS, filename
; Read the XWD file. Pixel intensity information is stored
; in the variable 'array'. Values to reconstruct the color
; table are stored in 'r', 'g', and 'b':
array = READ_XWD(filename, r, g, b)
; Reconstruct the color table:
TVLCT, r,g,b
; Display the image in an IDL window:
TV, array
; Find the size of the picture. The width of the picture
; (in pixels) is stored in s[1]. The height of the picture
; is stored in s[2]:
s = SIZE(array)
; Take the 'xwd' (for X Windows Dump) extension off of
; the old filename and replace it with 'eps':
fl = STRLEN(filename)
filename = STRMID(filename, 0, fl-4)
filename = filename + '.eps'
PRINT, 'Making file: ', filename
PRINT, s
; Set the plotting device to PostScript:
SET_PLOT, 'ps'
; Use the DEVICE procedure to make the output encapsulated,
```

```
; 8 bits, color, and only as wide and high as it needs to
; be to contain the XWD image:
DEVICE, /ENCAPSUL, BITS_PER_PIXEL=8, /COLOR, $
   FILENAME=filename, XSIZE=S[1]/1000., $
   YSIZE=S[2]/1000.
; Write the image to the file:
TV, array
; Close the file:
DEVICE, /CLOSE
; Return plotting to X Windows:
SET_PLOT, 'x'
END
```

## Multiple Plots on the Same Page

To put multiple plots on the same PostScript page, use the !P.MULTI system variable (described in more detail in "!P System Variable" on page 3917). !P.MULTI is a 5-element integer array that controls the number of rows and columns of plots to make on a page or in a graphics window.

The first element of !P.MULTI is a counter that reports how many plots remain on the page. The second element of !P.MULTI is the number of columns per page. The third element is the number of rows per page.

For example, the following lines of code create a PostScript file, `multi.ps`, with 6 different plots arranged as 2 columns and 3 rows:

```
; Set plotting to PostScript:
SET_PLOT, 'PS'
; Set the filename:
DEVICE, FILENAME='multi.ps'
; Make IDL's plotting area hold 2 columns and 3 rows of plots:
!P.MULTI = [0, 2, 3]
; Create a simple dataset:
A = FINDGEN(10)
; Make 6 different plots:
PLOT, A
PLOT, SIN(A)
PLOT, COS(A)
PLOT, TAN(A)
PLOT, TANH(A)
PLOT, SINH(A)
; Close the file:
DEVICE, /CLOSE
; Return plotting to Windows:
SET_PLOT, 'win'
; Reset plotting to 1 plot per page:
!P.MULTI = 0
```

The resulting file produces a set of plots as shown in the following figure:

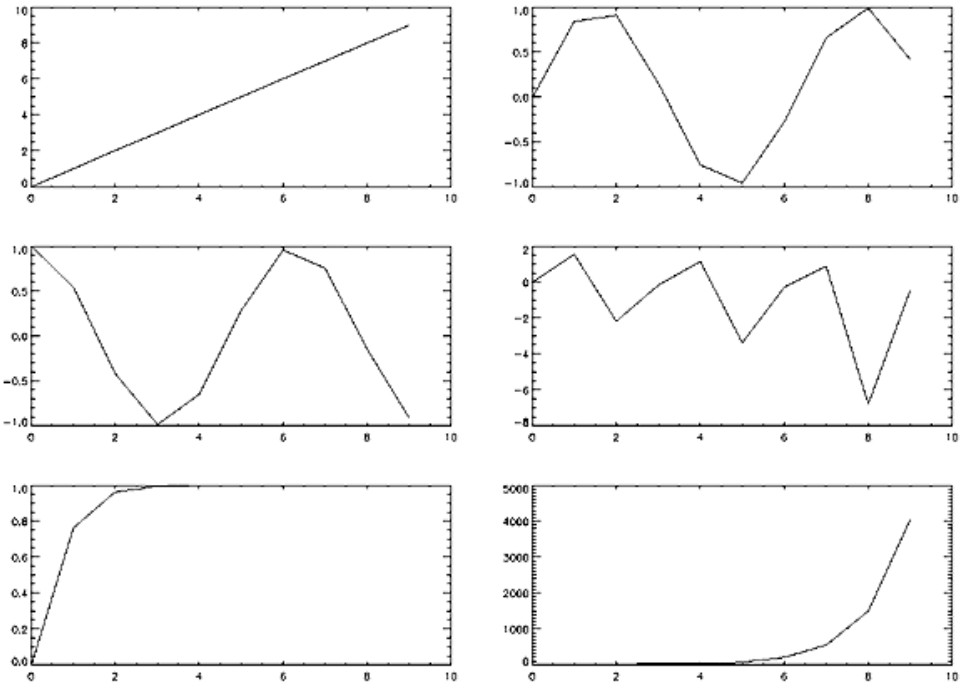


*Figure A-2: Multiple plots on a single page produced by setting the !P.MULTI system variable.*

# Importing IDL Plots into Other Documents

This section shows how to generate IDL PostScript graphics so that they can be inserted into other documents. It also provides several examples of how the PostScript graphics device is used. Simply omit the ENCAPSULATED keyword from the calls to DEVICE if you wish to produce plots that can be printed directly. The following figure is an encapsulated PostScript file suitable for inclusion in other documents. The figure was produced with the following IDL statements. Note the use of the ENCAPSULATED keyword in the call to DEVICE:

```
; Select the PostScript driver:
SET_PLOT, 'PS'
; Note use of ENCAPSULATED keyword:
DEVICE, /ENCAPSULATED, FILENAME = 'pic1.ps'
x = FINDGEN(200)
```

```
    ; Plot the sine wave:
    PLOT, 10000 * SIN(x/5) / EXP(x/100), $
        LINESTYLE = 2, TITLE = 'IDL PostScript Plot', $
        XTITLE = 'Point Number', YTITLE='Y Axis Title', $
        FONT = 0
    ; Add the cosine:
    OPLOT, 10000 * COS(x/5) / EXP(x/100), LINESTYLE = 4
    ; Annotate the plot:
    XYOUTS, 100, -6000, 'Sine', FONT = 0
    OPLOT, [120, 180], [-6000, -6000], LINESTYLE = 2
    XYOUTS, 100, -8000, 'Cosine', FONT = 0
OPLOT, [120, 180], [-8000, -8000], LINESTYLE = 4
```

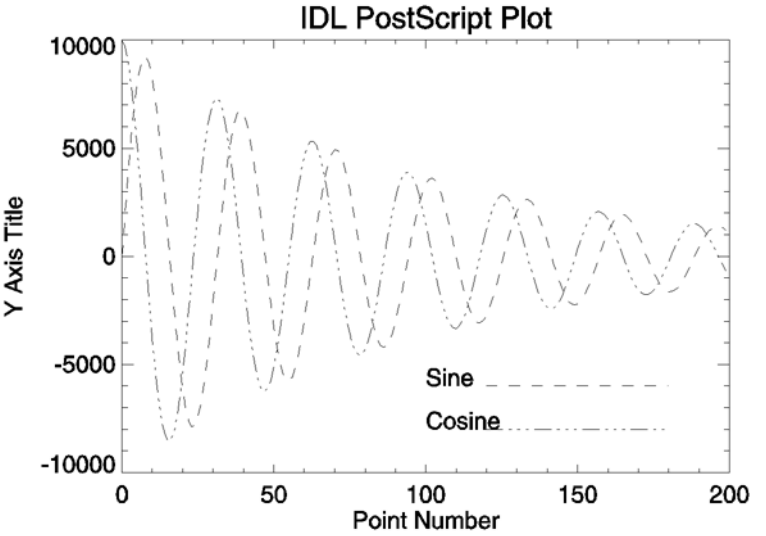



*Figure A-3: Sample PostScript plot using Helvetica font.*

The following figure is a more complicated plot. It demonstrates some of the three-dimensional plotting capabilities of IDL. It was produced with the following IDL statements:

```
    ; Select the PostScript driver:
    SET_PLOT, 'PS'
    ; Note use of ENCAPSULATED keyword:
    DEVICE, /ENCAPSULATED, FILENAME = 'pic2.ps'
    ; Access the data:
    OPENR, 1, FILEPATH('abnorm.dat', SUBDIR=['examples', 'data'])
    aa = ASSOC(1, BYTARR(64, 64))
```

```
   ; Get a smoothed version:
   a = SMOOTH(aa[0], 3)
   ; Generate the surface:
   SURFACE, a, /SAVE, ZAXIS = 1, XSTYLE = 1, YSTYLE = 1
   ; Add the contour:
   CONTOUR, a, /T3D, /NOERASE, ZVALUE = 1, $
      XSTYLE = 1, YSTYLE = 1, C_LINESTYLE = [0,1,2], $
      TITLE = 'IDL PostScript Plot'

CLOSE, 1
```

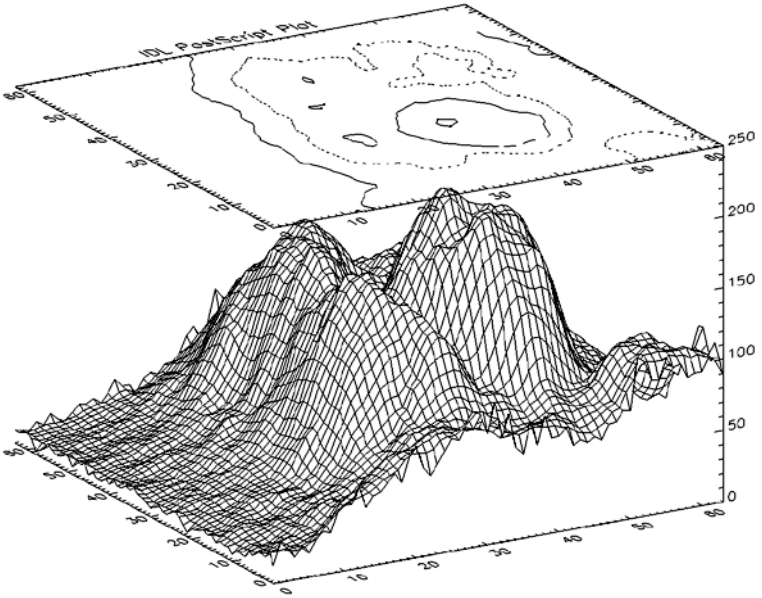



*Figure A-4: Three-Dimensional Plot with Vector-Drawn Characters*

The following figure illustrates polygon filling. It was produced with the following IDL statements:

```
   SET_PLOT, 'PS'
   DEVICE, /ENCAPSULATED, FILENAME = 'pic3.ps'
   x = FINDGEN(200)
   ; Upper sine wave:
   a = 10000 * sin(x / 5) / exp(x / 100)
   PLOT, a, /NODATA, TITLE = 'IDL PostScript Plot', $
      XTITLE='Point Number', YTITLE='Y Axis Title', $
      FONT = 0
```

```
    ; Vector of X vertices for polygon filling. Note that the
    ; ROTATE(V,2) function call returns the vector V in reverse order:
    C = [X, ROTATE(X, 2)]
    ; Vector of Y vertices for polygon filling:
    D = [A, ROTATE(A-2000, 2)]
    ; Fill the region using an intensity of about 75% white:
POLYFILL, C, D, COLOR=192
```

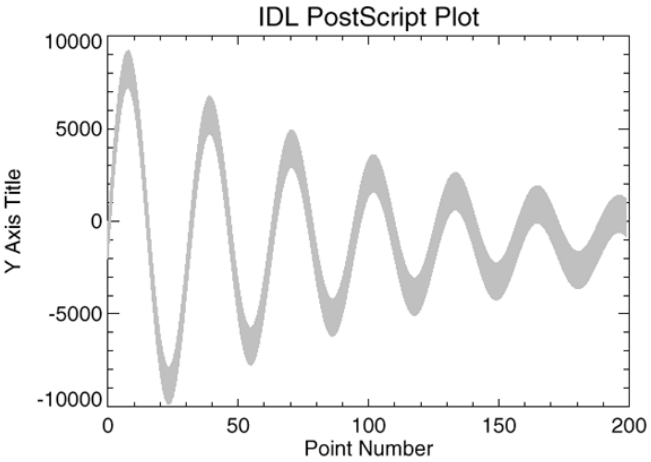



*Figure A-5: Polygon Filling Example*

The following figure illustrates IDL PostScript images. In this case, the same image is reproduced four times. In each case, a different number of bits are used per image pixel. It was produced with the following IDL statements:

```
SET_PLOT, 'PS'
DEVICE, /ENCAPSULATED, FILENAME = 'pic4.ps'
; Open image file:
OPENR, 1, FILEPATH('people.dat', SUBDIR = ['examples','data'])
; Variable to hold image:
a = BYTARR(192, 192, /NOZERO)
; Input the image:
READU, 1, a
; Done with the file:
CLOSE, 1
; Add a color table ramp to the bottom of the image:
A[0,0] = BYTSCL(INDGEN(192))#REPLICATE(1,16)
; Output the image four times:
FOR i = 0,3 DO BEGIN
   ; Use 1, 2, 4, and 8 bits per pixel:
```

```
      DEVICE, BITS_PER_PIXEL=2^i
      ; Output using TV with position numbers 0, 1, 2, and 3:
      TV, a, i, XSIZE=2.5, YSIZE=2.5, /INCHES

ENDFOR
```

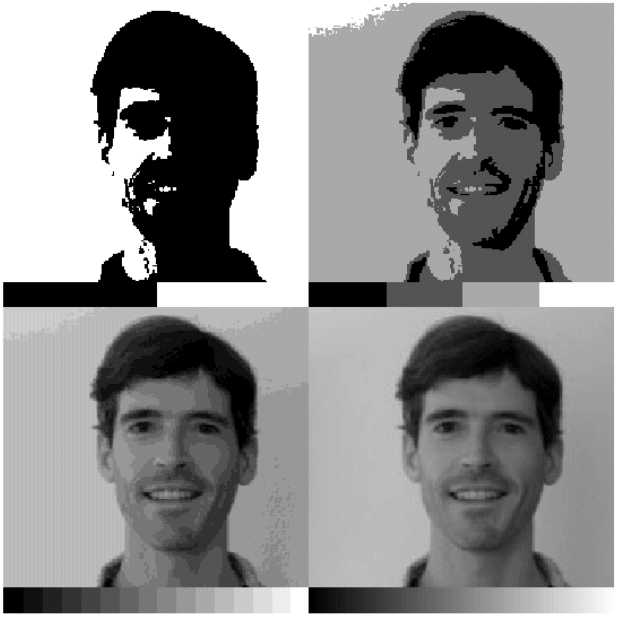


*Figure A-6: 1, 2, 4, and 8-bit PostScript Images*

# The Regis Terminal Device

### Device Keywords Accepted by the REGIS Device:

AVERAGE_LINES, CLOSE_FILE, FILENAME, PLOTTER_ON_OFF, SET_CHARACTER_SIZE, TTY, VT240, VT241, VT340, VT341

IDL provides Regis graphics output for the DEC VT240, VT330, and VT340 series of terminals. To output graphics to such terminals, issue the IDL command:

```
SET_PLOT, 'REGIS'
```

This causes IDL to use the Regis driver for producing graphical output.

## Defaults for Regis Devices

The default setting for Regis output is: VT340, 16 colors, 4 bits per pixel.

## Regis Limitations

- Four colors are available with VT240 and VT241 terminals, sixteen colors are available with the VT330 and VT340.
- Thick lines are emulated by filling polygons. There may be a difference in linestyle appearance between thick and normal lines.
- Image output is slow and is of poor quality, especially on the VT240 series. The VT240 is only able to write pixels on even numbered screen lines. IDL offers two methods of writing images to the 240:
  - Even and odd pairs of rows are averaged and written to the screen. An *n*, *m* image will occupy *n* columns and *m* screen rows. If this method is selected, graphics and image coordinates coincide. This method is the default (`AVERAGE_LINES = 1`). Routines that rely on a uniform graphics and image coordinate system, such as SHADE_SURF, work only in this mode.
  - Each line of the image is written to the screen, displaying every image pixel. An *n*, *m* image occupies 2*m* lines on the screen. (`AVERAGE_LINES = 0`). Graphics and image coordinates coincide only at the lower left corner of the image.
- Pixel values cannot be read back from the terminal, rendering the TVRD function inoperable.

# The Tektronix Device

### Device Keywords Accepted by the REGIS Device:

CLOSE_FILE, COLORS, FILENAME, GIN_CHARS, PLOT_TO, RESET_STRING, SET_CHARACTER_SIZE, SET_STRING, TEK4014, TEK4100, TTY

The Tektronix 4000 (4010, 4014, etc.), 4100 and 4200 series of graphics terminals (and the multitude of terminals and microcomputers that emulate them) are among the most common graphics devices available. To use IDL graphics with such terminals, issue the command:

```
SET_PLOT,'TEK'
```

This causes IDL to use the Tektronix driver for producing graphical output. Once the Tektronix driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, and to configure IDL for the specific features of your terminal. If you never call the DEVICE procedure, IDL assumes a plain vanilla Tektronix 4000 series compatible terminal. The 4200 series is upwardly compatible with the 4100 series; all references to the 4100 series also include the 4200 series. To set up IDL for use with a 4100 series compatible terminal with *n* colors, enter the following commands:

```
SET_PLOT, 'TEK'
DEVICE, /TEK4100, COLORS = n
```

The number of colors should be set to 2B where B is the number of bit planes in your terminal. If you use a Tektronix compatible terminal that requires calling the DEVICE procedure for configuration, you should probably create and use a start-up procedure the calls the DEVICE procedure, as described in Chapter 2. Because of the tremendous variation among the requirements and abilities of these terminals, it is crucial that you configure IDL properly for your terminal. In particular, the mode switching character sequences, set by the keyword parameters SET_STRING and RESET_STRING must be set correctly.

## The DEVICE Procedure For Tektronix Terminals

The default setting for Tektronix output is: 10-bit coordinates, 4000 series terminals, and no use of color. The DEVICE keywords can be used to modify these defaults.

## Tektronix Limitations

- The line drawing procedures work with all models. Line style and color capabilities vary greatly among terminal models and/or emulation programs.

- Color and the display of images (albeit very slowly and frequently of a poor quality because of the small number of colors) is usable only with 4100 series terminals. Hardware polygon fill and thick lines do not work with the 4000 series.
- The image coordinate system does not match the graphics coordinate system. The graphics coordinates range from 0 to 3071 in Y, and from 0 to 4095 in X. Image coordinates vary according to terminal model. A typical range is from 0 to 479 in Y, and 0 to 639 in X. Because of this, the SHADE_SURF procedure does not work with Tektronix terminals.

**Warning**

Not all 4100 series terminals are capable of displaying images—the Tektronix pixel operations option is required. Many terminal emulators do not emulate this option. The Tektronix commands used to output images are: RU, begin pixel operations, RS, set pixel viewport, and RP, raster write. If your terminal or emulator does not accept these commands, you will not be able to display images.

- The Tektronix graphics protocol does not allow the specification of line thickness. Lines with a thickness more than 1.0 are drawn using polygon filling in the case of 4100 series terminals. With 4000 series terminals, thick lines are emulated by drawing multiple thin lines. This scheme will produce artifacts on some Tektronix emulating devices because of differing resolutions, normal line thicknesses and inexact coordinate conversions.

## Tektronix Device Limitations

Usage of Tektronix and Tektronix-compatible terminals with IDL has the following limitations:

- Image coordinates do not match the coordinates used by the rest of the graphic procedures. This is because no two models of Tektronix terminals are compatible. The graphics procedures utilize the default coordinate system of 1024 by 780, or 4096 by 3120 in the 12-bit mode. The size of the pixel memory and coordinate system vary widely between models. The *Position* parameter of the TV and TVSCL procedures does not work.
- The cursor can not be positioned from the computer meaning that the TVCRS procedure cannot be used with the Tektronix driver.
- Pixel values may not be read back from the terminal, rendering the TVRD function inoperable.

# The Microsoft Windows Device

## Device Keywords Accepted by the WIN Device:

BYPASS_TRANSLATION, COPY, CURSOR_CROSSHAIR, CURSOR_ORIGINAL, CURSOR_STANDARD, DECOMPOSED, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GET_GRAPHICS_FUNCTION, GET_SCREEN_SIZE, GET_WINDOW_POSITION, PRINT_FILE, RETAIN, SET_CHARACTER_SIZE, SET_FONT, SET_GRAPHICS_FUNCTION, TRANSLATION, WINDOW_STATE

The Microsoft Windows version of IDL uses the “WIN” device by default. This device is similar to the X Windows device described below. The “WIN” device is only available in IDL for Windows.

To set plotting to the Microsoft Windows device, use the command:

```
SET_PLOT, 'WIN'
```

# The X Windows Device

### Device Keywords Accepted by the X Device:

BYPASS_TRANSLATION, COPY, CURSOR_CROSSHAIR, CURSOR_IMAGE, CURSOR_MASK, CURSOR_ORIGINAL, CURSOR_STANDARD, CURSOR_XY, DECOMPOSED, DIRECT_COLOR, FLOYD, GET_CURRENT_FONT, GET_FONTNAMES, GET_FONTNUM, GET_GRAPHICS_FUNCTION, GET_SCREEN_SIZE, GET_VISUAL_NAME, GET_WINDOW_POSITION, GET_WRITE_MASK, ORDERED, PSEUDO_COLOR, RETAIN, SET_CHARACTER_SIZE, SET_FONT, SET_GRAPHICS_FUNCTION, SET_TRANSLATION, SET_WRITE_MASK, STATIC_COLOR, STATIC_GRAY, THRESHOLD, TRUE_COLOR, TTY, WINDOW_STATE

X Windows is a network-based windowing system developed by MIT's project Athena. IDL uses the X System (often referred to simply as "X"), to provide an environment in which the user can create one or more independent windows, each of which can be used for the display of graphics and/or images.

In the X system, there are two basic cooperating processes: *clients* and *servers*. A server consists of a display, keyboard, and pointer (such as a mouse) as well as the software that controls them. Client processes (such as IDL) display graphics and text on the screen of a server by sending X protocol requests across the network to the server. Although in the most common case, the server and client reside on the same machine, this network based design allows much more elaborate configurations.

To use X Windows as the current graphics device, issue the IDL command:

```
SET_PLOT, 'X'
```

This causes IDL to use the X Window System for producing graphical output. Once the X driver is enabled via SET_PLOT, the DEVICE procedure is used to control its actions, as described below.

Use the statement:

```
HELP, /DEVICE
```

to view the current state of the X Windows driver.

## X Windows Visuals

Visuals specify how the hardware deals with color. The X Window server (your display) may provide colors or only gray scale (black and white), or both. The color

tables may be changeable from within IDL (read-write), or may be fixed (read-only). The value of each pixel value may be mapped to any color (Un-decomposed Colormap), or certain bits of each pixel are dedicated to the red, green, and blue primary colors (Decomposed Colormap).

There are six X Windows visual classes—read-write and read-only visuals for three types of displays: Gray Scale, Pseudo Color, and Decomposed Color. The names of the visuals are shown in the following table:

| Visual Name | Writable | Description |
|---|---|---|
| StaticGray | no | Gray scale |
| GrayScale | yes | Gray scale |
| StaticColor | no | Undecomposed color |
| PseudoColor | yes | Undecomposed color |
| TrueColor | no | Decomposed color |
| DirectColor | yes | Decomposed color |

*Table A-15: X Windows Visual Classes*

IDL supports all six types of visuals, although not at all possible depths. UNIX X Window System users can use the command `xdpyinfo` to determine which visuals are supported by their systems.

Each X Window server has a default visual class. Many servers may provide multiple visual classes. For example, a server with display hardware that supports an 8-bit-deep, un-decomposed, writable color map (PseudoColor), may also easily provide StaticColor, StaticGray, and GrayScale visuals.

You can select the visual used by IDL using the DEVICE procedure before a window is created, or by including the resource `idl.gr_visual` in your X defaults file, as explained in "Setting the X Window Defaults" on page 3864.

## How IDL Selects a Visual Class

When opening the display, IDL asks the display for the following visuals, in order, until a supported visual class is found:

1. DirectColor, 24-bit
2. TrueColor, 24-bit
3. TrueColor, 16-bin (on Linux platforms only)

4. PseudoColor, 8-bit, then 4-bit
5. StaticColor, 8-bit, then 4-bit
6. GrayScale, any depth
7. StaticGray, any depth

You can override this behavior by using the DEVICE routine to specify the desired visual class and depth before you create a window. For example, if you are using a display that supports both the DirectColor, 24-bit-deep visual, and an 8-bit-deep PseudoColor visual, IDL will select the 24-bit-deep DirectColor visual. To instead use PseudoColor, issue the following command before creating a window:

```
DEVICE, PSEUDO_COLOR = 8
```

The colormap/visual class combination is chosen when IDL first connects with the X Window server. Note that if you connect with the X server by creating a window or using the DEVICE keyword to the HELP procedure, the visual class will be set; it then cannot be changed until IDL is restarted. If you wish to use a visual class other than the default, be sure to set it with a call to the DEVICE procedure *before* creating windows or otherwise connecting with the X Window server.

Windows are created in two ways:

1. Using the WINDOW procedure. WINDOW allows you to explicitly control many aspects of how the window is created.
2. If no windows exist and a graphics operation requiring a window is executed, IDL implicitly creates window 0 with the default characteristics.

Once the visual class is selected, all subsequently-created windows share the same class and colormap. The number of simultaneous colors available is stored in the system variable !D.N_COLORS. The visual class and number of colors, once initialized, cannot be changed without first exiting IDL.

## How IDL Obtains a Colormap

IDL chooses the type of colormap in the following manner:

- By default, the shared colormap is used whenever possible (i.e., whenever IDL is using the default visual for the system). All available colors from the shared colormap are allocated for use by IDL. This is what happens when no window currently exists and a graphics operation causes IDL to implicitly create one.
- If the number of colors to use is explicitly specified using the COLORS keyword with the WINDOW procedure, IDL attempts to allocate the number of colors specified from the shared colormap using the default visual of the

screen. If there aren't enough colors available, a private colormap with that number of colors is used instead.

- Specifying a negative value for the COLORS keyword to the WINDOW procedure causes IDL to attempt to use the shared colormap, allocating all but the specified number of colors. For example:

```
WINDOW, COLORS = -8
```

  allocates all but 8 of the currently available colors. This allows other applications that might need their own colors to run in tandem with IDL.

- If a visual type and depth is specified, via the DEVICE procedure, which does not match the default visual of the screen, a new, private, colormap is created.

# Using Color Under X

Colormaps define the mapping from color index to screen color. Two attributes of colormaps are important to the IDL user: they may be *private* or *shared*; and they may be *static* or *writable*. These different types of colormaps are described below.

## Shared Colormaps

The window manager creates a colormap when it is started. This is known as the default colormap, and can be shared by most applications using the display. When each application requires a colormap entry (i.e., a mapping from a color index to a color), it allocates one from this shared table. Advantages and disadvantages of shared colormaps include:

- Using the shared colormap ensures that all applications share the available colors without conflict. A given application will not change a color that is allocated to a different application. In the case of IDL it means that IDL can change the colors it has allocated without changing the colors in use by the window manager or other applications.
- The window system interface routines must translate between the actual and allocated pixel values, significantly slowing the transfer of images.
- The shared colormap might not have enough colors available to perform the desired operations with IDL.
- The number of available colors in the shared colormap depends on the window manager in use and the demands of other applications. Thus, the number of available colors can vary.

- The allocated colors in a shared colormap do not generally start at zero and they are not necessarily contiguous. This makes it difficult to use the write mask for certain operations.

## Private Colormaps

An application can create its own private color map. Most hardware can only display a single colormap at a time, so these private colormaps are called virtual color maps, and only one at a time is actually in use and visible. When the window manager gives the color focus to a window with a private colormap, the X window system loads its virtual colormap into the hardware colormap.

- Every color index supported by the hardware is available to IDL, improving the quality of images.
- Allocated colors always start at zero and are contiguous. This simplifies using the write mask.
- No translation between internal pixel values and the values required by the server is required, making the transfer of images more efficient.
- When the IDL colormap is loaded, other applications are displayed using the wrong colors. Furthermore, colors from the shared colormap are usually allocated from the lower end of the map first. These are the colors allocated by the window manager for such things as window borders, the color of text, and so forth. Since most IDL colormaps have very dark colors in the lower entries, the end effect with the IDL colormap loaded is that the non-IDL portions of the screen go blank.

## Static Colormaps

As mentioned above, the contents of static colormaps are determined outside of IDL and cannot be changed. When using a static colormap, the TVLCT procedure simulates writable colormaps by finding the closest RGB color entry in the colormap to the requested color. The colormap translation table is then set to map IDL color indices to those of the closest colors in the colormap.

The colors present in the colormap may, and probably will, *not* match the requested colors exactly. For example, with a typical static color map, loading the IDL standard color table number 0, which consists of 256 intensities of gray, results in only 8 or 16 distinct intensities.

With static colormaps, loading a new color table does not affect the appearance of previously written objects. The internal translation tables are modified, which only affects objects that are subsequently written.

### Color Translation

As mentioned above, colors from the shared colormap do not necessarily start from index zero, and are not necessarily contiguous. IDL preserves the illusion of a zero based contiguous colormap by maintaining a translation table between user color indices, which range from 0 to !D.TABLE_SIZE, and the actual pixel values allocated from the X server. Normally, the user need not be concerned with this translation table, but it is available using the statement:

```
DEVICE, TRANSLATION=T
```

This statement stores the current translation table, a 256 element byte vector, in the variable T. Element zero of the vector contains the value pixel allocated for the zeroth color in the IDL colormap, and so forth. In the case of a private colormap, each element of the translation vector contains it's own index value, because private colormaps start at zero and are contiguous.

The translation table may be bypassed, allowing direct access to the display's color indices, by setting the BYPASS_TRANSLATION keyword in the DEVICE procedure.

```
DEVICE, /BYPASS_TRANSLATION
```

Translation can be reestablished by setting the keyword to zero:

```
DEVICE, BYPASS_TRANSLATION=0
```

When a private or static (read-only) color table is initialized, the bypass flag is cleared. It is set when initializing a shared color table.

## Using Pixmaps

X Windows can direct graphics to *windows* or *pixmaps*. Windows are the usual windows that appear on the screen and contain graphics. Pixmaps are invisible graphics memory contained in the server. Drawing to a window produces a viewable result, while drawing to a pixmap simply updates the pixmap memory.

Pixmaps are useful because it is possible to write graphics to a pixmap and then copy the contents of the pixmap to a window where it can be viewed. Furthermore, this copy operation is very fast because it happens entirely within the server. Provided enough pixmap memory is available, this technique works very well for animating a series of images by placing the images into pixmap memory and then sequentially copying them to a visible window.

To create a pixmap, use the PIXMAP keyword with the WINDOW procedure. For example, to create a square pixmap with 128 pixels per side as IDL window 1, use the command:

```
WINDOW, 1, /PIXMAP, XSIZE=128, YSIZE=128
```

Once they are created, pixmaps are treated just like normal windows, although some operations (WSHOW for instance) don't do anything useful when applied to a pixmap.

The following procedure shows how animation can be done using pixmap memory. It uses a series of 15 heart images taken from the file `abnorm.dat`. This file is supplied with all IDL distributions in the `examples/data` subdirectory of the main IDL directory. It creates a pixmap and writes the heart images to it. It then uses the COPY keyword of the DEVICE procedure to copy the images to a visible window. Pressing any key causes the display process to halt:

```
; Animate heart series:
PRO animate_heart
; Open the file containing the images:
OPENR, u, FILEPATH('abnorm.dat', SUBDIR = ['examples','data']), $
   /GET_LUN
; Associate a file variable with the file. Each heart image
; is 64x64 pixels:
frame = ASSOC(u, BYTARR(64,64))
; Window pixwin is a pixmap which is 4 images tall and 4
; images wide. The images will be placed in this pixmap:
WINDOW, pixwin, /PIXMAP, XSIZE = 512, YSIZE = 512, /FREE
; Write each image to the pixmap. SMOOTH is used to improve
; the appearance of each image and REBIN is used to
; enlarge/shrink each image to the final display size:
FOR i=0, 15-1 DO TV, REBIN(SMOOTH(frame[i],3), 128, 128),i
; Close the image file and free the file unit:
FREE_LUN, u
; Window win is a visible window. It will be used to display
; the animated heart cycle:
WINDOW, win, XSIZE = 128, YSIZE=128, TITLE='Heart', /FREE
; Current frame number:
i = 0L
; Display frames until any key is pressed:
WHILE GET_KBRD(0) EQ '' DO BEGIN
; Compute x and y locations of pixmap image's lower left corner:
   x = (i mod 4) * 128 & y = 384 - (i/4) * 128
; Copy the next image from the pixmap to the visible window:
DEVICE, COPY = [x, y, 128, 128, 0, 0, pixwin]
; Keep track of total frame count:
i = (i + 1) MOD 15
ENDWHILE
END
```

Animation sequences with more and/or larger images can be made. See the documentation for the XANIMATE procedure, which is a more generalized embodiment of the above procedure.

**Note**

Some X Windows servers will refuse to create a pixmap that is larger than the physical screen in either dimension.

## How Color is Interpreted for a TrueColor Visual

How a color (such as !P.COLOR) is interpreted by IDL (when a TrueColor visual is being utilized) depends in part upon the decomposed setting for the device.

To retrieve the decomposed setting:

```
DEVICE, GET_DECOMPOSED = currentDecomposed
```

To set the decomposed setting:

```
DEVICE, DECOMPOSED = newDecomposed
```

If the decomposed value is zero, colors (like !P.COLOR) are interpreted as indices into IDL's color table. A color should be in the range from 0 to !D.TABLE_SIZE - 1. The IDL color table contains a red, green, and blue component at a given index; each of these components is in the range of 0 up to 255.

**Note**

IDL’s color table does not map directly to a hardware color table for a TrueColor visual. If IDL’s color table is modified, for example using the LOADCT or TVLCT routines, then the new color table will only take effect for graphics that are drawn after it has been modified.

If the decomposed value is non-zero, colors (like !P.COLOR) are interpreted as a combination of red, green, and blue settings. The least significant 8 bits contain the red component, the next 8 bits contain the green component, and the most significant 8 bits contain the blue component.

In either case, the most significant bits of each of the resulting red, green, and blue components are utilized. The number of bits utilized per component depends upon the red, green, and blue masks for the visual. On UNIX systems, a new field (Bits Per RGB) has been added to the output from HELP, /DEVICE. This Bits Per RGB field indicates the amount of bits utilized for each component.

**Tip**

The UNIX command `xdpyinfo` also provides information about each of the visuals.

## Setting the X Window Defaults

You can set the initial default value of the following parameters by setting resources in the file `.Xdefaults` file in your home directory as follows:

| Resource Name | Description |
|---|---|
| idl.colors | The number of colors used by IDL. |
| idl.gr_depth | The depth, in bits, of the visual used by IDL. |
| idl.retain | The default setting for the *`retain`* parameter: 0=none, 1= by server, 2=by IDL. |
| idl.gr_visual | The type of visual: StaticGray, GrayScale, StaticColor, PseudoColor, TrueColor, or DirectColor. |

*Table A-16: IDL/ X Window Defaults*

For example, to set the default visual to PseudoColor, and to allocate 100 colors, insert the following lines in your defaults file:

```
idl.gr_visual: PseudoColor
idl.colors: 100
```

# The Z-Buffer Device

## Device Keywords Accepted by the Z Device:

CLOSE, GET_GRAPHICS_FUNCTION, GET_WRITE_MASK, SET_CHARACTER_SIZE, SET_COLORS, SET_FONT, SET_GRAPHICS_FUNCTION, SET_RESOLUTION, Z_BUFFERING

The IDL Z-buffer device is a pseudo device that draws 2-D or 3-D graphics in a buffer contained in memory. This driver implements the classic Z buffer algorithm for hidden surface removal. Although primarily used for 3-D graphics, the Z-buffer driver can be used to create 2-D objects in a frame buffer in memory. The resolution of this device can be set by the user.

All of the IDL plotting and graphics routines work with the Z-buffer device driver. In addition, the POLYFILL procedure has a few keyword parameters, allowing Gouraud shading and warping images over 3-D polygons, that are only effective when used with the Z-buffer.

When used for 3-D graphics, two buffers are present: an 8-bit-deep frame buffer that contains the picture; and a 16-bit-deep Z-buffer of the same resolution, containing the z-value of the visible surface of each pixel. The Z-buffer is initialized to the depth at the back of the viewing volume. When objects are drawn, the z-value of each pixel is compared with the value at the same location in the Z-buffer, and if the z-value is greater (closer to the viewer), the new pixel is written in the frame buffer and the Z-buffer is updated with the new z-value.

The Z-buffer device is a “pseudo device” in that drawing commands update buffers in memory rather than sending commands to a physical device or file. The TVRD function reads the contents of either buffer to an IDL array. This array may then be further processed, written to a file, or output to a raster-based graphics output device.

The Z-buffer driver can be used for 2-D graphics by disabling the depth computations.

To use the Z-buffer as the current graphics device, issue the IDL command:

```
SET_PLOT, 'Z'
```

Once the Z-buffer driver is enabled the DEVICE procedure is used to control its actions, as described below.

Use the statement:

```
HELP, /DEVICE
```

to view the current state of the Z-buffer driver and the amount of memory used for the buffers.

## Reading and Writing Buffers

The contents of both buffers are directly accessed by the TV and TVRD routines. The frame buffer that contains the picture is 8 bits deep and is accessed as channel 0. The Z depth buffer contains 16 bit integers and is accessed as channel 1. Always use `CHANNEL=1` and set the keyword WORDS when reading or writing the depth buffer.

The normal procedure is to set the graphics device to “Z”, draw the objects, read the frame buffer, and then select another graphics device and write the image. For example, to create an image with the Z-buffer driver and then display it on an X-Window display:

```
; Select Z-buffer device:
SET_PLOT,'Z'
; Write objects to the frame buffer using normal graphics
; routines, e.g. PLOT, SURFACE, POLYFILL
... ... ...
; Read back the entire frame buffer:
a=TVRD()
; Select X Windows:
SET_PLOT,'X'
; Display the contents of the frame buffer:
TV, a
```

To read the depth values in the Z-buffer, use the command:

```
a = TVRD(CHANNEL=1, /WORDS)
```

To write the depth values, use the command:

```
TV, a, /WORDS, CHANNEL=1
```

The TV, TVSCL, and TVRD routines write or read pixels directly to a rectangular area of the designated buffer without affecting the other buffer.

## Z-Axis Scaling

The values in the depth buffer are short integers, scaled from -32765 to +32765, corresponding to normalized Z-coordinate values of 0.0 to 1.0.

## Polyfill Procedure

The following POLYFILL keywords are active only with the Z-buffer device: IMAGE_COORDINATES, IMAGE_INTERPOLATE, and TRANSPARENT. These

parameters allow images, specified via the PATTERN keyword, to be warped over 2-D and 3-D polygons.

The IMAGE_COORDINATES keyword contains a 2 by *N* array containing the image space coordinates that correspond to each of the *N* vertices of the polygon. The IMAGE_INTERPOLATE keyword indicates that bilinear interpolation is to be used, rather than the default nearest neighbor sampling. Pixels less than the value of TRANSPARENT are not drawn, simulating transparency. For Gouraud shading of polygons, the COLOR keyword can contain an array specifying the color index for each polygon vertex.

## Examples Using the Z-Buffer

This example forms a Bessel function, draws its shaded surface and overlays its contour, using the Z-buffer as shown in the following figure.The final output is directed to PostScript.

```
; Select the Z-buffer:
SET_PLOT, 'Z'
n = 50 ; Size of array for Bessel
; Make the Bessel function:
a = BESELJ(SHIFT(DIST(n), n/2, n/2)/2, 0)
; Draw the surface, label axes in black, background in white:
SHADE_SURF, a, /SAVE, COLOR=1, BACKGROUND=255
nlev = 8 ; Number of contour levels
; Make the Contour at normalized Z=.6:
CONTOUR, a, /OVERPLOT, ZVALUE=.6, /T3D, $
   LEVELS=FINDGEN(nlev)*1.5/nlev-.5, COLOR=1
; Read image:
b=TVRD()
; Select PostScript output:
SET_PLOT, 'PS'
; Output the image:
TV, b
; Close the new PostScript file:
DEVICE, /CLOSE
```

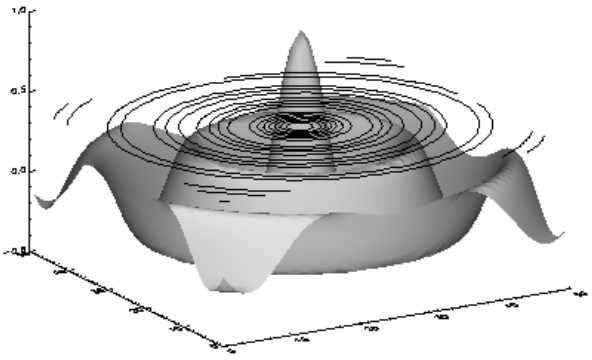


*Figure A-7: Combined Shaded Surface and Contour Plot*

The following example warps an image to a cube as shown in the figure below. The lower two quadrants of the image are warped to the front two faces of the cube. The upper-right quadrant is warped to the top face of the cube. The image is held in the array a, with dimensions nx by ny. The image is then output to PostScript as in the previous example.

```
; Select the Z-buffer:
SET_PLOT, 'Z'
; Make a white background for final output to PostScript:
ERASE, 255
; Establish 3-D scaling as (0,1) cube:
SCALE3, XRANGE=[0,1], YRANGE=[0,1], ZRANGE=[0,1]
; Define vertices of cube. Vertices 0-3 are bottom, 4-7 are top:
verts = [[0,0,0], [1,0,0], [1,1,0], [0,1,0], $
   [0,0,1], [1,0,1], [1,1,1], [0,1,1]]
; Fill lower left face:
POLYFILL, verts[*, [3,0,4,7]], /T3D, PATTERN=a, $
   IMAGE_COORD=[[0,0], [nx/2,0], [nx/2,ny/2], [0,ny/2]]
; Fill lower right face:
POLYFILL, verts[*, [0,1,5,4]], /T3D, PATTERN=a, $
   IMAGE_COORD=[[nx/2,0], [nx-1,0], $
   [nx-1,ny/2], [nx/2,ny/2]]
; Fill top face:
POLYFILL, verts[*, [4,5,6,7]], /T3D, PATTERN=a, $
   IMAGE_COORD = [[nx/2,ny/2], [nx-1,ny/2], $
   [nx-1,ny-1], [nx/2,ny-1]]
; Draw edges of cube in black:
PLOTS, verts[*, [0,4]], /T3D, COLOR=0
```

```
   ; Edges of top face:
PLOTS, verts[*, [4,5,6,7,4]], /T3D, COLOR=0
```

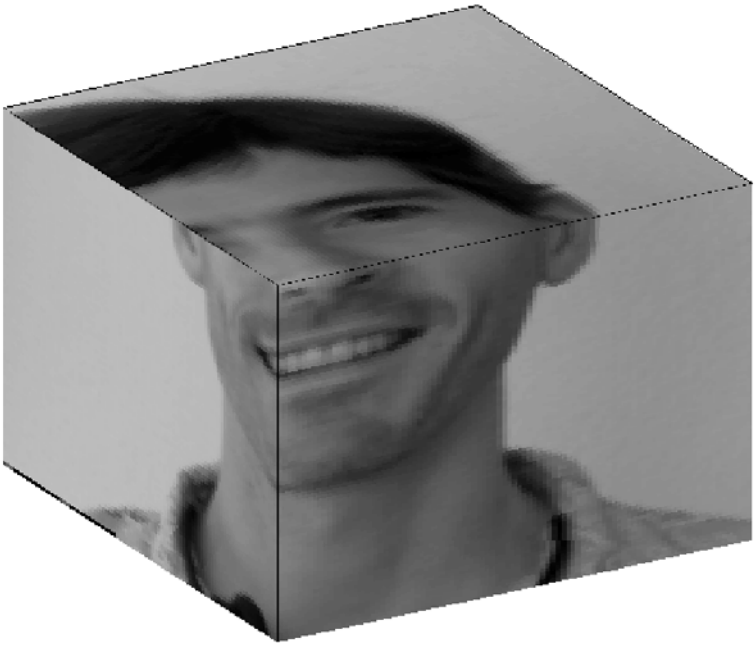
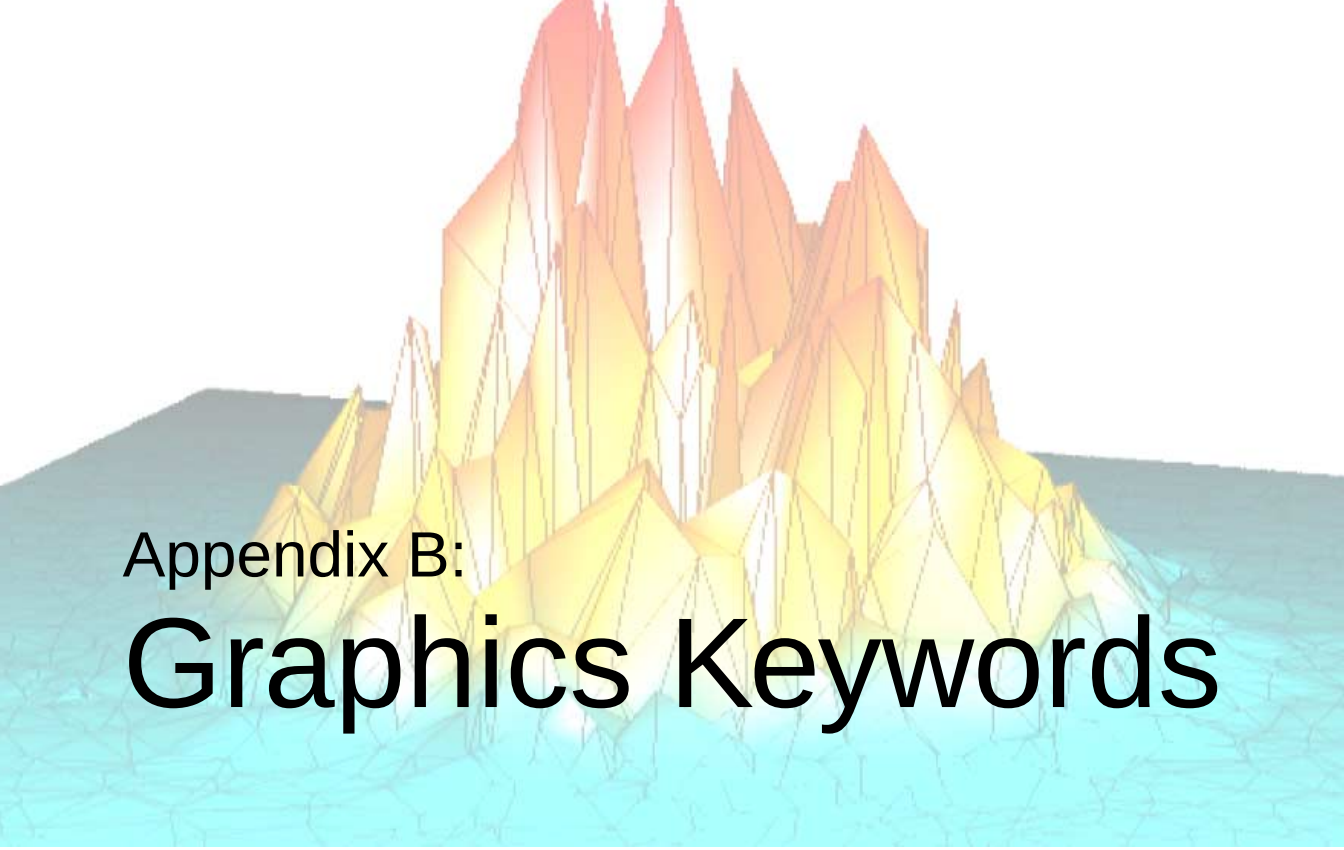


*Figure A-8: Image Warped to a Cube Using the Z-Buffer*



# Appendix B: Graphics Keywords

The IDL Direct Graphics routines, CURSOR, ERASE, PLOTS, POLYFILL, TV (and TVSCL), TVCRS, TVRD, and XYOUTS, and the plotting procedures, AXIS, CONTOUR, PLOT, OPLOT, SHADE_SURF, and SURFACE, accept a number of common keywords. Therefore, instead of describing each keyword along with the description of each routine, this section contains a brief summary of each graphics keyword. Routine-specific keywords are documented in the description of the routine.

The graphics keywords are described below. The name of each keyword is followed by a list of routines that accept that keyword. Keywords that have a direct correspondence to fields in a system variable (usually !P) are also indicated.

The keywords that control the plot axes are prefixed with the character ‘X’, ‘Y’, or ‘Z’ depending on the axis in question. These keywords correspond to fields in the axis system variables: !X, !Y, and !Z, and are described in more detail in “Graphics System Variables” on page 3913 The axis keywords are shown in the form [XYZ]NAME. For example, [XYZ]CHARSIZE refers to the three keywords XCHARSIZE, YCHARSIZE, and ZCHARSIZE, which control the size of the characters annotating the three axes.

The system variable fields that control this are !X.CHARSIZE, !Y.CHARSIZE, and !Z.CHARSIZE.

The following graphics keywords are discussed in this appendix:



# BACKGROUND

Accepted by: CONTOUR, PLOT, SURFACE.

System variable equivalent: !P.BACKGROUND.

The background color index to which all pixels are set when erasing the screen or page. The default is 0 (black). Not all devices support erasing the background to a specified color index.

For example, to produce a black plot with a white background on a color display:

```
PLOT, Y, BACKGROUND = 255, COLOR = 0
```

# CHANNEL

Accepted by: ERASE, TV, TVRD. System variable equivalent: !P.CHANNEL.

This keyword specifies the memory channel for the operation. This parameter is ignored on display systems that have only one memory channel. When using a "decomposed" display system, the red channel is 1, the green channel is 2, and the blue channel is 3. Channel 0 indicates all channels. If omitted, !P.CHANNEL contains the default channel value.

**Note**

CONTOUR, PLOT, SHADE_SURF, and SURFACE also accept the CHANNEL keyword, but simply pass it to ERASE.

## CHARSIZE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.CHARSIZE.

The overall character size for the annotation when Hershey fonts are selected. This keyword does not apply when hardware (i.e. PostScript) fonts are selected. A CHARSIZE of 1.0 is normal. The size of the annotation on the axes may be set, relative to CHARSIZE, with *x*CHARSIZE, where *x* is X, Y, or Z. The main title is written with a character size of 1.25 times this parameter.

## CHARTHICK

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.CHARTHICK.

An integer value specifying the line thickness of the vector drawn font characters.This keyword has no effect when used with the hardware drawn fonts. The default value is 1.

## CLIP

Accepted by: CONTOUR, DRAW_ROI, OPLOT, PLOT, PLOTS, POLYFILL, SURFACE, XYOUTS. System variable equivalent: !P.CLIP.

The coordinates of a rectangle used to clip the graphics output. The rectangle is specified as a vector of the form $[X_0, Y_0, X_1, Y_1]$, giving coordinates of the lower left and upper right corners, respectively. The default clipping rectangle is the plot window, the area enclosed within the axes of the most recent plot. Coordinates are specified in data units unless an overriding coordinate unit specification keyword is present (i.e., NORMAL or DEVICE). If the clipping is provided in data or

normalized units, the actual clipping rectangle is computed by converting those values to device units. The clipping itself always occurs in device space.

**Note**

The default is not to clip the output of PLOTS and XYOUTS. To enable clipping include the keyword parameter NOCLIP = 0. With PLOTS, POLYFILL, and XYOUTS, this keyword controls the clipping of vectors and vector-drawn text.

For example, to draw a vector using normalized coordinates with its contents clipped within a rectangle covering the upper left quadrant of the display:

```
PLOTS, X, Y, CLIP=[0.,.5,.5,1.0], /NORM, NOCLIP=0
```

## COLOR

Accepted by: AXIS, CONTOUR, DRAW_ROI, ERASE, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.COLOR.

The color index of the data, text, line, or solid polygon fill to be drawn. If this keyword is omitted, !P.COLOR specifies the color index.

When used with the PLOTS, POLYFILL, or XYOUTS procedure, this keyword parameter can be set to a vector to specify multiple color indices.

Gouraud shading of polygons is performed with the Z-buffer graphics output device and POLYFILL procedure when COLOR contains an array of color indices, one for each vertex.

## DATA

Accepted by: AXIS, CONTOUR, CURSOR, DRAW_ROI, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS.

Set this keyword to indicate that the clipping and/or positioning coordinates supplied are specified in the data coordinate system. The default coordinate system is DATA if no other coordinate-system specifications are present.

## DEVICE

AXIS, CONTOUR, CURSOR, DRAW_ROI, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS.

Set this keyword to indicate that the clipping and/or positioning coordinates supplied are specified in the device coordinate system. The default coordinate system is DATA if no other coordinate-system specifications are present.

For example, the following code displays an image contained in the variable A and then draws a contour plot of pixels [100:499, 100:399] over the correct section of the image:

```
;Display the image.
TV,A

;Draw the contour plot, specify the coordinates of the plot, in
;device coordinates, do not erase, set the X and Y axis styles to
;EXACT.
CONTOUR, A[100:499, 100:399], $
    POS = [100,100, 499,399], /DEVICE, $
   /NOERASE, XSTYLE=1, YSTYLE=1
```

Note that in the above example, the keyword specification `/DEVICE` is equivalent to `DEVICE = 1`.

## FONT

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, XYOUTS. System variable equivalent: !P.FONT.

An integer that specifies the graphics text font system to use. Set FONT equal to -1 to selects the Hershey character fonts, which are drawn using vectors. Set FONT equal to 0 (zero) to select the device font of the output device. Set FONT equal to 1 (one) to select the TrueType font system. See Appendix H, “Fonts” for a complete description of IDL’s font systems.

## LINESTYLE

Accepted by: DRAW_ROI, OPLOT, PLOT, PLOTS, SURFACE. System variable equivalent: !P.LINESTYLE.

This keyword indicates the line style used to draw lines; it indicates the line style of the lines used to connect the data points. This keyword should be set to the appropriate index for the desired linestyle as described in the following table.

| Index | Linestyle |
|---|---|
| 0 | Solid |
| 1 | Dotted |
| 2 | Dashed |
| 3 | Dash Dot |
| 4 | Dash Dot Dot |
| 5 | Long Dashes |

*Table B-1: IDL Linestyles*

## NOCLIP

Accepted by: CONTOUR, DRAW_ROI, OPLOT, PLOT, PLOTS, POLYFILL, SURFACE, XYOUTS. System variable equivalent: !P.NOCLIP.

Set this keyword to suppress clipping of the plot. The clipping rectangle is contained in !P.CLIP. By default, the plot is clipped within the plotting window.

**Note**

The default value is clipping-disabled for PLOTS, POLYFILL, and XYOUTS. For all other routines, the default is to enable clipping.

With PLOTS, POLYFILL, and XYOUTS, this keyword controls the clipping of vectors and vector-drawn text. The default is to disable clipping, so to enable clipping include the parameter NOCLIP = 0. To explicitly disable clipping set this parameter to one.

## NODATA

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE.

If this keyword is set, only the axes, titles, and annotation are drawn. No data points are plotted.

For example, to draw an empty set of axes between some given values:

```
PLOT, [XMIN, XMAX],[YMIN, YMAX], /NODATA
```

## NOERASE

Accepted by: AXIS, CONTOUR, PLOT, SURFACE. System variable equivalent: !P.NOERASE.

Specifies that the screen or page is not to be erased. By default, the screen is erased, or a new page is begun, before a plot is produced.

## NORMAL

Accepted by: AXIS, CONTOUR, CURSOR, DRAW_ROI, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS.

Set this keyword to indicate that the clipping and/or positioning coordinates supplied are specified in the normalized coordinate system, and range from 0.0 to 1.0. The default coordinate system is DATA if no other coordinate-system specifications are present.

## ORIENTATION

Accepted by: DRAW_ROI, POLYFILL, XYOUTS.

Specifies the counterclockwise angle in degrees from horizontal of the text baseline and the lines used to fill polygons.When used with the POLYFILL procedure, this keyword forces the “linestyle” type of fill, rather than solid or patterned fill.

## POSITION

Accepted by: CONTOUR, MAP_SET, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.POSITION.

Allows direct specification of the plot window. POSITION is a 4-element vector giving, in order, the coordinates [($X_0$, $Y_0$), ($X_1$, $Y_1$)], of the lower left and upper right corners of the data window. Coordinates are expressed in normalized units ranging from 0.0 to 1.0, unless the DEVICE keyword is present, in which case they are in actual device units. The value of POSITION is never specified in data units, even if the DATA keyword is present.

When setting the position of the window, be sure to allow space for the annotation, which resides outside the window. IDL outputs the message “% Warning: Plot truncated.” if the plot region is larger than the screen or page size. The plot region is the rectangle enclosing the plot window and the annotation.

When plotting in three dimensions, the POSITION keyword is a 6-element vector with the first four elements describing, as above, the XY position, and with the last two elements giving the minimum and maximum Z coordinates. The Z specification is always in normalized coordinate units.

When making more than one plot per page it is more convenient to set !P.MULTI than to manipulate the position of the plot directly with the POSITION keyword.

For example, the following statement produces a contour plot with data plotted in only the upper left quarter of the screen:

```
CONTOUR, Z, POS=[0., 0.5, 0.5, 1.0]
```

Because no space on the left or top edges was allowed for the axes or their annotation, the above described warning message results.

# PSYM

Accepted by: DRAW_ROI, OPLOT, PLOT, PLOTS. System variable equivalent: !P.PSYM.

The symbol used to mark each data point. Normally, PSYM is 0, data points are connected by lines, and no symbols are drawn to mark the points. Set this keyword, or the system variable !P.PSYM, to the symbol index as shown in the table below to mark data points with symbols. The keyword SYMSIZE is used to set the size of the symbols.

| PSYM Value | Plotting Symbol |
|---|---|
| 1 | Plus sign (+) |
| 2 | Asterisk (*) |
| 3 | Period (.) |
| 4 | Diamond |
| 5 | Triangle |
| 6 | Square |
| 7 | X |
| 8 | User-defined. See USERSYM procedure. |

*Table B-2: Values for the PSYM Keyword*

| PSYM Value | Plotting Symbol |
|---|---|
| 9 | Undefined |
| 10 | Histogram mode. Horizontal and vertical lines connect the plotted points, as opposed to the normal method of connecting points with straight lines. |

*Table B-2: Values for the PSYM Keyword*

Negative values of PSYM cause the symbol designated by PSYM to be plotted at each point with solid lines connecting the symbols. For example, a value of -5 plots triangles at each data point and connects the points with lines. Histogram mode is the exception to this rule; since the points are already connected when PSYM=10, specifying the value -10 is meaningless, and will result in an error.

The following IDL code plots an array using points, and then overplots the smoothed array, connecting the points with lines:

```
;Plot using points.
PLOT, A, PSYM=3

;Overplot smoothed data.
OPLOT, SMOOTH(A,7)
```

## SUBTITLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.SUBTITLE.

A text string to be used as a subtitle for the plot. Subtitles appear below the X axis.

## SYMSIZE

Accepted by: DRAW_ROI, OPLOT, PLOT, PLOTS.

Specifies the size of the symbols drawn when PSYM is set. The default size of 1.0 produces symbols approximately the same size as a character.

## T3D

Accepted by: AXIS, CONTOUR, DRAW_ROI, MAP_SET, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE, TV, TVCRS, XYOUTS. System variable equivalent: !P.T3D.

Set this keyword to indicate that the generalized transformation matrix in !P.T is to be used. If not present, the user-supplied coordinates are simply scaled to screen coordinates. See the examples in the description of the SAVE keyword.

**Note**

Since T3D uses the transformation matrix in !P.T, it is important that !P.T contain a valid transformation matrix. This can be achieved in several ways:

- Use the SAVE keyword to save the transformation matrix from an earlier graphics operation.
- Establish a transformation matrix using the T3D, SURFR, or, SCALE3 procedures.
- Set the value of !P.T directly.

## THICK

Accepted by: AXIS, DRAW_ROI, OPLOT, PLOT, PLOTS, POLYFILL, SHADE_SURF, SURFACE. System variable equivalent: !P.THICK.

Indicates the line thickness. THICK overrides the setting of !P.THICK.

## TICKLEN

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.TICKLEN.

Controls the length of the axis tick marks, expressed as a fraction of the window size. The default value is 0.02. TICKLEN of 1.0 produces a grid, while a negative TICKLEN makes tick marks that extend outside the window, rather than inwards.

For example, to produce outward-going tick marks of the normal length:

```
PLOT, X, Y, TICKLEN = -0.02
```

To provide a new default tick length, set !P.TICKLEN.

## TITLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: !P.TITLE.

Produces a main title centered above the plot window. The text size of this main title is larger than the other text by a factor of 1.25. For example:

```
PLOT, X, Y, TITLE = 'Final Results'
```

## [XYZ]CHARSIZE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalents: ![XYZ].CHARSIZE.

The size of the characters used to annotate the axis and its title when Hershey fonts are selected. This keyword does not apply when hardware (i.e. PostScript) fonts are selected. This field is a scale factor applied to the global scale factor set by !P.CHARSIZE or the keyword CHARSIZE.

## [XYZ]GRIDSTYLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE

The index of the linestyle to be used for plot tickmarks and grids (i.e., when [XYZ]TICKLEN is set to 1.0). See LINESTYLE for a list of linestyles.

## [XYZ]MARGIN

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].MARGIN.

A 2-element array specifying the margin on the left (bottom) and right (top) sides of the plot window, in units of character size. Default margins are 10 and 3 for the X axis, and 4 and 2 for the Y axis. The ZMARGIN keyword is present for consistency and is currently ignored.

## [XYZ]MINOR

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].MINOR.

The number of minor tick mark intervals.

## [XYZ]RANGE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].RANGE.

The desired data range of the axis, a 2-element vector. The first element is the axis minimum, and the second is the maximum. IDL will frequently round this range. This override can be defeated using the [XYZ]STYLE keywords.

# [XYZ]STYLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].STYLE.

This keyword allows specification of axis options such as rounding of tick values and selection of a box axis. Each option is described in the following table:

| Value | Description |
|---|---|
| 1 | Force exact axis range. |
| 2 | Extend axis range. |
| 4 | Suppress entire axis |
| 8 | Suppress box style axis (i.e., draw axis on only one side of plot) |
| 16 | Inhibit setting the Y axis minimum value to 0 (Y axis only) |

*Table B-3: Values for the [XYZ]STYLE Keyword*

Note that this keyword is set bitwise, so multiple effects can be set by adding values together. For example, to make an X axis that is both exact (value 1) and suppresses the box style (setting 8), set the XAXIS keyword to `1+8`, or 9.

# [XYZ]THICK

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].THICK.

This keyword controls the thickness of the lines forming the axis and tick marks. A value of 1.0 is the default.

# [XYZ]TICK_GET

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE.

A named variable in which to return the values of the tick marks for the designated axis. The result is a double precision floating-point array with the same number of elements as ticks.

For example, to retrieve in the variable V the values of the tick marks selected by IDL for the Y axis:

```
PLOT, X, Y, YTICK_GET = V
```

# [XYZ]TICKFORMAT

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKFORMAT.

Set this keyword to a string or a vector of strings. If a vector is provided, each string corresponds to a level of the axis. The [XYZ]TICKUNITS keyword determines the number of levels for an axis.

Each string is one of the following:

## A format code:

If the string begins with an open parenthesis, it is treated as a standard format string. See "Format Codes" in Chapter 10 of the *Building IDL Applications* manual for more information on format codes.

**Example 1**: Display the X axis tick values using a format of F6.2 (six characters, with 2 places after the decimal point):

```
PLOT, X, Y, XTICKFORMAT='(F6.2)'
```

**Example 2**: Display the Y tick values using the "dollars and cents" format $*dddd.dd*:

```
PLOT, X, Y, YTICKFORMAT='("$", F7.2)'
```

## The string 'LABEL_DATE' :

Set [XYZ]TICKFORMAT to the string 'LABEL_DATE' to create axes with date labels. The formatting of the labels is specified by first calling LABEL_DATE with the DATE_FORMAT keyword. See LABEL_DATE for more information.

**Example**: Use the LABEL_DATE function as the callback function to display the X tick values in a date/time format:

```
dummy = LABEL_DATE(DATE_FORMAT='%M %Z')
mytimes = TIMEGEN(12, UNITS='MONTHS', START=JULDAY(1,1,2000))
y = FINDGEN(12)
PLOT, mytimes, y, XTICKUNITS='Time', XTICKFORMAT='LABEL_DATE'
```

## The name of a user-defined function:

If the string does not begin with an open parenthesis, it is interpreted as the name of a callback function to be used to generate tick mark labels. This function is defined with either three or four parameters, depending on whether [XYZ]TICKUNITS is specified:

If [XYZ]TICKUNITS is *not* specified, the callback function is called with three parameters, *Axis*, *Index*, and *Value*, where:

- *Axis* is the axis number: 0 for X axis, 1 for Y axis, 2 for Z axis.
- *Index* is the tick mark index (indices start at 0).
- *Value* is the data value at the tick mark (a double-precision floating point value).

**Note**

*Value* is a double-precision floating-point value that represents the Julian date. The Julian date follows the astronomical convention, where Julian date 0.0d corresponds to 1 Jan 4713 B.C.E. at 12 pm.

If [XYZ]TICKUNITS is specified, the callback function is called with four parameters, *Axis*, *Index*, *Value*, and *Level*, where:

- *Axis*, *Index*, and *Value* are the same as described above.
- *Level* is the index of the axis level for the current tick value to be labeled (level indices start at 0).

**Example 1**: Use a callback function to display the Y tick values as a percentage of a fixed value. Note that because we don't specify [XYZ]TICKUNITS, we do not include the *Level* parameter in our function definition:

```
FUNCTION YTICKS, axis, index, value
   fixvalue = 389.0d
   pvalue = (value/fixvalue) * 100.0d
   RETURN, STRING(pvalue, FORMAT='(D5.2,"%")')
END

PRO use_callback

   Y = FINDGEN(10)
   PLOT, Y, YTICKFORMAT='YTICKS'

END
```

**Example 2**: Create a two-level X axis. Display the X tick values in a customized date/time format that shows the number of days open for business for each month on one level, and marks leap years with an asterisk on another level:

```
FUNCTION XTICKS, axis, index, value, level

   CASE level OF
     0: BEGIN ; months
          ; Number of days open for business in given month:
```

```
            CALDAT, value, month
            open = [18,19,23,20,22,22,19,10,20,21,22,14]
            nbdays = open[month]
            ; Return a string containing the month name plus
            ; the number of business days in parentheses:
            RETURN, STRING(value, nbdays, $
               FORMAT='(C(CMoA), "(", I2, ")")')
         END
      1: BEGIN ; years
            ; Generate a string for the year.
            yrStr = STRING(value, FORMAT='(C(CYI))')
            ; Determine if a leap year.  If so,
            ; append an asterisk to the string.
            CALDAT, value, mo, da, yr
            IF (yr MOD 4 EQ 0) THEN BEGIN
               IF (yr MOD 100 EQ 0) THEN $
                  isLeap = (yr MOD 400) EQ 0 $
               ELSE $
                  IsLeap = 1b
            ENDIF ELSE $
            isLeap = 0b
            IF (isLeap NE 0b) THEN $
               yrStr = yrStr + '*'
               RETURN, yrStr
            END
      ENDCASE

END

PRO plot_sales

   myDates = TIMEGEN(12, UNITS='Months', START=JULDAY(1,1,2000))
   sales = [180,190,230,200,220,220,190,100,200,210,220,140]
   PLOT, myDates, sales, XTICKUNITS=['Months', 'Years'], $
      XTICKFORMAT='XTICKS', XTITLE = 'Date (* = Leap Year)', $
      YTITLE='Sales (units)', POSITION = [0.2, 0.2, 0.9, 0.9]

END
```

# [XYZ]TICKINTERVAL

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE

variable equivalent: ![XYZ].TICKINTERVAL

Set this keyword to a scalar indicating the interval between major tick marks for the first axis level. The default value is computed according to the axis range

([XYZ]RANGE) and the number of major tick intervals ([XYZ]TICKS). This keyword takes precedence over [XYZ]TICKS.

For example, if TICKUNITS=[“Seconds”, “Hours”, “Days”], and XTICKINTERVAL=30, then the interval between major ticks for the first axis level will be 30 seconds.

# [XYZ]TICKLAYOUT

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKLAYOUT.

Set this keyword to a scalar that indicates the tick layout style to be used to draw each level of the axis.

Valid values include:

- 0 = The axis line, major tick marks and tick labels are all included. Minor tick marks only appear on the first level of the axis. This is the default tick layout style.
- 1 = Only the labels for the major tick marks are drawn. The axis line, major tick marks, and minor tick marks are omitted.
- 2 = Each major tick interval is outlined by a box. The tick labels are positioned within that box (left-aligned). For the first axis level only, the major and minor tick marks will also be drawn.

**Note**

For all tick layout styles, at least one tick label will appear on each level of the axis (even if no major tick marks fall along the axis line). If there are no major tick marks, the single tick label will be centered along the axis.

# [XYZ]TICKLEN

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKLEN.

This keyword controls the lengths of tick marks (expressed in normal coordinates) for the individual axes. This keyword, if nonzero, overrides the global tick length specified in !P.TICKLEN, and/or the TICKLEN keyword parameter, which is expressed in terms of the window size.

# [XYZ]TICKNAME

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKNAME.

A string array of up to 30 elements that controls the annotation of each tick mark.

# [XYZ]TICKS

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKS.

The number of major tick *intervals* to draw for the axis. If this keyword is omitted, IDL selects from three to six tick intervals. Setting this field to *n*, where $n > 1$, produces exactly *n* tick intervals, and *n*+1 tick marks. Setting this field equal to 1 suppresses tick marks.

# [XYZ]TICKUNITS

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKUNITS.

Set this keyword to a string or a vector of strings indicating the units to be used for axis tick labeling. If a vector of strings is provided, the axis will be drawn in multiple levels, where each string represents one level in the specified units.

**Note**

When creating multiple-level axes, you may need to adjust the plot positioning using the POSITION or [XYZ]MARGIN keywords in order to ensure that axis labels and titles are visible in the plot window.

The order in which the strings appear in the vector determines the order in which the corresponding unit levels will be drawn. The first string corresponds to the first level (the level nearest to the primary axis line).

Valid unit strings include:

- 'Numeric'
- 'Years'
- 'Months'
- 'Days'
- 'Hours'

- 'Minutes'
- 'Seconds'
- 'Time' - Use this value to indicate that the tick values are time values; IDL will determine the appropriate time intervals and tick label formats based upon the range of values covered by the axis.
- "- Use the empty string to indicate that no tick units are being explicitly set. This implies that a single axis level will be drawn using the 'Numeric' unit. This is the default setting.

If any of the time units are utilized, the tick values are interpreted as Julian date/time values.

Note that the singular form of each of the time value strings is also acceptable (e.g, TICKUNITS='Day' is equivalent to TICKUNITS='Days').

**Note**

Julian values must be in the range -1095 to 1827933925, which corresponds to calendar dates 1 Jan 4716 B.C.E. and 31 Dec 5000000, respectively.

## [XYZ]TICKV

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TICKV.

The data values for each tick mark, an array of up to 60 elements.

**Note**

To specify the number of ticks and their values exactly, set [XYZ]TICKS=*N(where N > 1)* and [XYZ]TICKV=*Values*, where *Values* has *N*+1 elements.

## [XYZ]TITLE

Accepted by: AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE. System variable equivalent: ![XYZ].TITLE.

A string that contains a title for the specified axis.

## Z

Accepted by: PLOTS, POLYFILL, TV, TVCRS, XYOUTS.

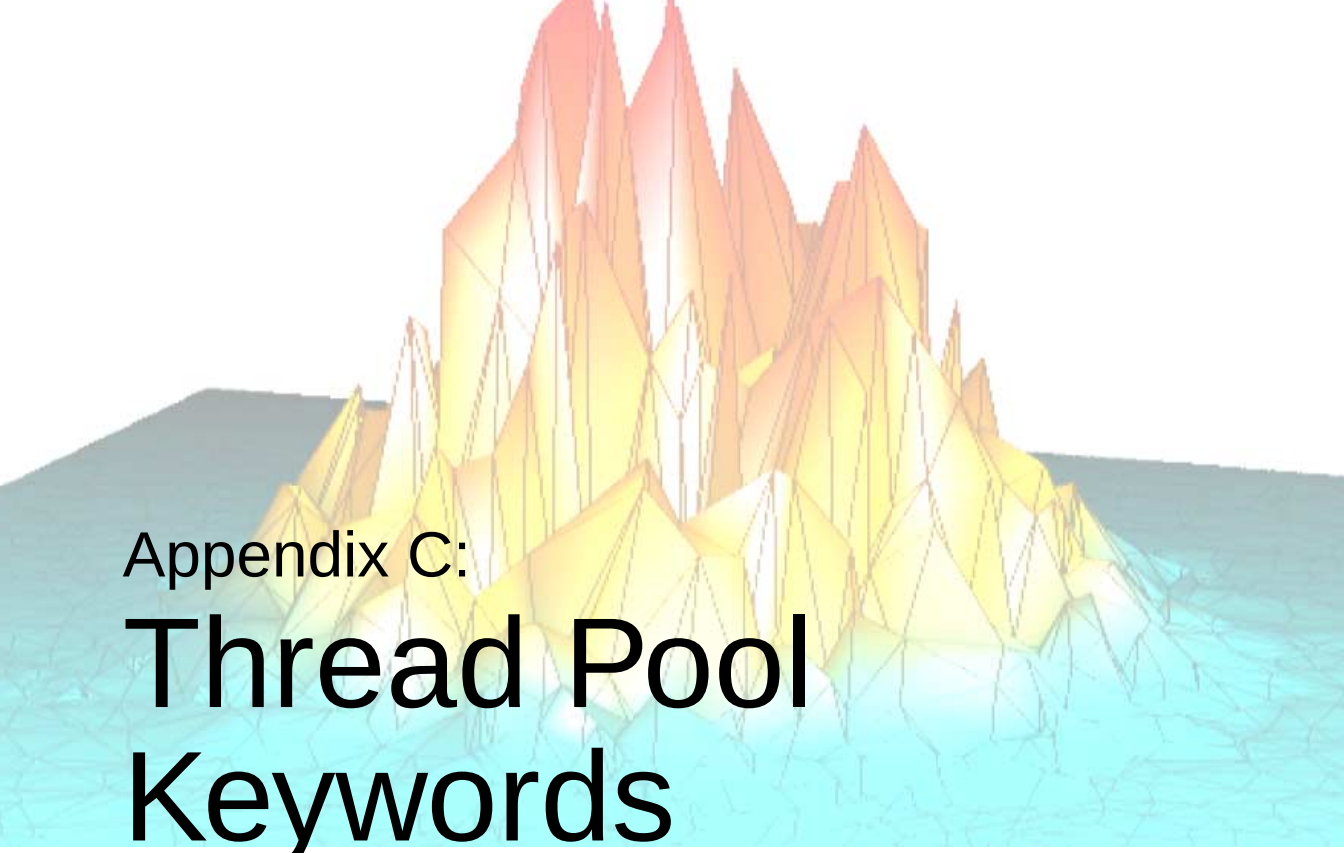
Provides the Z coordinate if a Z parameter is not present in the call. This is of use only if the three-dimensional transformation is in effect (i.e., the T3D keyword is set).

## ZVALUE

Accepted by: AXIS, CONTOUR, MAP_SET, OPLOT, PLOT, SHADE_SURF, SURFACE.

Sets the Z coordinate, in normalized coordinates in the range of 0 to 1, of the axis and data output from PLOT, OPLOT, and CONTOUR.

This keyword has effect only if !P.T3D is set and the three-dimensional to two-dimensional transformation is stored in !P.T. If ZVALUE is not specified, CONTOUR will output each contour at its Z coordinate, and the axes and title at a Z coordinate of 0.0.



# Appendix C: Thread Pool Keywords

Many of the system routines documented in this manual make use of the IDL thread pool. The thread pool is discussed in detail in Chapter 14, “Multithreading in IDL” in the *Building IDL Applications* manual. System-wide use of the thread pool can be controlled with the CPU procedure, and the current system settings are visible via the !CPU system variable.

All system routines that use the thread pool accept the following keywords, which can be used to modify the default behavior for the duration of a single call. This allows you to modify the settings for a particular computation without affecting the global default settings of the IDL session.

# Thread Pool Keywords

## TPOOL_MAX_ELTS

Set this keyword to a non-zero value to set the maximum number of data elements involved in a computation that uses the thread pool. If the number of elements in the computation exceeds the number you specify, IDL will not use the thread pool for the computation. Setting this value to 0 removes any limit on the maximum number of elements, and any computation with at least TPOOL_MIN_ELTS will use the thread pool.

This keyword overrides the default value, given by !CPU.TPOOL_MAX_ELTS. See "Possible Drawbacks to the Use of the IDL Thread Pool" in Chapter 14 of the *Building IDL Applications* manual for discussion of the circumstances under which it may be useful to specify a maximum number of elements.

## TPOOL_MIN_ELTS

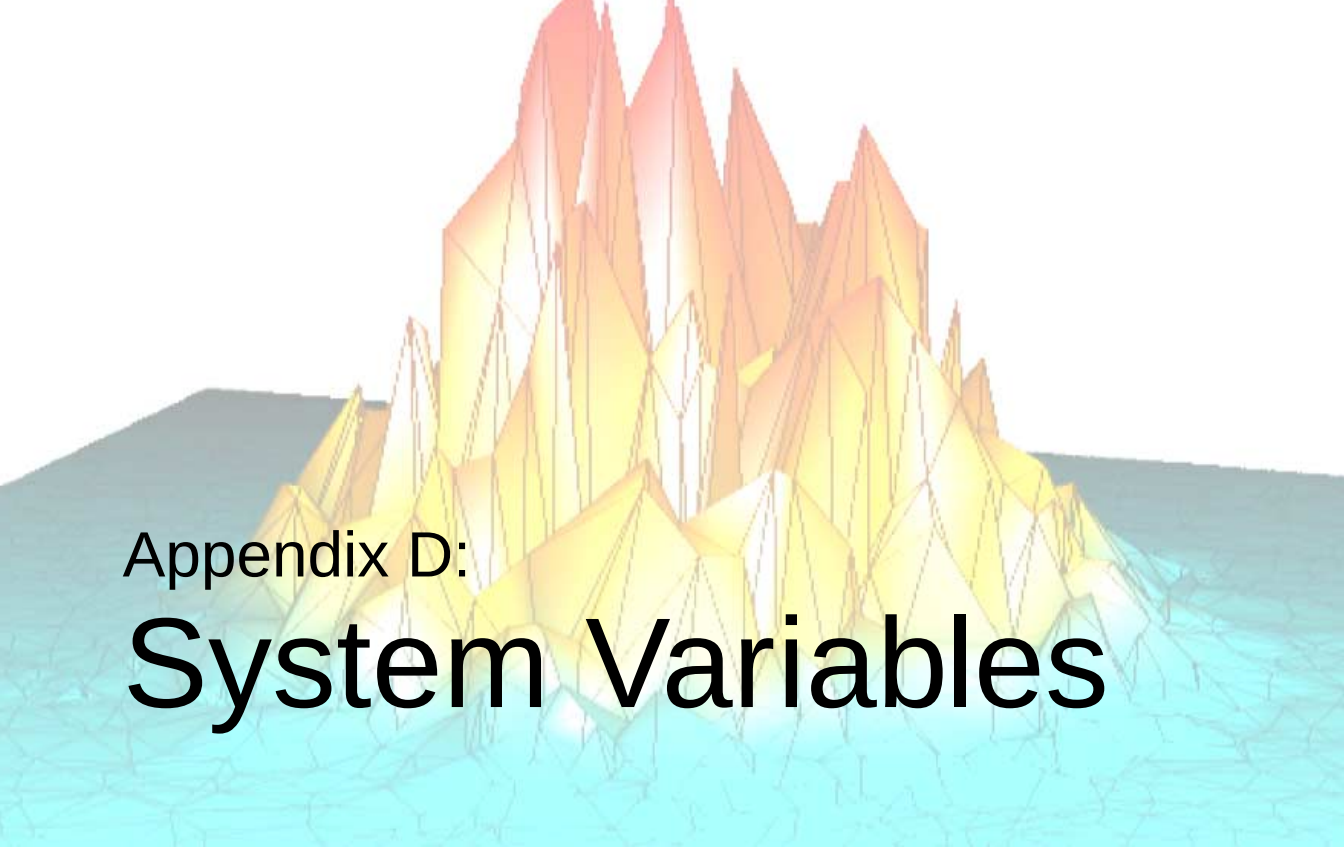
Set this keyword to a non-zero value to set the minimum number of data elements involved in a computation that uses the thread pool. If the number of elements in the computation is less than the number you specify, IDL will not use the thread pool for the computation. Use this keyword to prevent IDL from using the thread pool on tasks that are too small to benefit from it.

This keyword overrides the default value, given by !CPU.TPOOL_MIN_ELTS. See "Possible Drawbacks to the Use of the IDL Thread Pool" in Chapter 14 of the *Building IDL Applications* manual for discussion of the circumstances under which it may be useful to specify a minimum number of elements.

## TPOOL_NOTHREAD

Set this keyword to explicitly prevent IDL from using the thread pool for the current computation. If this keyword is set, IDL will use the non-threaded implementation of the routine even if the current settings of the !CPU system variable would allow use of the threaded implementation.

This keyword overrides the default value, given by !CPU.TPOOL_NTHREADS. See "Possible Drawbacks to the Use of the IDL Thread Pool" in Chapter 14 of the *Building IDL Applications* manual for discussion of the circumstances under which it may be useful to disable use of the thread pool entirely.



# Appendix D: System Variables

The following topics are included in this appendix:

# What Are System Variables?

System variables are a special class of predefined variables available to all program units. Their names always begin with the exclamation mark character (!). System variables are used to set the options for plotting, to set various internal modes, to return error status, etc.

System variables have a predefined type and structure that cannot be changed. When an expression is stored into a system variable, it is converted to the variable type, if necessary and possible. Certain system variables are *read only*, and their values cannot be changed. The user can define new system variables with the DEFSYSV procedure.

# Constant System Variables

The following system variables contain pre-defined constants or values for use by IDL routines. System variables can be used just like other variables. For example, the command:

```
PRINT, ACOS(A) * !RADEG
```

converts a result expressed in radians to one expressed in degrees.

## !DPI

A read-only variable containing the double-precision value of pi ($\pi$).

## !DTOR

A read-only variable containing the floating-point value used to convert degrees to radians ($\pi/180 \cong 0.01745$).

## !MAP

An array variable containing the information needed to effect coordinate conversions between points of latitude and longitude and map coordinates. The values in this array are established by the MAP_SET procedure; the user should not change them directly.

## !PI

A read-only variable containing the single-precision value of pi ($\pi$).

## !RADEG

A read-only variable containing the floating-point value used to convert radians to degrees ($180/\pi \cong 57.2958$).

## !VALUES

A read-only variable containing the IEEE single- and double-precision floating-point values *Infinity* and *NaN* (Not A Number). !VALUES is a structure variable with the following fields:

```
** Structure !VALUES, 4 tags, length=24:
   F_INFINITY      FLOAT          Infinity
   F_NAN           FLOAT               NaN
   D_INFINITY      DOUBLE         Infinity
   D_NAN           DOUBLE              NaN
```

where *Infinity* is the value Infinity and *NaN* is the value Not A Number. For more information on these special floating-point values, see "Special Floating-Point Values" in Chapter 18 of the *Building IDL Applications* manual.

# Error Handling System Variables

The following system variables are either set by IDL when an error condition occurs or used by IDL when displaying information about errors.

## !ERR

*This system variable is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !ERR system variable will continue to function as before, but all new code should use !ERROR_STATE.CODE.*

## !ERROR_STATE

A structure variable which contains the status of the last error message. !ERROR_STATE includes the following fields:

```
** Structure !ERROR_STATE, 8 tags, length=112, data length=108:
   NAME            STRING    'IDL_M_SUCCESS'
   BLOCK           STRING    'IDL_MBLK_CORE'
   CODE            LONG                 0
   SYS_CODE        LONG      Array[2]
   SYS_CODE_TYPE   STRING    ''
   MSG             STRING    ''
   SYS_MSG         STRING    ''
   MSG_PREFIX      STRING    '% '
```

- NAME: A read-only string variable containing the error name of the IDL-generated component of the last error message.
- BLOCK: A read-only string variable containing the name of the message block for the last error message's IDL-generated component.

  **Note**

  See the *External Development Guide* for more information about blocks.

- CODE: A long-integer variable containing the error code of the last error's IDL-generated component.
- SYS_CODE: A long-integer variable containing the error code of the last error's operating system-generated component, if it exists.

  For historical reasons, SYS_CODE is a two-element longword array. The first element of the array (that is, SYS_CODE[0]) contains the OS-defined error code. The second element of the array is not used, and always contains zero.

Either !ERROR_STATE.SYS_CODE or !ERROR_STATE.SYS_CODE[0] will return the relevant error code.

- SYS_CODE_TYPE: A string describing the type of system code contained in SYS_CODE. A null string in this field indicates that there is no system code corresponding to the current error. The possible non-NULL values are:

| Value | Meaning |
|---|---|
| errno | Unix/Posix system error |
| win32 | Microsoft Windows Win32 system error |
| winsock | Microsoft Windows sockets library error |

*Table D-1: SYS_COD_TYPE Values*

- MSG: A read-only string variable containing the text of the last IDL-generated error message.
- SYS_MSG: A read-only string variable containing the text of the last error's operating system-generated component, if it exists.
- MSG_PREFIX: A string variable containing the prefix string used for error messages.

This system variable replaces !ERROR, !ERR_STRING, !MSG_PREFIX, !SYSERR_STRING, and !SYSERROR, and includes two new fields: error name and block name. For a more detailed explanation of !ERROR_STATE, see "Error Handling" in Chapter 18 of the *Building IDL Applications* manual.

# !ERROR

*This system variable is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !ERROR system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.CODE.*

# !ERR_STRING

*This system variable is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !ERR_STRING system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.MSG.*

# !EXCEPT

An integer variable that controls when IDL checks for invalid mathematical computations (exceptions), such as division by zero. The three allowed values are:

| Value | Description |
|---|---|
| 0 | Never report exceptions. |
| 1 | Report exceptions when the interpreter is returning to an interactive prompt (the default). |
| 2 | Report exceptions at the end of each IDL statement. Note that this slows IDL by roughly 5% compared to setting !EXCEPT=1. |

*Table D-2: EXCEPT Values*

For more information on invalid mathematical computations and error reporting, see "Math Errors" in Chapter 18 of the *Building IDL Applications* manual.

The value of !EXCEPT is used by the CHECK_MATH function to determine when to return errors. See "CHECK_MATH" on page 226 for details.

**Note**

In versions of IDL up to and including IDL 4.0.1, the default exception handling was functionally identical to setting !EXCEPT=2.

# !MOUSE

A structure variable that contains the status from the last cursor read operation. !MOUSE has the following fields:

```
** Structure !MOUSE, 4 tags, length=16:
   X               LONG               511
   Y               LONG               252
   BUTTON          LONG                 4
   TIME            LONG        1428829775
```

- X and Y: Contain the location (in device coordinates) of the cursor when the mouse button was pressed.
- BUTTON: Contains
  - 1 (one) if the left mouse button was pressed,

- 2 (two) if the middle mouse button was pressed
- 4 (four) if the right mouse button was pressed.

- TIME: Contains the number of milliseconds since a base time.

See "CURSOR" on page 344 for details on reading the cursor position.

## !MSG_PREFIX

*This keyword is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !MSG_PREFIX system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.MSG_PREFIX.*

## !SYSERROR

*This keyword is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !SYSERROR system variable will continue to function as before, but we suggest that all new code use !ERROR_STATE.SYS_CODE.*

## !SYSERR_STRING

*This keyword is now obsolete and has been replaced by the !ERROR_STATE system variable. Code that uses the !*SYSERR_STRING *system variable will continue to function as before, but we suggest that all new code use !ERROR_*STATE.SYS_MSG*.*

## !WARN

A structure variable that causes IDL to print warnings to the console or command log when obsolete IDL features are found at compile time. !WARN has the following fields:

```
** Structure !WARN, 3 tags, length=3:
   OBS_ROUTINES         BYTE         0
   OBS_SYSVARS          BYTE         0
   PARENS               BYTE         0
```

Setting each of the three fields to 1 (one) generates a warning for a different type of obsolete code. If the OBS_ROUTINES field is set equal to one, IDL generates warnings when it encounters references to obsolete internal or library routines. If the OBS_SYSVARS field is set equal to one, IDL generates warnings when it encounters references to obsolete system variables. If the PARENS field is set equal to one, IDL generates warnings when it encounters a use of parentheses to specify an index into an array.

No warnings are generated when the fields of the !WARN structure are set equal to zero (the default).

# IDL Environment System Variables

The following system variables contain information about IDL's configuration.

## !CPU

IDL can use multiple system processors to perform some computations in parallel. See Chapter 14, "Multithreading in IDL" in the *Building IDL Applications* manual for additional information.

The !CPU system variable supplies information about the state of the system processor, and of IDL's use of it. !CPU is readonly, and cannot be modified directly. Use the CPU procedure to modify values contained in !CPU.

The !CPU structure is defined as follows:

```
{ !CPU, HW_VECTOR:0L, VECTOR_ENABLE:0L, HW_NCPU:0L,
  TPOOL_NTHREADS:0L, TPOOL_MIN_ELTS:0L, TPOOL_MAX_ELTS:0L }
```

The meaning of the fields of !CPU are given in the following table.!

| Field | Meaning |
|---|---|
| HW_VECTOR | True (1) if the system supports a vector unit (e.g. Macintosh Altivec/Velocity Engine). False (0) otherwise.<br>**Note -** This value is currently always 0 (False) on platforms other than Macintosh. |
| VECTOR_ENABLE | True (1) if IDL will use a vector unit, if such a unit is available on the current system, and False (0) otherwise.<br>**Note -** This value is currently always 0 (False) on platforms other than Macintosh. |
| HW_NCPU | The number of CPUs contained in the system on which IDL is currently running. |

*Table D-3: Meaning of !CPU fields*

| Field | Meaning |
|---|---|
| TPOOL_NTHREADS | The number of threads that IDL will use in thread pool computations. The default is to use HW_NCPU threads, so that each thread will have the potential to run in parallel with the others. For numerical computation, there is no benefit to using more threads than your system has CPUs. However, depending on the size of the problem and the number of other programs running on the system, there may be a performance advantage to using fewer CPUs. |
| TPOOL_MIN_ELTS | The number of elements in a computation that are necessary before IDL will use the thread pool to perform the work. For fewer than TPOOL_MIN_ELTS, the main IDL thread will simply perform the work without using the thread pool. It is important not to use the thread pool for small tasks because the overhead of threading will not be offset by the overhead incurred by operation of the pool, and the overall computation will go slower than if threading is not used. |
| TPOOL_MAX_ELTS | The maximum number of elements in a computation for which IDL will use the thread pool. If this value is 0 (zero) (the default), then no limit is imposed and any computation with at least TPOOL_MIN_ELTS is a candidate for the thread pool. If your computation is too large for the physical memory available on the system, the virtual memory system of the operating system will begin paging. Under such conditions, the performance of the thread pool can be worse than that of a single threaded computation because the threads end up fighting each other for access to memory. TPOOL_MAX_ELTS can be used to prevent this. |

*Table D-3: Meaning of !CPU fields (Continued)*

## !DIR

A string variable containing the path to the main IDL directory.

# !DLM_PATH

Significant portions of IDL's built in functionality are packaged in the form of Dynamically Loadable Modules (DLMs). DLMs correspond to UNIX sharable libraries or Windows DLLs, depending on the operating system in use. At startup, IDL searches for DLM definition files (which end in the `.dlm` suffix) and makes note of the routines supplied by each DLM. If such are routine is called, IDL loads the DLM that supplies it into memory. To see a list of the DLMs that IDL knows about, use `HELP, /DLM` (see "HELP" on page 800 for more information).

!DLM_PATH is initialized from the environment variable IDL_DLM_PATH at startup. This initialization is similar to that performed for IDL_PATH, (see "!PATH" on page 3909), including recursive path expansion denoted with a leading "+" but *not* including any use of IDLDE preferences settings. See "Environment Variables Used by IDL" in Chapter 1 of the *Using IDL* manual for details on setting the IDL_DLM_PATH environment variable.

If the IDL_DLM_PATH environment variable is not defined, IDL supplies a default that contains the directory in the IDL distribution where the DLMs supplied by RSI reside. Once !DLM_PATH is expanded, IDL uses it as the list of places to look for DLM definition files.

Since all DLM searching happens once at startup time, it would be meaningless to change the value of !DLM_PATH afterwards. For this reason, it is a read-only system variable and cannot be assigned to. The value of !DLM_PATH is useful because it shows you where IDL looked for DLMs when it started.

## Using Path Definition Tokens to Load a DLM Path

Note that using the `<IDL_BIN_DIRNAME>` token in the IDL_DLM_PATH environment variable can be useful for distributing packages of DLMs with support for multiple operating system and hardware combinations. This token is described in "The Path Definition String" under EXPAND_PATH.

For example, assume that you have your DLMs installed in `/usr/local/mydlm`, with support for each platform in a subdirectory using the same naming convention that IDL uses for the platform dependant subdirectories underneath the bin directory of the IDL distribution. The following line, which might be located in a file executed by a UNIX shell when you log in (`.cshrc`, `.login`), will add the location of the proper DLM for your current system to IDL's !DLM_PATH at startup:

```
% setenv IDL_DLM_PATH
"/usr/local/mydlm/<IDL_BIN_DIRNAME>:<IDL_DEFAULT>"
```

(all on a single line). Setting the Windows environment variable IDL_DLM_PATH to a similar string would produce the same result on a Windows system.

Similarly, the `<IDL_VERSION_DIRNAME>` token can be useful for distributing packages of DLMs with support for multiple IDL versions, operating systems, and hardware platforms. This token is described in "The Path Definition String" under EXPAND_PATH.

For example, assume that you have your DLMs installed in `/usr/local/mydlm`. Within the `mydlm` subdirectory would be a directory for each supported version of IDL. Within each of those subdirectories would be a subdirectory for each operating system and hardware combination supported by that version of IDL. The following line, which might be located in a file executed by your shell when you log in (`.cshrc`, `.login`) will add the location of the proper DLM for your current system to IDL's !DLM_PATH at startup:

```
% setenv IDL_DLM_PATH
"/usr/local/mydlm/<IDL_VERSION_DIRNAME>/<IDL_BIN_DIRNAME>:<IDL_DEFAULT>"
```

(all on a single line). Setting the Windows environment variable IDL_DLM_PATH to a similar string would produce the same result on a Windows system.

## !EDIT_INPUT

An integer variable indicating whether keyboard line editing is enabled (when set to a non-zero value) or disabled (when set to zero). By default, !EDIT_INPUT is set equal to one, and line editing is enabled.

By default, IDL saves the last 20 command lines. You can change the number of command lines saved in the recall buffer by setting !EDIT_INPUT equal to the number of lines you would like to save. In order for the change to take effect, IDL must be able to process the assignment statement before providing a command prompt. This means that you must put the assignment statement in the IDL startup file. (See "Startup Files" in Chapter 1 of the *Using IDL* manual for more information on startup files.)

## !HELP_PATH

A string variable listing the directories IDL will search for online help files. On UNIX systems, help files must be Adobe Portable Document Format (`.pdf`) files or HTML (`.html` or `.htm`) files. On Windows systems, help files can be HTML Help (`.chm`), Windows Help (`.hlp`), Portable Document Format (`.pdf`), or HTML (`.html` or `.htm`) files.

!HELP_PATH is initialized from the environment variable IDL_HELP_PATH at startup. This initialization is similar to that performed for IDL_PATH (see "!PATH" on page 3909), including recursive path expansion denoted with a leading "+" but *not* including any use of IDLDE preferences settings. See "Environment Variables Used by IDL" in Chapter 1 of the *Using IDL* manual for details on setting the IDL_HELP_PATH environment variable

If the IDL_HELP_PATH environment variable is not defined, IDL supplies a default that contains the directory in the IDL distribution where the help files supplied by RSI reside.

To change the value of !HELP_PATH for the duration of an IDL session, simply set the variable equal to a new string containing the desired path. See "Changing the Value of !PATH After IDL Starts" on page 3910 for tips that also apply to setting the value of !HELP_PATH.

# !JOURNAL

A read-only long-integer variable containing the logical unit number of the file used for journal output.

# !MAKE_DLL

The MAKE_DLL procedure and the CALL_EXTERNAL function's AUTO_GLUE keyword use the standard system C compiler and linker to generate sharable libraries that can be used by IDL in various contexts (CALL_EXTERNAL, DLMs, LINKIMAGE). There is a great deal of variation possible in the use of these tools between different platforms, operating system versions, and compiler releases. The !MAKE_DLL system variable is used to configure how IDL uses them for the current platform.

The !MAKE_DLL structure is defined as follows:

```
{ !MAKE_DLL, COMPILE_DIRECTORY:'', COMPILER_NAME:'', CC:'', LD:''}
```

The meaning of the fields of !MAKE_DLL are given in the following table. When expanding !MAKE_DLL.CC and !MAKE_DLL.LD, IDL substitutes text in place of the PRINTF style codes described in the following table. These codes are case-insensitive, and can be either upper or lower case.

It is possible to use C compilers other than the one assumed by RSI in !MAKE_DLL to build sharable libraries. To do so, you can alter the contents of !MAKE_DLL or use the CC and/or LD keyword to MAKE_DLL and CALL_EXTERNAL. Please understand that RSI cannot and does not maintain a list of all possible compilers and the necessary compiler options. This information is available in your compiler and

system documentation. It is the programmers responsibility to understand the rules for their chosen compiler.

| Field | Meaning |
|---|---|
| COMPILE_DIRECTORY | IDL requires a place to create the intermediate files necessary to build a sharable library, and possibly the final library itself. Unless told to use an explicit directory, it uses the directory given by the COMPILE_DIRECTORY field of !MAKE_DLL. If the IDL_MAKE_DLL_COMPILE_DIRECTORY environment variable is set, IDL uses its value to initialize the COMPILE_DIRECTORY field. Otherwise, IDL supplies a standard location.<br>**Note -** If the directory given by !MAKE_DLL.COMPILE_DIRECTORY does not exist when IDL needs it, IDL automatically creates it for you if possible. |
| COMPILER_NAME | A string containing the name of the C compiler used by RSI to build the currently running IDL. This field is not used by IDL, and exists solely for informational purposes and to help the end user decide which C compiler to install on their system. |
| CC | A string used by IDL as a template to construct the command for using the C compiler. This template uses PRINTF style substitution codes, as described in the following table. |
| LD | A string used by IDL as a template to construct the command for using the linker. This template uses PRINTF style substitution codes, as described in the following table. |

*Table D-4: Meaning of !MAKE_DLL Fields*

The following table describes the substitution codes for the CC and LD fields:

| Code | Meaning |
|---|---|
| %B %b | The base name of a C file to compile. For example, if the C file is `moose.c`, then %B substitutes `moose`. |
| %C %c | The name of the C file. |
| %E %e | The name of the linker options file. This file, which is automatically generated by IDL as needed, is used to control the linker. Under UNIX, the system documentation refers to this as an export file, or a linker map file. Microsoft Windows calls it a `.DEF` file. |
| %F %f | This substitution code is no longer meaningful, and will be ignored. |
| %L %l | The name of the resulting sharable library. IDL constructs this name by using the base name (%B) and adding the appropriate suffix for the current platform (`.dll`, `.so`, `.sl`, `.exe`, ...). |
| %O %o | An object file name. IDL constructs this name by using the base name (%B) and adding the appropriate suffix for the current platform (`.o`, `.obj`). |
| %X %x | When expanding !MAKE_DLL.CC, any text supplied via the EXTRA_CFLAGS keyword to MAKE_DLL or CALL_EXTERNAL is inserted in place of %X. IDL does not interpret this text. It is the users responsibility to ensure that it is meaningful in the command. When expanding !MAKE_DLL.LD, the text from the EXTRA_LFLAGS keyword is substituted. The primary use for this code is to include necessary header include directories and link libraries. |
| %% | Replaced with a single % character. |

*Table D-5: Description of CC and LD Field Codes*

# !MORE

An integer variable indicating whether IDL should paginate help output sent to a tty device. Setting !MORE to zero (0) prevents IDL from paginating the output text. A non-zero value (the default) causes IDL to display output text one screen at a time.

# !PATH

A string variable listing the directories IDL will search for libraries, include files, and executive commands.

**Note**

The current directory is always searched before consulting !PATH.

!PATH is initialized from the environment variable IDL_PATH when IDL starts. See "Environment Variables Used by IDL" in Chapter 1 of the *Using IDL* manual for details on setting the IDL_PATH environment variable.

**Note**

If the IDL_PATH environment variable does not exist, IDL uses the value set in the **Path** tab of the **Preferences** dialog of the IDLDE. If no preference value is set, or if you are using the UNIX command-line interface rather than the IDLDE, IDL uses a default value in order to initialize !PATH.

## Note on Path Expansion

When IDL starts, it reads the IDL_PATH environment variable (or the default value, if IDL_PATH does not exist) and builds a value to be stored in !PATH from the specified initialization value. While the initialization value can consist of a normal path string specifying all directories to be included in !PATH, it can also take advantage of several special values that IDL uses to dynamically create the value of !PATH. These values (the "+" symbol and the "<IDL_*>" strings) are described in detail in "The Path Definition String" under "EXPAND_PATH" in the *IDL Reference Guide* manual.

## Path Caching

By default, as IDL searches directories included in the !PATH system variable for `.pro` or `.sav` files to compile, it creates an in-memory list of *all* `.pro` and `.sav` files contained in each directory. When IDL later searches for a `.pro` or `.sav` file, before attempting to open the file in a given directory, IDL checks the path cache to determine whether the directory has already been cached. If the directory is included in the cache, IDL uses the cached information to determine whether the file will be found in that directory, and will only attempt to open the file there if the cache tells it that the file exists. By eliminating unnecessary attempts to open files, the path cache speeds the path searching process. See "PATH_CACHE" in the *IDL Reference Guide* manual for details.

### Changing the Value of !PATH After IDL Starts

Once IDL has started, you can alter the value of !PATH by setting it to a new string value. For example, on a UNIX system, to add a directory to !PATH for the duration of an IDL session, you would use a command like the following:

```
!PATH = '/usr2/project/idl_files:' + !PATH
```

Keep the following in mind when changing the value of !PATH by setting its value to a new string:

- Remember to use the proper path string separator character for your platform. If you are writing a cross-platform application that changes !PATH, you may want to use code that looks something like this:

  ```
  pathsep = PATH_SEP(/SEARCH_PATH)
  !PATH = 'new_path' + pathsep + !PATH
  ```

  where *new_path* is the path to the directory you want to add.

- You can use the EXPAND_PATH function to generate a path string. This method allows you to specify one or more directories and let IDL figure out whether those directories contain `.pro` or `.sav` files. It also allows you to use the "+" character path expansion technique. For example, the following commands add all directories below the *new_path* directory that contain `.pro` or `.sav` files to !PATH:

  ```
  pathsep = PATH_SEP(/SEARCH_PATH)
  !PATH = EXPAND_PATH('+new_path') + pathsep + !PATH
  ```

  See "EXPAND_PATH" in the *IDL Reference Guide* manual for details.

## !PROMPT

A string variable containing the text string used by IDL to prompt the user for input. The default is `IDL>`.

## !QUIET

A long-integer variable indicating whether informational messages should be printed (0) or suppressed (nonzero). By default, !QUIET is set to zero.

## !VERSION

A structure variable containing information about the version of IDL in use. The structure is defined as follows:

```
{ !VERSION, ARCH:'', OS:'', OS_FAMILY:'', OS_NAME:'', $
   RELEASE:'', BUILD_DATE:'', MEMORY_BITS:0, FILE_OFFSET_BITS:0 }
```

The meaning of the fields of !VERSION are given in the following table.

| Field | Meaning |
|---|---|
| ARCH | CPU hardware architecture of the system. |
| OS | The vendor name of the operating system (for example: AIX, HP-UX, IRIX, linux, MacOS, OSF, sunos, Win32). This is the name of the underlying operating system kernel (not necessarily of the overall operating environment: see OS_NAME). Once an OS name is assigned to a platform by RSI, it is not altered in subsequent releases. This makes it safe for use in IDL programs that need to distinguish between platforms. RSI recommends that you first consider using the OS_FAMILY field before using the OS field, as most programs are mainly concerned with high level platform differences. |
| OS_FAMILY | The generic name of the operating system (UNIX, Windows). RSI recommends that whenever possible this field (rather than OS or OS_NAME) be used in code that must distinguish between platforms. |
| OS_NAME | The vendor's name for the operating system environment, as used by the vendor for casual descriptive and promotional purposes. For example, on Sun workstations, the name of the operating system kernel (!VERSION.OS) is "sunos", whereas the name of the overall system (!VERSION.OS_NAME) is "Solaris". Vendors change their descriptive environment names from time to time, and RSI updates the OS_NAME field to reflect this. As a result, RSI recommends that IDL users restrict their use of this field to descriptive textual uses, and that the OS_FAMILY or OS fields of !VERSION be used in code that must distinguish between platforms. |
| RELEASE | IDL version number. |

*Table D-6: Meaning of the !VERSION Fields*

| Field | Meaning |
|---|---|
| BUILD_DATE | The date the IDL executable was compiled, in the format dictated by ANSI C for the `__DATE__` macro. |
| MEMORY_BITS | The number of bits used to address memory. Possible values are 32 or 64. The number of bits used to address memory places a theoretical upper limit on the amount of memory available to IDL. |
| FILE_OFFSET_BITS | The number of bits used to position file offsets. Possible values are 32 or 64. The number of bits used to position files places a theoretical upper limit on the largest file IDL can access. |

*Table D-6: Meaning of the !VERSION Fields*

If you need to differentiate between different IDL versions in your code, use !VERSION.OS_FAMILY. At present, two operating system families are supported: UNIX and Windows. For even more detail, you can use !VERSION.OS.

# Graphics System Variables

The following system variables control various IDL Direct Graphics functions. These system variables are structures that contain many tags. For example, the command

```
!P.TITLE = 'Cross Section'
```

sets the default plot title.

Many of the functions of the graphics keywords described in Appendix B, “Graphics Keywords”, are also controlled by the system variables !P, !X, !Y, and !Z.

You can change the default style of plots, fonts, etc., by setting the corresponding field in the appropriate system variable. Also, some effects that persist longer than one call are controlled only by system variables. The field !P.MULTI is one example.

## !C System Variable

The cursor system variable. Currently, the only function of this system variable is to contain the subscript of the largest or smallest element found by the MAX and MIN functions. That information is better obtained through the optional output arguments to those routines. !C is included only for compatibility with old versions of IDL.

## !D System Variable

This system variable is a structure that contains information about the current graphics output device (or window, on a windowing system). Fields, in alphabetical order, are:

### FILL_DIST

The line interval, in device coordinates, required to obtain a solid fill.

## FLAGS

A longword of flags that provide information about the current device. Each bit is a flag encoded as shown in the following table.

| Bit | Value | Function |
|---|---|---|
| 0 | 1 | Device has scalable pixel size (e.g., PostScript). |
| 1 | 2 | Device can output text at an arbitrary angle using hardware. |
| 2 | 4 | Device can control line thickness with hardware. |
| 3 | 8 | Device can display images. |
| 4 | 16 | Device supports color. |
| 5 | 32 | Device supports polygon filling with hardware. |
| 6 | 64 | Device hardware characters are monospace. |
| 7 | 128 | Device can read pixels (i.e., it supports TVRD). |
| 8 | 256 | Device supports windows. |
| 9 | 512 | Device prints black on a white background (e.g., printers are plotters). |
| 10 | 1024 | Device has *no* hardware characters. |
| 11 | 2048 | Device does line-fill style polygon filling in hardware. |
| 12 | 4096 | Device will apply Hershey-style embedded formatting commands to device fonts. |
| 13 | 8192 | Device is a pen plotter. |
| 14 | 16384 | Device can transfer 16-bit pixels. |
| 15 | 32768 | Device supports Kanji characters. |
| 16 | 65536 | Device supports widgets. |
| 17 | 131072 | Device has Z-buffer. |
| 18 | 262144 | Device supports TrueType fonts. |

*Table D-7: !D.FLAGS Bit Definitions*

To test whether a particular bit is set on your system, use an IDL command like the following:

```
IF (!D.FLAGS AND value) NE 0 THEN PRINT, 'Bit is set.'
```

where value is the value associated with the bit you wish to examine. For example, to check whether the device supports color, use:

```
IF (!D.FLAGS AND 16) NE 0 THEN PRINT, 'Bit is set.'
```

## N_COLORS

The number of allowed color values. In the case of devices with windows, this field is set after the window system is initialized. For a monochrome system, !D.N_COLORS is 2. For TrueColor displays, !D.N_COLORS is 2^24-1 (roughly 16.7 million colors).

## NAME

A string containing the name of the device.

## ORIGIN

A two-element integer array containing the current pan/scroll offset. An offset of (0, 0) is normal. Positive offsets shift the display memory to the right and upwards. This field has relevance only with devices with hardware pan and scroll abilities.

## TABLE_SIZE

The number of color table indices.

**Note**

For TrueColor visuals, !D.TABLE_SIZE will always be 256. If the visual depth is less than 24 bits, IDL emulates 256 entries.

## UNIT

The logical number of the file open for output by the current graphics device. This field only has meaning for devices that write to a file if the file is accessible to the user from IDL, and is 0 if no file is open.

For example, the PostScript driver fills this field with the unit number of the file open for PostScript output. In the case of Tektronix output to a file, !D.UNIT may be set to either + or – the logical unit number.

## WINDOW

The index of the currently open window. This field is set to -1 if no window is currently open. This field is used only with devices that support windows.

## X_CH_SIZE, Y_CH_SIZE

The width and height of the rectangle that encloses the “average” character in the current font, in device units (usually pixels).

These values describe the size of the rectangle that contains the “average” character in the current font. (It is not important what the “average” character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The first element specifies the width of the rectangle in device units (usually pixels), and the second element specifies the height.

For vector and TrueType fonts, the height of the “average” character is determined by the *width* of the rectangle. The aspect ratio of the “average” character remains fixed; the character is scaled so that its width is the value of X_CH_SIZE. The resulting scale factor is then applied to all of the characters in the font. The amount of spacing between lines is determined explicitly by the value of Y_CH_SIZE.

For device fonts, the character size is fixed. When the device font system is in use, the value of X_CH_SIZE is silently ignored, and only the Y_CH_SIZE value is used.

## X_PX_CM, Y_PX_CM

The approximate number of pixels per centimeter in the X and Y directions.

## X_SIZE, Y_SIZE

The total size of the display or window in the X and Y directions, in device units.

## X_VSIZE, Y_VSIZE

The size of the visible area of the display or window. This area can be smaller than the total size fields.

## ZOOM

This field contains the current X and Y zoom factors for the display or window. This field has relevance only with devices equipped with hardware zoom. A zoom factor of [1, 1] is normal.

# !ORDER System Variable

Controls the direction of image transfers when using the TV, TVSCL, and TVRD procedures. If !ORDER is 0, images are transferred from bottom to top, i.e. the row with a 0 subscript is written on the bottom. Setting !ORDER to 1, transfers images from top to bottom.

# !P System Variable

The main plotting system variable structure. All fields, except !P.MULTI, have a directly corresponding keyword parameter in the plot procedures: PLOT, OPLOT, CONTOUR, and SURFACE. Fields, in alphabetical order, are:

## BACKGROUND

The background color index. When erasing the screen or page, all pixels are set to this color. The default value is 0. Not all devices support this feature.

## CHANNEL

The default source or destination channel. This field has meaning only on graphics devices that contain multiple display channels, and is device dependent. It may contain either a channel mask or index.

## CHARSIZE

The overall character size of all annotations when Hershey fonts are selected. This field has no effect on the character size when hardware (device) fonts are selected, except for devices that support scalable pixel sizes (i.e., Postscript). Note, however, that !P.CHARSIZE always affects the layout and scaling of a plot, regardless of the font system being used. The default size is 1.0.

## CHARTHICK

An integer specifying the thickness of the lines used to draw the characters when using the vector drawn fonts. This field has no effect on the appearance of characters drawn with the hardware fonts. Normal thickness is 1.

## CLIP

The device coordinates of the clipping window, a 6-element vector of the form $[x_0, y_0, x_1, y_1, z_0, z_1]$, specifying two opposite corners of the volume to be displayed. In the case of two-dimensional displays, the Z coordinates can be omitted. Normally, the clipping window coordinates are implicitly set by PLOT, CONTOUR,

SHADE_SURF, and SURFACE to correspond to the plot window. You may also manually set !P.CLIP if you want to specify a different rectangular clipping window or if the clipping coordinates have not yet been set in the current IDL session.

## COLOR

The default color index.

## FONT

An integer that specifies the graphics text font system to use. Set FONT equal to -1 to selects the Hershey character fonts, which are drawn using vectors. Set FONT equal to 0 (zero) to select the device font of the output device. Set FONT equal to 1 (one) to select the TrueType font system. See Appendix H, “Fonts”, for a complete description of IDL’s font systems.

## LINESTYLE

The default style of the lines used to connect points. A line style index of 0 yields a solid line. See “LINESTYLE” on page 3875 for a description of the linestyles.

## MULTI

!P.MULTI allows making multiple plots on a page or screen. It is a 5-element integer array defined as follows:

!P.MULTI[0] contains the number of plots remaining on the page. If !P.MULTI[0] is less than or equal to 0, the page is cleared, the next plot is placed in the upper left hand corner, and !P.MULTI[0] is reset to the number of plots per page.

Setting !P.MULTI[0] to a value greater than zero can be used to manually set the plotting area to a specific row and column. For example, to plot in the lower left corner of a window of two rows and two columns, set !P.MULTI as follows:

```
!P.MULTI=[2,2,2]
PLOT, X, Y
```

!P.MULTI[1] is the number of plot columns per page. If this value is less than or equal to 0, one is assumed. If more than two plots are ganged in either the X or Y direction, the character size is halved.

!P.MULTI[2] is the number of rows of plots per page. If this value is less than or equal to 0, one is assumed.

!P.MULTI[3] contains the number of plots stacked in the Z dimension.

!P.MULTI[4] is 0 to make plots from left to right (column major), and top to bottom, and is 1 to make plots from top to bottom, left to right (row major).

**Note**

If !P.MULTI[0] is zero, an erase will occur before the current plot is displayed (unless the /NOERASE keyword is set). This is true no matter whether !P.POSITION and/or !P.REGION are set.

For example, to gang two plots across the page:

```
!P.MULTI = [0, 2, 0, 0, 0]
PLOT, X0, Y0                    ;Make left plot.
PLOT, X1, Y1                    ;Right plot.
```

To gang two plots vertically:

```
!P.MULTI = [0, 0, 2, 0, 0]
PLOT, X0, Y0                    ;Make top plot.
PLOT, X1, Y1                    ;Bottom plot.
```

To make four plots per page, two across and two up and down:

```
!P.MULTI = [0, 2, 2, 0, 0]
```

and then call plot four times.

To reset !P.MULTI back to the normal one plot per page:

```
!P.MULTI = 0
```

## NOCLIP

A field which, if set, inhibits the clipping of the graphic vectors and vector-drawn text. By default, most routines clip to the plotting window, with the exception of PLOTS and XYOUTS. !P.CLIP contains the clipping rectangle.

## NOERASE

Set this field to a non-zero value to inhibit erasing the screen before plotting.

## NSUM

The number of adjacent points to average to obtain a plotted point.

## POSITION

Specifies the normalized coordinates of the rectangular plot window. This is a four element floating point vector $(x_0, y_0, x_1, y_1)$, where $(x_0, y_0)$ is the origin, and $(x_1, y_1)$ is the upper right corner.

!P.POSITION determines the plotting window if $x_0$ does not equal $x_1$, and the POSITION keyword is not present. If set, it overrides the effect of the MARGIN and !P.MULTI variables and keywords.

**Note**

If !P.POSITION (or the POSITION keyword) or !P.REGION is set, all but the first element of !P.MULTI are ignored.

## PSYM

The default plotting symbol index. Each point drawn by PLOT, PLOTS, and OPLOT is marked with a symbol if this field is non-zero. The possible symbols are given in "PSYM" on page 3878.

## REGION

A four element vector that specifies the normalized coordinates of the rectangle enclosing the plot region, which includes the plot data window and its surrounding annotation area. It is in the same form as !P.POSITION, $(x_0, y_0, x_1, y_1)$, where $(x_0, y_0)$ is the origin, and $(x_1, y_1)$ is the upper right corner. It is ignored if !P.REGION[0] is equal to !P.REGION[2].

**Note**

!P.POSITION (or the POSITION keyword) takes precedence over !P.REGION.

## SUBTITLE

The plot subtitle, placed under the X axis label.

## T

Contains the homogeneous 4 x 4 transformation matrix. This field is a two-dimensional array of double-precision floating-point values. For more information about transformations, refer to "Three-Dimensional Graphics" in Chapter 18 of the *Using IDL* manual.

## T3D

Enables the three-dimensional to two-dimensional transformation contained in the homogeneous 4 by 4 matrix !P.T. Note that if T3D is set, !P.T must contain a valid transformation matrix.

### THICK

The thickness of the lines connecting points. 1.0 is normal.

### TITLE

The main plot title.

### TICKLEN

The length of the tick marks, expressed as a fraction of the plot size (from 0.0 to 1.0). The default is 0.02. A value of 0.5 makes a grid. Negative values make the tick marks point outward.

## !X, !Y, !Z System Variables

The system variables !X, !Y, and !Z, are structures of type AXIS, that affect the appearance and scaling of the three axes. The fields for !X, !Y, and !Z have identical fields with identical meanings and usage. In addition, almost all fields have corresponding keyword parameters, with identical function, but with temporary effect. For example, to suppress the minor tick marks on the X axis using the !X system variable, you could use the command:

```
!X.MINOR = -1
```

To suppress the tick marks for just one call to plot, you could use the command:

```
PLOT, X, Y, XMINOR = -1
```

The name of the keyword parameter is simply the name of the system variable field, prefixed with the letter X, Y, or Z.

The fields for these system variables, in alphabetical order are:

### CHARSIZE

The size of the characters used to annotate the axis and its title when Hershey fonts are selected. This field has no meaning when hardware (i.e. PostScript) fonts are selected. This field is a scale factor applied to the global scale factor. For example, setting !P.CHARSIZE to 2.0, and !X.CHARSIZE to 0.5 results in a character size of 1.0 for the X axis.

### CRANGE

The output axis range. Setting this variable has no effect; set ![XYZ].RANGE to change the range. ![XYZ].CRANGE[0]) always contains the minimum axis value,

and ![XYZ].CRANGE[1] contains the maximum axis value of the last plot before extending the axes.

**Note**

If the axis is logarithmic, the CRANGE field reports the log (base 10) of the minimum and maximum axis values.

Example 1:

```
;Create a 10-element array.
a = INDGEN(10)

;Plot the straight line.
PLOT, a

;Print the minimum and maximum axis values.
PRINT, !X.CRANGE
```

IDL prints:

```
0.00000      10.0000
```

Example 2:

```
;Plot a with logarithmic scaling on the X axis.
PLOT, a, /XLOG

;Print the minimum and maximum axis values.
PRINT, !X.CRANGE
```

The axis is scaled from $10^{-12}$ to $10^{2}$. IDL prints:

```
-12.0000      2.00000
```

## GRIDSTYLE

The index of the linestyle to be used for tick marks and grids. See “LINESTYLE” on page 3875 for a description of the linestyles

## MARGIN

A 2-element array specifying the margin on the left (bottom) and right (top) sides of the plot window, in units of character size. The plot window is the rectangular area that contains the plot data, i.e. the area enclosed by the axes.

The default values for !X.MARGIN are [10, 3] yielding a 10-character wide left margin and a 3-character wide right margin. The values for !Y.MARGIN are [4, 2], for a 4-character high bottom margin and a 2-character high top margin. While specifying !Z.MARGIN will not cause an error, Z margins are currently ignored.

When calculating the size and position of the plot window, IDL first determines the plot region, the area enclosing the window plus the axis annotation and titles. It then subtracts the appropriate margin from each side, obtaining the window.

Setting !P.POSITION, or specification of the POSITION parameter overrides the effect of this field.

## MINOR

The number of minor tick mark intervals. If !X.MINOR is 0, the default, the number of minor tick intervals is automatically determined from the tick mark increment. You can force a given number of minor tick intervals by setting this field to the desired number. To suppress minor tick marks, set !X.MINOR to -1.

## OMARGIN

A 2-element array specifying the “outer” margin on the left (bottom) and right (top) sides of a multi-plot window, in units of character size. A multi-plot window is created by setting the !P.MULTI system variable field. OMARGIN controls the amount of space around the entire plot area, including individual plot margins set with !X.MARGIN and !Y.MARGIN. The default values for !X.OMARGIN and !Y.OMARGIN are [0, 0].

When calculating the size and position of the individual plots, IDL first determines the plot region, the area enclosing the window plus the axis annotation and titles. It then subtracts the appropriate margin from each side, obtaining the window.

Setting !P.POSITION, or specification of the POSITION parameter overrides the effect of this field.

## RANGE

The input axis range, a 2-element vector. The first element is the axis minimum, and the second is the maximum. Set this field, or use the corresponding keyword parameter, to specify the data range to plot. If axis end point rounding is selected (see STYLE above), the final axis range may not be equal to this input range. The field !X.CRANGE contains the axis range used for the plot before extending the axes. Set both elements equal to 0 for automatic axis ranges:

```
!X.RANGE = 0
```

For example, to force the X axis to run from 5.5 to 8.3:

```
!X.RANGE = [5.5, 8.3]
PLOT, X, Y
```

Alternatively, by using keywords:

```
PLOT, X, Y, XRANGE=[5.5, 8.3]
```

Note that even though the range was set to (5.5, 8.3), the resulting plot has a range of (5.5, 8.5), because axis rounding is the default.

## REGION

Contains the normalized coordinates of the region. This field is similar to WINDOW, in that it is set by the graphics procedures and is a 2-element floating point array. To change the default plotting region, set !P.REGION.

## S

The scaling factors for converting between data coordinates and normalized coordinates (a 2-element array). The formula for conversion from data ($X_d$) to normalized ($X_n$) coordinates is $X_n = S_1 X_d + S_0$

If logarithmic scaling is in effect, substitute $\log_{10}(X_d)$ for $X_d$.

The CONVERT_COORD function can be used to convert between coordinate systems. The user should save and restore these fields when switching between windows or devices with different sizes and/or scaling.

## STYLE

The style of the axis encoded as bits in a longword. The axis style can be set to exact, extended, none, or no box using this field. The following table lists the axis style bit values:

| Bit | Value | Function |
|---|---|---|
| 0 | 1 | Exact. By default, the end points of the axis are rounded in order to obtain even tick increments. Setting this bit inhibits rounding, making the axis fit the data range exactly. |
| 1 | 2 | Extend. If this bit is set, the axes are extended by 5% in each direction, leaving a border around the data. |
| 2 | 4 | None. If this bit is set, the axis and its annotation are not drawn. |
| 3 | 8 | No box. Normally, PLOT and CONTOUR draw a box-style axis with the data window surrounded by axes. |
| 4 | 16 | Inhibits setting the Y axis minimum value to zero when the data are all greater than 0. The keyword YNOZERO sets this bit temporarily. |

*Table D-8: Axis Style Bit Values*

Note that this system variable field is set bitwise, so multiple effects can be set by adding values together. For example, to make an X axis that is both exact (value 1) and suppresses the box style (setting 8), set the !X.STYLE system variable to `1+8`, or 9.

For example, to set the Y axis style to exact using the !Y system variable:

```
!Y.STYLE = 1
```

or by using a keyword parameter:

```
PLOT, X, Y, YSTYLE = 1
```

## THICK

The thickness of the axis line. 1.0 is normal.

## TICKFORMAT

Set this field to a format string or a string containing the name of a function that returns a string to be used to format the axis tick mark labels.

See “[XYZ]TICKFORMAT” on page 3883 for more information.

## TICKINTERVAL

A scalar indicating the interval between major tick marks for the first axis level. This setting takes precedence over ![XYZ].TICKS.

For example, if !X.TICKUNITS=[“Seconds”, “Hours”, “Days”], and !X.TICKINTERVAL=30, then the interval between major ticks for the first axis level will be 30 seconds.

See “[XYZ]TICKINTERVAL” on page 3885 for more information.

## TICKLAYOUT

Set this keyword to a scalar that indicates the tick layout style to be used to draw each level of the axis.

See “[XYZ]TICKLAYOUT” on page 3886 for more information.

## TICKLEN

The lengths of tick marks (expressed in normal coordinates) for the individual axes.

## TICKNAME

The annotation for each tick. A string array of up to 60 elements. Setting elements of this array allows direct specification of the tick label. If this element contains a null string, the default value, IDL annotates the thick with its numeric value. Setting the element to a 1-blank string suppresses the tick annotation.

For example, to produce a plot with an abscissa labeled with the days of the week:

```
;Set up X axis tick labels.
!X.TICKNAME = ['SUN', 'MON', 'TUE', 'WED', $
    'THU', 'FRI', 'SAT']

;Use six tick intervals, requiring seven tick labels.
!X.TICKS = 6

;Plot the data, this assumes that Y contains 7 elements.
PLOT, Y
```

The same plot can be produced, using keyword parameters, with:

```
;Set fields, as above, only temporarily.
PLOT, Y, XTICKN = ['SUN', 'MON', 'TUE', 'WED',$
    'THU', 'FRI', 'SAT'], XTICKS = 6
```

## TICKS

The number of major tick intervals to draw for the axis. If !X.TICKS is set to 0, the default, IDL will select from three to six tick intervals. Setting this field to *n*, where *n* > 1, produces exactly *n* tick intervals, and *n*+1 tick marks. Setting this field equal to 1 suppresses tick marks.

## TICKUNITS

Set this keyword to a string (or a vector of strings) indicating the units to be used for axis tick labeling.

**Note**

The singular form of each of the time value strings is also acceptable (e.g, !X.TICKUNITS='Day' is equivalent to !X.TICKUNITS='Days').

**Note**

To set the ![XYZ].TICKUNITS field to a single string, the following approach is recommended:

```
!X.TICKUNITS = ''     ; Clear all previous tick unit strings.
!X.TICKUNITS = ['Days']  ;Single unit string in array.
```

The following:

```
!X.TICKUNITS = 'Days'
```

will copy the 'Days' string to all levels, resulting in a multi-level axis.

See “[XYZ]TICKUNITS” on page 3887 for more information.

## TICKV

An array of up to 60 elements containing the data values for each tick mark. You can directly specify the location of each tick by setting !X.TICKS to the number of tick marks (the number of intervals plus 1) and storing the data values of the tick marks in !X.TICKV. If, as is true by default, !X.TICKV[0] is equal to !X.TICKV[1], IDL automatically determines the value of the tick marks.

## TITLE

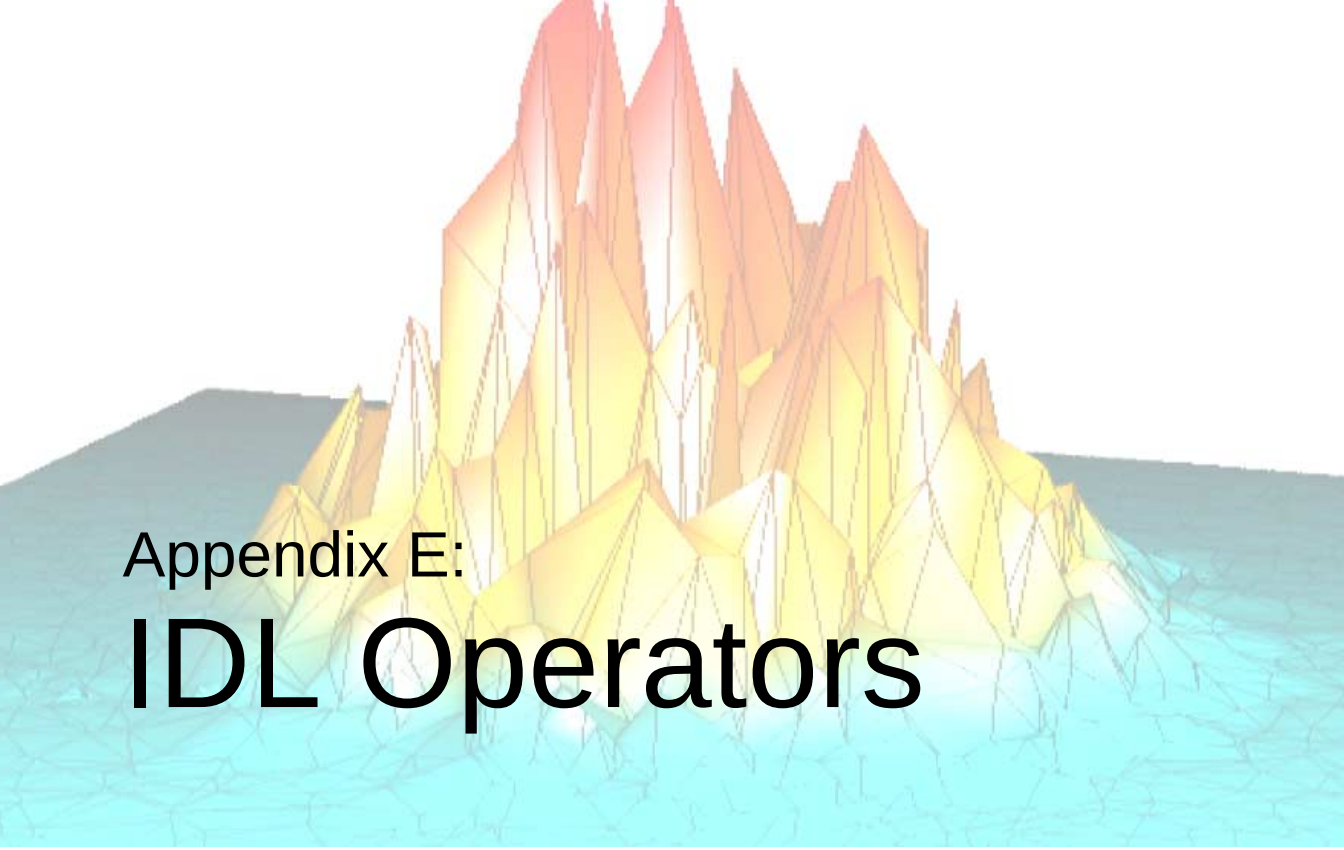
A string containing the axis title.

## TYPE

The type of axis, 0 for linear, 1 for logarithmic.

## WINDOW

Contains the normalized coordinates of the axis end points, the plot data window. This field is set by PLOT, CONTOUR, SHADE_SURF, and SURFACE. Changing its value has no effect. A 2-element floating point array. To change the default plotting window, set !P.POSITION. The keyword parameter POSITION sets the plot data window on a per call basis.



# Appendix E: IDL Operators

This appendix lists all IDL operators and provides brief examples of their usage. For more information on IDL operators, see Chapter 2, “Expressions and Operators” in the *Building IDL Applications* manual. The following topics are covered in this appendix:

# Mathematical Operators

| Operator | Description | Example |
|---|---|---|
| + | Addition | ;Store the sum of 3 and 6 in B:<br>B = 3 + 6 |
| | String Concatenation | ;Store the string value of "John Doe" in B:<br>B = 'John' + ' ' + 'Doe' |
| ++ | Increment | Adds one to the operand:<br>A = 3<br>A++<br>PRINT, A<br>IDL Prints:<br>4<br>**Note -** The increment operator supports both pre- and post-fix syntax. See "Increment/Decrement" in Chapter 2 of the *Building IDL Applications* manual. |
| – | Subtraction | ;Store the value of 5 subtracted from 9 in C:<br>C = 9 - 5 |
| | Negation | ;Change the sign of C:<br>C = -C |
| -- | Decrement | Subtracts one from the operand:<br>A = 3<br>A--<br>PRINT, A<br>IDL Prints:<br>2<br>**Note -** The decrement operator supports both pre- and post-fix syntax. See "Increment/Decrement" in Chapter 2 of the *Building IDL Applications* manual. |

*Table E-1: Mathematical Operators*

| Operator | Description | Example |
|---|---|---|
| * | Multiplication | `;Store the product of 2 and 5 in variable C:`<br>`C = 2 * 5` |
| | Pointer dereference | If `ptr` is a valid pointer (created via the PTR_NEW function), then `*ptr` is the value held by the heap variable that `ptr` points to. For more information on IDL pointers, see Chapter 8, "Pointers" in the *Building IDL Applications* manual. |
| / | Division | `;Store result of 10.0 divided by 3.2 in`<br>`;variable D:`<br>`D = 10.0/3.2` |
| ^ | Exponentiation | `;Store result of 2 raised to the 3rd power in`<br>`;variable B:`<br>`B = 2^3` |
| MOD | Modulo | `;Print the value of 9 modulo 5:`<br>`PRINT, 9 MOD 5`<br><br>IDL Prints:<br>`4` |

*Table E-1: Mathematical Operators (Continued)*

# Minimum and Maximum Operators

| Operator | Description | Example |
|---|---|---|
| < | Minimum operator. The value of "A < B" is equal to the smaller of A or B.<br>For complex numbers the absolute value is used. | ;Set A equal to 3.<br>A = 5 < 3<br><br>;Set all points in array ARR that are larger<br>;than 100 to 100:<br>ARR = ARR < 100<br><br>;Set X to the smallest of the three operands:<br>X = X0 < X1 < X2 |
| > | Maximum operator. "A > B" is equal to the larger of A or B.<br>For complex numbers the absolute value is used. | ;'>' is used to avoid taking the log of zero<br>;or negative numbers:<br>C = ALOG(D > 1E - 6)<br><br>;Plot positive points only. Negative points<br>;are plotted as zero:<br>PLOT, ARR > 0 |

*Table E-2: Minimum and Maximum Operators*

# Matrix Operators

| Operator | Description | Example |
|---|---|---|
| # | Computes array elements by multiplying the columns of the first array by the rows of the second array. | ;A 3-column by 2-row array:<br>array1 = [ [1, 2, 1], [2, -1, 2] ]<br>;A 2-column by 3-row array:<br>array2 = [ [1, 3], [0, 1], [1, 1] ]<br>PRINT, array1#array2<br><br>IDL prints:<br>7 -1 7<br>2 -1 2<br>3 1 3 |
| ## | Computes array elements by multiplying the rows of the first array by the columns of the second array. | ;A 3-column by 2-row array:<br>array1 = [ [1, 2, 1], [2, -1, 2] ]<br>;A 2-column by 3-row array:<br>array2 = [ [1, 3], [0, 1], [1, 1] ]<br>PRINT, array1##array2<br><br>IDL prints:<br>2 6<br>4 7 |

*Table E-3: Matrix Operators*

# Logical Operators

| Operator | Description | Example |
|---|---|---|
| && | Logical AND.<br>Returns 1 whenever both of its operands are true; otherwise, returns 0. Non-zero numerical values, non-null strings, and non-null heap variables (pointers and object references) are considered true, everything else is false.<br>Operands must be scalars or single-element arrays. The && operator *short-circuits*; the second operand will not be evaluated if the first is false. | `PRINT, 5 && 7`<br>IDL Prints: `1`<br><br>`PRINT, 5 && 2`<br>IDL Prints: `1`<br><br>`PRINT, 4 && 0`<br>IDL Prints: `0` |
| \|\| | Logical OR.<br>Returns 1 whenever either of its operands are true; otherwise, returns 0. Uses the same test for "truth" as the && operator.<br>Operands must be scalars or single-element arrays. The \|\| operator *short-circuits*; the second operand will not be evaluated if the first is true. | `IF ((5 GT 3) \|\| (4 GT 5)) THEN $`<br>`  PRINT, 'True'`<br><br>IDL Prints:<br>`True` |
| ~ | Logical negation.<br>Returns 1 when its operand is false; otherwise, returns 0.<br>Uses the same test for "truth" as the && operator. | `PRINT, ~ [1, 2, 0]`<br><br>IDL Prints:<br>`0  0  1` |

*Table E-4: Logical Operators*

# Bitwise Operators

| Operator | Description | Example |
|---|---|---|
| AND | Bitwise AND.<br>For integer, longword, and byte operands, a bitwise AND operation is performed. For operations on other types, the result is equal to the second operand if the first operand is not equal to zero or the null string; otherwise, the result is zero or the null string. | `PRINT, (5 GT 2) AND (4 GT 2)`<br>IDL Prints: `1`<br><br>`PRINT, (5 GT 2) AND (4 GT 5)`<br>IDL Prints: `0`<br><br>`PRINT, 5 AND 7`<br>IDL Prints: `5`<br><br>`PRINT, 5 AND 2`<br>IDL Prints: `0`<br><br>`PRINT, 4 AND 2`<br>IDL Prints: `0` |
| NOT | Bitwise complement.<br>For integer, longword, and byte operands, NOT returns the complement of each bit of the operand. For floating-point operands, the result is 1.0 if the operand is zero; otherwise, the result is zero. Not valid for string or complex operands. | `PRINT, NOT 1`<br><br>IDL Prints:<br>`-2`<br><br>`IF (NOT (5 GT 6)) THEN $`<br>`  PRINT, 'True'`<br><br>IDL Prints:<br>`True` |
| OR | Bitwise OR.<br>For integer or byte operands, a bitwise inclusive OR is performed. For floating- point operands, returns the first operand if it is non-zero, or the 2nd operand otherwise. | `IF ((5 GT 3) OR (4 GT 5)) THEN $`<br>`  PRINT, 'True'`<br><br>IDL Prints:<br>`True` |

*Table E-5: Logical Operators*

| Operator | Description | Example |
|---|---|---|
| XOR | Bitwise exclusive OR.<br>XOR is only valid for byte, integer, and longword operands. A bit in the result is set to 1 if the corresponding bits in the operands are different; if they are equal, it is set to zero. | `IF ((5 GT 3) XOR (4  GT 5)) THEN $`<br>`  PRINT, 'Different' $`<br>`  ELSE PRINT, 'Same'`<br><br>IDL Prints:<br>`Different` |

*Table E-5: Logical Operators (Continued)*

# Relational Operators

| Operator | Description | Example |
|---|---|---|
| EQ | Equal to | `;Determine if A equals B:`<br>`IF (A EQ B) THEN PRINT, 'True'` |
| GE | Greater than or equal to | `;Determine if A is greater than or equal`<br>`;to B:`<br>`IF (A GE B) THEN PRINT, 'True'` |
| GT | Greater than | `;Determine if A is greater than B:`<br>`IF (A GT B) THEN PRINT, 'True'` |
| LE | Less than or equal to | `;Determine if A is less than or equal`<br>`;to B:`<br>`IF (A LE B) THEN PRINT, 'True'` |
| LT | Less than | `; Determine if A is less than B:`<br>`IF (A LT B) THEN PRINT, 'True'` |
| NE | Not equal to | `; Determine if A does not equal B:`<br>`IF (A NE B) THEN PRINT, 'True'` |

*Table E-6: Relational Operators*

# Other Operators

| Operator | Description | Examples |
|---|---|---|
| [ ] | Array concatenation.<br>The expression `[A,B]` is an array formed by concatenating A and B. | `;Define C as three-point vector:`<br>`C = [0, 1, 3]`<br><br>`;Add 5 to the end of C:`<br>`PRINT, [C, 5]`<br>IDL Prints: `0 1 3 5`<br><br>`;Insert -1 at the beginning of C:`<br>`PRINT, [-1, C]`<br>IDL Prints: `-1 0 1 3` |
| | Enclose array subscripts | `A = [2, 1, 5]`<br>`;Print the 3rd element in A:`<br>`PRINT, A[2]`<br>IDL Prints: `5` |
| ( ) | Group expressions to control order of evaluation | `PRINT, 3 + 4 * 2 ^ 2 /2`<br>IDL Prints: `11`<br><br>`PRINT, (3 + (4 * 2) ^ 2 / 2)`<br>IDL Prints: `35` |
| = | Assignment | `;Assign 5 to variable A:`<br>`A = 5`<br><br>`;Assign "Hello World" to variable B:`<br>`B='Hello World'` |

*Table E-7: Other Operators*

| Operator | Description | Examples |
|---|---|---|
| *op*= | Compound Assignment where *op* is one of the following operators: ##, #, *, +, -, /, <, >, ^, AND, EQ, GE, GT, LE, LT, MOD, NE, OR, XOR | Applies the specified operation to the target variable "in place," without making a copy of the variable. For example,<br>`A += 5`<br>adds 5 to the value of the variable A.<br>**Note -**<br>`A op= expression`<br>is equivalent to:<br>`A = TEMPORARY(A) op (expression)`<br>See "Compound Assignment Operators" in Chapter 11 of the *Building IDL Applications* manual for details. |
| ?: | Conditional expression. For<br>*value=expr1 ? expr2 : expr3*<br>*expr1* is evaluated first. If *expr1* is true, then *value=expr2*. If *expr1* is false, *value=expr3*. | `A=6 & B=4`<br>`;Set Z to the greater of A and B:`<br>`Z = (A GT B) ? A : B`<br>`PRINT, Z`<br>IDL Prints: `6` |

*Table E-7: Other Operators (Continued)*

# Operator Precedence

The following table lists IDL's operator precedence. Operators with the highest precedence are evaluated first. Operators with equal precedence are evaluated from left to right.

| Priority | Operator |
|---|---|
| First (highest) | ( ) (parentheses, to group expressions) |
| | [ ] (brackets, to concatenate arrays) |
| Second | . (structure field dereference) |
| | [ ] (brackets, to subscript an array) |
| | ( ) (parentheses, used in a function call) |
| Third | * (pointer dereference) |
| | ^ (exponentiation) |
| | ++ (increment) |
| | -- (decrement) |
| Fourth | * (multiplication) |
| | # and ## (matrix multiplication) |
| | / (division) |
| | MOD (modulus) |
| Fifth | + (addition) |
| | - (subtraction and negation) |
| | < (minimum) |
| | > (maximum) |
| | NOT (bitwise negation) |

*Table E-8: Operator Precedence*

| Priority | Operator |
|---|---|
| Sixth | EQ (equality) |
| | NE (not equal) |
| | LE (less than or equal) |
| | LT (less than) |
| | GE (greater than or equal) |
| | GT (greater than) |
| Seventh | AND (bitwise AND) |
| | OR (bitwise OR) |
| | XOR (bitwise exclusive OR) |
| Eighth | && (logical AND) |
| | \|\| (logical OR) |
| | ~ (logical negation) |
| Ninth | ?: (conditional expression) |

*Table E-8: Operator Precedence (Continued)*

# Appendix F: Special Characters

Within the IDL environment, a number of characters have special meanings.

The following table lists characters with special interpretations and states their functions in IDL. These characters are discussed further in the descriptions following the table.

| Character | Function |
|---|---|
| ! | • First character of system variable names and font-positioning commands. |
| ' | • Delimit string constants<br>• Indicate part of octal or hex constant |
| ; | • Begin comment field |

*Table F-1: Special Characters*

| Character | Function |
|---|---|
| $ | • Continue current command on the next line<br>• Issue operating system command if entered on a line by itself. |
| " | • Delimit string constants or precede octal constants |
| . | • Indicate constant is floating point<br>• Start executive command |
| & | • Separate multiple statements on one line |
| : | • End label identifiers<br>• Separate start and end subscript ranges |
| * | • Multiplication operator<br>• Array subscript range<br>• Pointer dereference (if in front of a valid pointer) |
| @ | • Include file<br>• Execute IDL batch file |
| ? | • Invokes online help when entered at the IDL command line.<br>• Part of the ?: ternary operator used in conditional expressions. |

*Table F-1: Special Characters (Continued)*

# Exclamation Point (!)

The exclamation point is the first character of names of IDL system-defined variables. System variables are predefined scalar variables of a fixed type. Their purpose is to override defaults for system procedures, to return status information, and to control the action of IDL.

## Apostrophe (')

The apostrophe delimits string literals and indicates part of an octal or hex constant.

## Semicolon (;)

The semicolon is the first character of the optional comment field of an IDL statement. All text on a line following a semicolon is ignored by IDL. A line can consist of a comment only or both a valid statement and a comment.

## Dollar Sign ($)

The dollar sign at the end of a line indicates that the current statement is continued on the following line. The dollar sign character can appear anywhere a space is legal except within a string constant or between a function name and the first open parenthesis. Any number of continuation lines are allowed.

When the $ character is entered as the first character after the IDL prompt, the rest of the line is sent to the operating system as a command. If $ is the only character present, an interactive subprocess is started. Under UNIX, IDL execution suspends until the new shell process terminates.

## Quotation Mark (")

The quotation mark precedes octal numbers, which are always integers, and delimits string constants. Example: "`100B` is a byte constant equal to 64 base 10 and "`Don't drink the water`" is a string constant.

## Period (.)

The period or decimal point indicates in a numeric constant that the number is of floating-point or double-precision type. Example: 1.0 is a floating-point number. Also, in response to the IDL prompt, the period begins an executive command. For example,

```
.run myfile
```

causes IDL to compile the file *myfile.pro*. If *myfile.pro* contains a main program, the program also will be executed. In addition, the period precedes the name of a tag when referring to a field within a structure. For example, a reference to a tag called NAME in a structure stored in the variable A is A.NAME.

# Ampersand (&)

The ampersand separates multiple statements on one line. Statements can be combined until the maximum line length is reached. For example, the following line contains two statements:

```
I = 1 & PRINT, 'value:', I
```

# Colon (:)

The colon ends label identifiers. Labels can only be referenced by GOTO and ON_ERROR statements. The following line contains a statement with the label LOOP1.

```
LOOP1: X = 2.5
```

The colon also separates the starting and ending subscripts in subscript range specifiers. For example, A(3:6) designates elements three to six of the variable A.

# Asterisk (*)

The asterisk represents one of the following, depending on context:

1. Multiplication (3 * 3).
2. An ending subscript range equal to the size of the dimension. For example, `A[3:*]` represents all elements of the vector A from A[3] to the last element, while `B[*,3]` represents all elements of row four of matrix B.
3. A pointer dereference operation. For example, if `ptr` is a valid pointer (created via the PTR_NEW function), then `*ptr` is the value held by the heap variable that `ptr` points to. For more information on IDL pointers, see Chapter 8, "Pointers" in the *Building IDL Applications* manual.

# At Sign (@)

The "at" sign is used both as an include character and to signal batch execution.

## @ as an Include Character

The "at" sign at the beginning of a line causes the IDL compiler to substitute the contents of the file whose name appears after the @ for the line. If the full path name is not specified after the @ symbol, IDL searches the current directory and a list of known locations where procedures are kept.

- **UNIX:** IDL searches for the file in the list of directories (as established by the environment variable IDL_PATH) stored in the system variable !PATH.
- **Windows:** IDL searches for the file in the list of directories stored in the system variable !PATH (specified in the “Preferences” dialog of the File menu).

For example, the line

```
@doit
```

when included in a file, causes the file *doit.pro* to be compiled in its place. (The suffix *.pro* is the default for IDL program files.) When the end of the file is reached, compilation resumes at the line after the @.

### @ to Signal Batch Processing

When IDL is running in interactive mode, a line beginning with the character @ is entered in response to the IDL prompt and the file is opened for batch input. See Chapter 10, “Executing Batch Jobs in IDL” in the *Using IDL* manual for details.

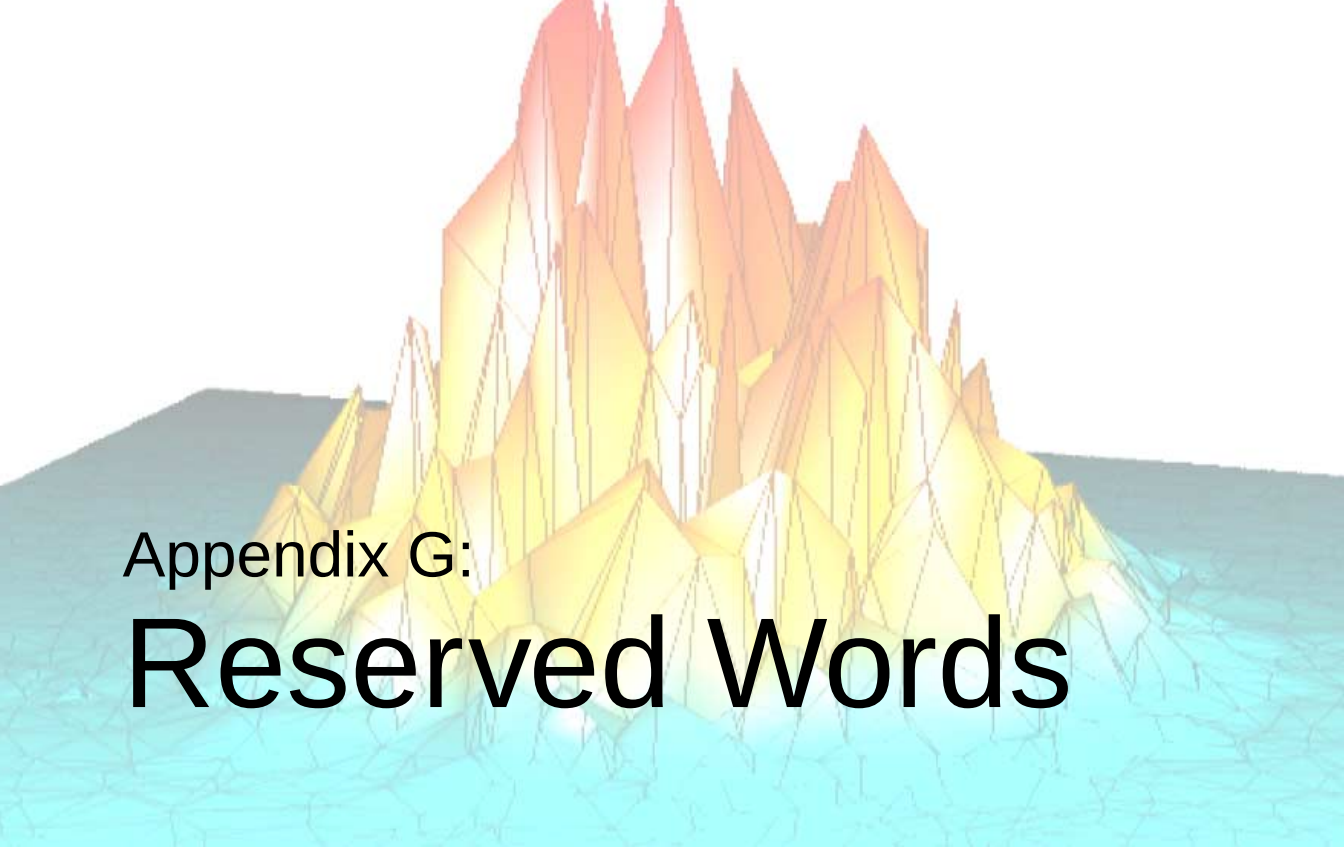
## Question Mark (?)

The question mark is used as follows:

- When entered at the IDL command line, the IDL online help facility is invoked.
- Used in conditional expressions as part of the ?: ternary operator. For example:

```
; A shorter way of saying IF (a GT b) THEN z=a ELSE z=b:
z = (a GT b) ? a : b
```

For more on conditional expressions, see “Conditional Expression” in Chapter 2 of the *Building IDL Applications* manual.

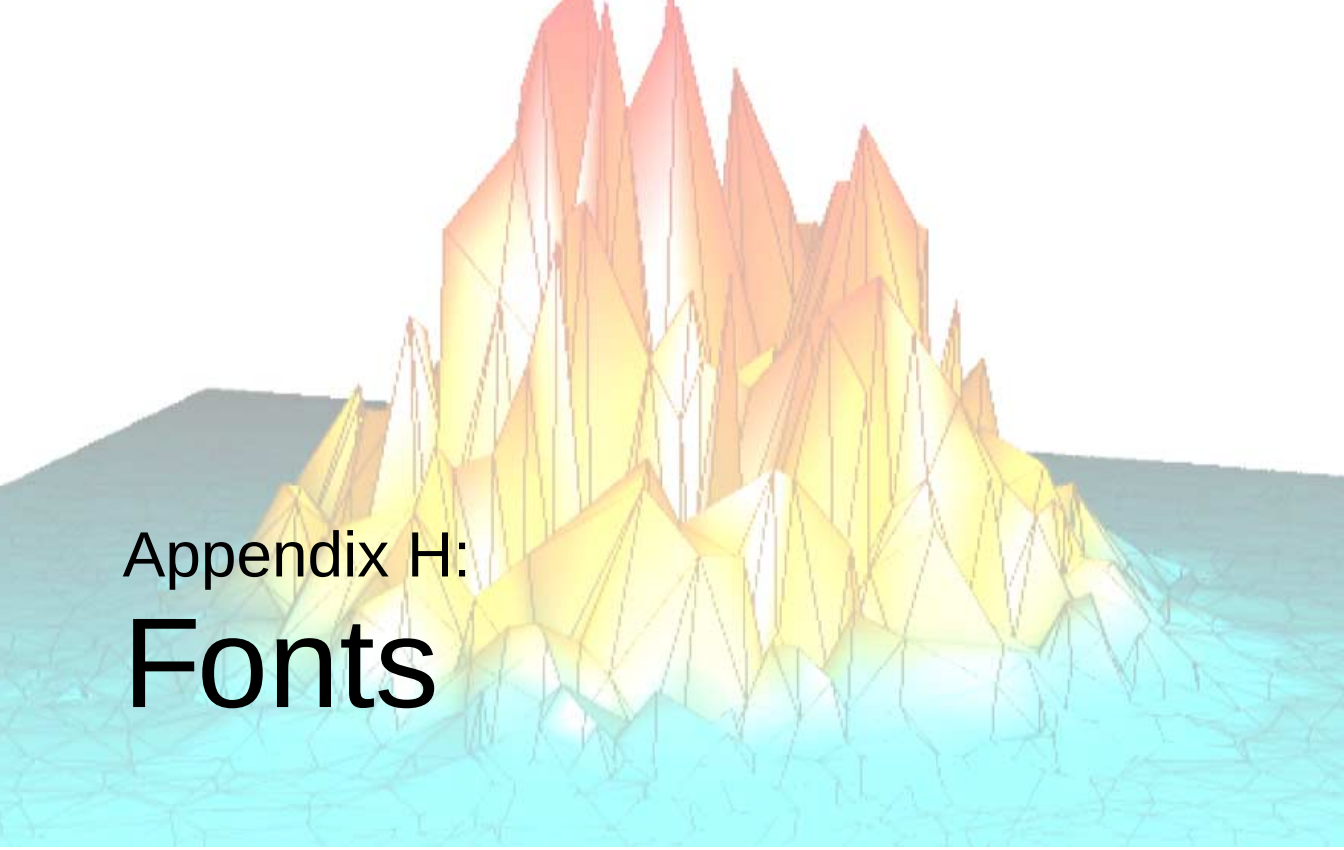


# Appendix G: Reserved Words

Variables, user-written procedures, and user-written functions should not have the same names as IDL functions or procedures. Re-using names of IDL routines can lead to syntax errors or to “hiding” variables. In addition, certain words representing IDL language constructs are strictly forbidden—using any of these *reserved words* as a variable, procedure, or function name will cause an immediate syntax error. The following table lists all of the reserved words in IDL.

| | | |
|---|---|---|
| AND | BEGIN | BREAK |
| CASE | COMMON | COMPILE_OPT |
| CONTINUE | DO | ELSE |
| END | ENDCASE | ENDELSE |
| ENDFOR | ENDIF | ENDREP |
| ENDSWITCH | ENDWHILE | EQ |
| FOR | FORWARD_FUNCTION | FUNCTION |

| | | |
|---|---|---|
| GE | GOTO | GT |
| IF | INHERITS | LE |
| LT | MOD | NE |
| NOT | OF | ON_IOERROR |
| OR | PRO | REPEAT |
| SWITCH | THEN | UNTIL |
| WHILE | XOR | |



# Appendix H: Fonts

The following topics are covered in this appendix:

# Overview

IDL uses three font systems for writing characters on the graphics device: Hershey (vector) fonts, TrueType (outline) fonts, and device (hardware) fonts. This chapter describes each of the three types of fonts, discusses when to use each type, and explains how to use fonts when creating graphical output in IDL.

Vector-drawn fonts, also referred to as *Hershey fonts*, are drawn as lines. They are device-independent (within the limits of device resolution). All vector fonts included with IDL are guaranteed to be available in any IDL installation. See "About Vector Fonts" on page 3954 for additional details.

TrueType fonts, also referred to here as *outline fonts*, are drawn as character outlines, which are filled when displayed. They are largely device-independent, but do have some device-dependent characteristics. Four TrueType font families are included with IDL; these fonts should display in a similar way on any IDL platform. TrueType font support for IDL Object Graphics was introduced in IDL version 5.0 and support in IDL Direct Graphics was introduced in IDL version 5.1. See "About TrueType Fonts" on page 3957 for additional details.

Device fonts, also referred to as *hardware fonts*, rely on character-display hardware or software built in to a specific display device. Device fonts, necessarily, are device-dependent and differ from platform to platform and display device to display device. See "About Device Fonts" on page 3962 for additional details.

# Fonts in IDL Direct vs. Object Graphics

This volume deals almost exclusively with IDL Direct Graphics. However, the vector and TrueType font systems described here are also available in the IDL Object Graphics system, described in *Using IDL*.

## IDL Direct Graphics

When generating characters for Direct Graphics plots, IDL uses the font system specified by the value of the system variable !P.FONT. The normal default for this variable is -1, which specifies that the built-in, vector-drawn (Hershey) fonts should be used. Setting !P.FONT equal to 1 specifies that TrueType fonts should be used. Setting !P.FONT equal to zero specifies that fonts supplied by the graphics device should be used.

The setting of the IDL system variable !P.FONT can be overridden for a single IDL Direct Graphics routine (AXIS, CONTOUR, PLOT, SHADE_SURF, SURFACE, or XYOUTS) by setting the FONT keyword equal to -1, 0, or 1.

Once a font system has been selected, an individual font can be chosen either via a formatting command embedded in a text string as described in “Embedded Formatting Commands” on page 3971, or by setting the value of the SET_FONT keyword to the DEVICE routine (see “SET_FONT” on page 3813).

## IDL Object Graphics

IDL Object Graphics can use the vector and TrueType font systems. See *Using IDL* for more information on using fonts with Object Graphics. Any TrueType fonts you add to your IDL installation as described in “About TrueType Fonts” on page 3957 will also be available to the Object Graphics system.

# About Vector Fonts


The vector fonts used by IDL were digitized by Dr. A.V. Hershey of the Naval Weapons Laboratory. Characters in the vector fonts are stored as equations, and can be scaled and rotated in three dimensions. They are drawn as lines on the current graphics device, and are displayed quickly and efficiently by IDL. The vector fonts are built into IDL itself, and are always available.

All the available fonts are illustrated in "Vector Font Samples" on page 3983. The default vector font (Font 3, Simplex Roman) is in effect if no font changes have been made.

## Using Vector Fonts

To use the vector font system with IDL Direct Graphics, either set the value of the IDL system variable !P.FONT equal to -1 (negative one), or set the FONT keyword of one of the Direct Graphics routines equal to -1. The vector font system is the default font system for IDL.

Once the vector font system is selected, use an embedded formatting command to select a vector font (or fonts) for each string. (See "Embedded Formatting Commands" on page 3971 for details on embedded formatting commands.) The font selected "sticks" from string to string; that is, if you change fonts in one string, future strings will use the new font until you change it again or exit IDL.

For example, to use the Duplex Roman vector font for the title of a plot, you would use a command that looks like this:

```
PLOT, mydata, TITLE="!5Title of my plot"
```

Consult *Using IDL* for details on using the vector font system with IDL Object Graphics.

## Specifying Font Size

To specify the size of a vector font, use the SET_CHARACTER_SIZE keyword to the DEVICE procedure. The SET_CHARACTER_SIZE keyword takes a two-

element vector as its argument. The first element specifies the width of the “average” character in the font (in pixels) and calculates a scaling factor that determines the height of the characters. (It is not important what the “average” character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The second element of the vector specifies the number of pixels between baselines of lines of text.

The ratio of the “average” character’s height to its width differs from font to font, so specifying the same value [*x*, *y*] to the SET_CHARACTER_SIZE keyword may produce characters of different sizes in different fonts.

**Note**

While the first element of the vector specified to SET_CHARACTER_SIZE is technically a width, it is important to note that the width value has no effect on the widths of individual characters in the font. The width value is used only to calculate the appropriate scaling factor for the font.

For example, the following IDL commands display the word “Hello There” on the screen, in letters based on an “average” character that is 70 pixels wide, with 90 pixels between lines:

```
DEVICE, SET_CHARACTER_SIZE=[70,90]
XYOUTS, 0.1, 0.5, 'Hello!CThere'
```

You can also use the CHARSIZE keyword to the graphics routines or the CHARSIZE field of the !P System Variable to change the size of characters to a multiple of the size of the currently-selected character size. For example, to create characters one half the size of the current character size, you could use the following command:

```
XYOUTS, 0.1, 0.5, 'Hello!CThere', CHARSIZE=0.5
```

**Note**

Changing CHARSIZE adjusts both the character size and the space between lines.

## ISO Latin 1 Encoding

The default font (Font 3, Simplex Roman) follows the ISO Latin 1 Encoding scheme and contains many international characters. The illustration of this font under “Vector Font Samples” on page 3983 can be used to find the octal codes for the special characters.

For example, suppose you want to display some text with an Angstrom symbol in it. Looking at the chart of font 3, we see that the Angstrom symbol has octal code 305. Non-printable characters can be represented in IDL using octal or hexadecimal

notation and the STRING function (see "Representing Non-Printable Characters" in Chapter 3 of the *Building IDL Applications* manual for details). So the Angstrom can be printed by inserting a `STRING("305B)` character in our text string as follows:

```
XYOUTS,.1, .5, 'Here is an Angstrom symbol: ' + STRING("305B), $
    /NORM, CHARSIZE=3
```

## Customizing the Vector Fonts

The EFONT procedure is a widget application that allows you to edit the Hershey fonts and save the results. Use this routine to add special characters or completely new, custom fonts to the Hershey fonts.

# About TrueType Fonts

A TrueType Font

Beginning with version 5.2, five TrueType font families are included with IDL. The fonts included are:

| Font Family | Italic | Bold | BoldItalic |
|---|---|---|---|
| Courier | Courier Italic | Courier Bold | Courier Bold Italic |
| Helvetica | Helvetica Italic | Helvetica Bold | Helvetica Bold Italic |
| Monospace Symbol | | | |
| Times | Times Italic | Times Bold | Times Bold Italic |
| Symbol | | | |

*Table H-1: TrueType Font Names*

When TrueType fonts are rendered on an IDL graphics device or destination object, the font outlines are first scaled to the proper size. After scaling, IDL converts the character outline information to a set of polygons using a triangulation algorithm. When text in a TrueType font is displayed, IDL is actually drawing a set of polygons calculated from the font information. This process has two side effects:

1. Computation time is used to triangulate and create the polygons. This means that you may notice a slight delay the first time you use text in a particular font and size. Once the polygons have been created, the information is cached by IDL and there is no need to re-triangulate each time text is displayed. Subsequent uses of the same font and size happen quickly.
2. Because the TrueType font outlines are converted into polygons, you may notice some chunkiness in the displayed characters, especially at small point sizes. The smoothness of the characters will vary with the quality of the TrueType font you are using, the point size, and the general smoothness of the font outlines.

# Using TrueType Fonts

To use the TrueType font system with IDL Direct Graphics, either set the value of the IDL system variable !P.FONT equal to 1 (one), or set the FONT keyword to on one of the Direct Graphics routines equal to 1.

Once the TrueType font system is selected, use the SET_FONT keyword to the DEVICE routine to select the font to use. The value of the SET_FONT keyword is a *font name string*. The font name is the name by which IDL knows the font; the names of the TrueType fonts included with IDL are listed under "About TrueType Fonts" on page 3957. Finally, specify the TT_FONT keyword in the call to the DEVICE procedure. For example, to use Helvetica Bold Italic, use the following statement:

```
DEVICE, SET_FONT='Helvetica Bold Italic', /TT_FONT
```

To use Times Roman Regular:

```
DEVICE, SET_FONT='Times', /TT_FONT
```

IDL's default TrueType font is 12 point Helvetica regular.

# Specifying Font Size

To specify the size of a TrueType font, use the SET_CHARACTER_SIZE keyword to the DEVICE procedure. The SET_CHARACTER_SIZE keyword takes a two-element vector as its argument. The first element specifies the width of the "average" character in the font (in pixels) and calculates a scaling factor that determines the height of the characters. (It is not important what the "average" character is; it is used only to calculate a scaling factor that will be applied to all of the characters in the font.) The second element of the vector specifies the number of pixels between baselines of lines of text.

The ratio of the "average" character's height to its width differs from font to font, so specifying the same value [*x*, *y*] to the SET_CHARACTER_SIZE keyword may produce characters of different sizes in different fonts.

**Note**

While the first element of the vector specified to SET_CHARACTER_SIZE is technically a width, it is important to note that the width value has no effect on the widths of individual characters in the font. The width value is used only to calculate the appropriate scaling factor for the font.

For example, the following IDL commands display the word "Hello There" on the screen in Helvetica Bold, in letters based on an "average" character that is 70 pixels wide, with 90 pixels between lines:

```
DEVICE, FONT='Helvetica Bold', /TT_FONT,
SET_CHARACTER_SIZE=[70,90]
XYOUTS, 0.1, 0.5, 'Hello!CThere'
```

You can also use the CHARSIZE keyword to the graphics routines or the CHARSIZE field of the !P System Variable to change the size of characters to a multiple of the size of the currently-selected character size. For example, to create characters one half the size of the current character size, you could use the following command:

```
XYOUTS, 0.1, 0.5, 'Hello!CThere', CHARSIZE=0.5
```

Note that changing the CHARSIZE adjusts both the character size and the space between lines.

## Using Embedded Formatting Commands

Embedded formatting commands allow you to position text and change fonts within a single line of text. A subset of the embedded formatting commands available for use with the vector fonts are also available when using the TrueType font system. See "Embedded Formatting Commands" on page 3971 for a list of in-line formatting commands.

## IDL TrueType Font Resource Files

The TrueType font system relies on a resource file named `ttfont.map`, located in the `resource/fonts/tt` subdirectory of the IDL directory. The format of the ttfont.map file is:

*`FontName FileName DirectGraphicsScale ObjectGraphicsScale`*

where the fields in each column must be separated by white space (spaces and/or tabs). The fields contain the following information

The *Fontname* field contains the name that would be used for the SET_FONT keywords to the DEVICE routine.

The *Filename* field contains the name of the TrueType font file. On UNIX platforms, IDL will search for the file specified in the *FileName* field in the current directory (that is, in the `resource/fonts/tt` subdirectory of the IDL directory) if a bare filename is provided, or it will look for the file in the location specified by the fully-qualified file name if a complete path is provided. Because different platforms use different path-specification syntax, we recommend that you place any TrueType font files you wish to add to the `ttfont.map` file in the `resource/fonts/tt` subdirectory of the IDL directory. On Windows platforms, this entry may be '*', in which case the font will be loaded from the operating system font list, but that the following two scale entries will be honored.

The *DirectGraphicsScale* field contains a correction factor that will be applied when choosing a scale factor for the glyphs prior to being rendered on a Direct Graphics device. If you want the tallest character in the font to fit exactly within the vertical dimension of the device's current character size (as set via the SET_CHARACTER_SIZE keyword to the DEVICE procedure), set the scale factor equal to 1.0. Change the scale factor to a smaller number to scale a smaller portion of the tallest character into the character size.

For example, suppose the tallest character in your font is "Ã". Setting the scale factor to 1.0 will scale this character to fit the current character size, and then apply the same scaling to all characters in the font. As a result, the letter "M" will fill only approximately 85% of the full height of the character size. To scale the font such that the height of the "M" fills the vertical dimension of the character size, you would include the value 0.85 in the scale field of the `ttfont.map` file.

The *ObjectGraphicsScale* field contains a correction factor that will be applied when choosing a scale factor for the glyphs prior to being rendered on a Object Graphics device. (This field works just like the *DirectGraphicsScale* field.) This scale factor should be set to 1.0 if the maximum ascent among all glyphs within a given font is to fit exactly within the font size (as set via the SIZE property to the IDLgrFont object).

## Adding Your Own Fonts

To add a your own font to the list of fonts known to IDL, use a text editor to edit the `ttfont.map` file, adding the *FontName*, *FileName*, *DirectGraphicsScale*, and *ObjectGraphicsScale* fields for your font. You will need to restart IDL for the changes to the `ttfont.map` file to take effect. On Windows systems, you can use fonts that are not mentioned in the `ttfont.map` file, as long as they are installed in the Fonts control panel, as described below.

**Warning**

If you choose to modify the `ttfont.map` file, be sure to keep a backup copy of the original file so you can restore the defaults if necessary. Note also that applications that use text may appear different on different platforms if the scale entries in the `ttfont.map` file have been altered.

## Where IDL Searches for Fonts

The TrueType font files included with IDL are located in the `resource/fonts/tt` subdirectory of the IDL directory. When attempting to resolve a font name (specified via the FONT keyword to the DEVICE procedure), IDL will look in the

`ttfont.map` file first. If it fails to find the specified font file in the `ttfont.map` file, it will search for the font file in the following locations:

## UNIX

No further search will be performed. If the specified font is not included in the `ttfont.map` file, IDL will substitute Helvetica.

## Microsoft Windows

If the specified font is not included in the `ttfont.map` file, IDL will search the list of fonts installed in the system (the fonts installed in the Font control panel). If the specified font is not found, IDL will substitute Helvetica.

# About Device Fonts


Device, or hardware, fonts are fonts that are provided directly by your system's hardware or by software other than IDL. In past releases of IDL, we have used the term "*hardware fonts*" extensively to discuss these types of fonts. This is because in the early days of IDL, computer displays were either text-only terminals or dedicated graphics display devices such as plotters or Tektronix graphics terminals. These graphics displays generally came with a set of fonts built-in; when IDL asked the device to display characters in a built-in font, it was making a request to the hardware to display those characters.

As computer displays have become more sophisticated, the concept of fonts provided "by the hardware" has expanded to include fonts provided by the computer's operating system, or by font-management software. For example, many computers now use font management software like Adobe Type Manager to manage the fonts made available by the operating system to all applications. We use the term "device font" to refer to a font that is available to one of IDL's graphics devices from a source *other than IDL itself*. (In this case, a "graphics device" can be either a Direct Graphics device as specified by the DEVICE routine or an Object Graphics "destination" such as a window or a printer.) While device fonts may include fonts only available because a particular piece of hardware knows how to draw characters in that font (a pen plotter is an example of a device that may still have its own special fonts), in most cases device fonts are fonts supplied by the operating system to any application that may want to use them.

## Which Device Fonts Are Available?

To determine which device fonts are available on your system and the exact font strings to specify for each, use the GET_FONTNAMES keyword to the DEVICE procedure. You can also use an operating system specific method to determine which fonts are available:

### UNIX

On most systems, the `xlsfonts` utility displays a list of fonts available to the operating system.

### Microsoft Windows

Fonts available to the system are displayed in the Fonts control panel. You may also have other fonts available if you use font-management software such as Adobe Type Manager.

## Using Device Fonts

To use the Device font system with IDL Direct Graphics, either set the value of the IDL system variable !P.FONT equal to 0 (zero), or set the FONT keyword to on one of the Direct Graphics routines equal to 0.

Once the Device font system is selected, use the SET_FONT keyword to the DEVICE routine to select the font to use. Because device fonts are specified differently on different platforms, the syntax of the *fontname* string depends on which platform you are using.

### UNIX

Usually, the window system provides a directory of font files that can be used by all applications. List the contents of that directory to find the fonts available on your system. The size of the font selected also affects the size of vector drawn text. On some machines, fonts are kept in subdirectories of `/usr/lib/X11/fonts`. You can use the `xlsfonts` command to list available X Windows fonts.

For example, to select the font 8X13:

```
!P.FONT = 0
DEVICE, SET_FONT = '8X13'
```

### Microsoft Windows

The SET_FONT keyword should be set to a string with the following form:

```
DEVICE, SET_FONT="font*modifier1*modifier2*...modifiern"
```

where the asterisk (*) acts as a delimiter between the font's name (*font*) and any modifiers. The string is *not* case sensitive. Modifiers are simply "keywords" that change aspects of the selected font. Valid modifiers are:

- For font weight: THIN, LIGHT, BOLD, HEAVY
- For font quality: DRAFT, PROOF
- For font pitch: FIXED, VARIABLE
- For font angle: ITALIC
- For strikeout text: STRIKEOUT
- For underlined text: UNDERLINE
- For font size: Any number is interpreted as the font height in pixels.

For example, if you have Garamond installed as one of your Windows fonts, you could select 24-pixel cell height Garamond italic as the font to use in plotting. The following commands tell IDL to use hardware fonts, change the font, and then make a simple plot:

```
!P.FONT = 0
DEVICE, SET_FONT = "GARAMOND*ITALIC*24"
PLOT, FINDGEN(10), TITLE = "IDL Plot"
```

This feature is compatible with TrueType and Adobe Type Manager (and, possibly, other type scaling programs for Windows). If you have TrueType or ATM installed, the TrueType or PostScript outline fonts are used so that text looks good at any size.

## Fonts and the PostScript Device

A special set of device fonts are available when the current Direct Graphics device is PS (PostScript). IDL includes font metric information for 35 standard PostScript fonts, and can create PostScript language files that include text in these fonts. (The 35 fonts known to IDL are listed in the following table; they the standard fonts included in memory in the vast majority of modern PostScript printers.) The PostScript font

metric files (`*.afm` files) are located in the `resource/fonts/ps` subdirectory of the IDL directory.

| | |
|---|---|
| AvantGarde-Book | Helvetica-Narrow-Oblique |
| AvantGarde-BookOblique | Helvetica-Oblique |
| AvantGarde-Demi | NewCenturySchlbk-Bold |
| AvantGarde-DemiOblique | NewCenturySchlbk-BoldItalic |
| Bookman-Demi | NewCenturySchlbk-Italic |
| Bookman-DemiItalic | NewCenturySchlbk-Roman |
| Bookman-Light | Palatino-Bold |
| Bookman-LightItalic | Palatino-BoldItalic |
| Courier | Palatino-Italic |
| Courier-Bold | Palatino-Roman |
| Courier-BoldOblique | Symbol |
| Courier-Oblique | Times-Bold |
| Helvetica | Times-BoldItalic |
| Helvetica-Bold | Times-Italic |
| Helvetica-BoldOblique | Times-Roman |
| Helvetica-Narrow | ZapfChancery-MediumItalic |
| Helvetica-Narrow-Bold | ZapfDingats |
| Helvetica-Narrow-BoldOblique | |

*Table H-2: Names of Supported PostScript Fonts*

## Using PostScript Fonts

To use a PostScript font in your Direct Graphics output, you must first specify that IDL use the device font system, they switch to the `PS` device, then choose a font using the SET_FONT keyword to the DEVICE procedure.

The following IDL commands choose the correct font system, set the graphics device, select the font Palatino Roman, open a PostScript file to print to, plot a simple data set, and close the PostScript file:

```
!P.FONT = 0
SET_PLOT, 'PS'
DEVICE, SET_FONT = 'Palatino-Roman', FILE = 'testfile.ps'
PLOT, INDGEN(10), TITLE = 'My Palatino Title'
DEVICE, /CLOSE
```

**Note**

Subsequent PostScript output will continue to use the font Palatino Roman until you explicitly change the font again, or exit IDL.

You can also specify PostScript fonts using a set of keywords to the DEVICE procedure. The keyword combinations for the fonts included with IDL are listed in the following table.

| PostScript Font | DEVICE Keywords |
|---|---|
| Courier | /COURIER |
| Courier Bold | /COURIER, /BOLD |
| Courier Oblique | /COURIER, /OBLIQUE |
| Courier Bold Oblique | /COURIER, /BOLD, /OBLIQUE |
| Helvetica | /HELVETICA |
| Helvetica Bold | /HELVETICA, /BOLD |
| Helvetica Oblique | /HELVETICA, /OBLIQUE |
| Helvetica Bold Oblique | /HELVETICA, /BOLD, /OBLIQUE |
| Helvetica Narrow | /HELVETICA, /NARROW |
| Helvetica Narrow Bold | /HELVETICA, /NARROW, /BOLD |
| Helvetica Narrow Oblique | /HELVETICA, /NARROW, /OBLIQUE |
| Helvetica Narrow Bold Oblique | /HELVETICA, /NARROW, /BOLD, /OBLIQUE |
| ITC Avant Garde Gothic Book | /AVANTGARDE, /BOOK |
| ITC Avant Garde Gothic Book Oblique | /AVANTGARDE, /BOOK, /OBLIQUE |
| ITC Avant Garde Gothic Demi | /AVANTGARDE, /DEMI |

*Table H-3: The Standard 35 PostScript Fonts*

| PostScript Font | DEVICE Keywords |
|---|---|
| ITC Avant Garde Gothic Demi Oblique | /AVANTGARDE, /DEMI, /OBLIQUE |
| ITC Bookman Demi | /BKMAN, /DEMI |
| ITC Bookman Demi Italic | /BKMAN, /DEMI, /ITALIC |
| ITC Bookman Light | /BKMAN, /LIGHT |
| ITC Bookman Light Italic | /BKMAN, /LIGHT, /ITALIC |
| ITC Zapf Chancery Medium Italic | /ZAPFCHANCERY, /MEDIUM, /ITALIC |
| ITC Zapf Dingbats | /ZAPFDINGBATS |
| New Century Schoolbook | /SCHOOLBOOK |
| New Century Schoolbook Bold | /SCHOOLBOOK, /BOLD |
| New Century Schoolbook Italic | /SCHOOLBOOK, /ITALIC |
| New Century Schoolbook Bold Italic | /SCHOOLBOOK, /BOLD, /ITALIC |
| Palatino | /PALATINO |
| Palatino Bold | /PALATINO, /BOLD |
| Palatino Italic | /PALATINO, /ITALIC |
| Palatino Bold Italic | /PALATINO, /BOLD, /ITALIC |
| Symbol | /SYMBOL |
| Times | /TIMES |
| Times Bold | /TIMES, /BOLD |
| Times Italic | /TIMES, /ITALIC |
| Times Bold Italic | /TIMES, /ITALIC, /BOLD |

*Table H-3: The Standard 35 PostScript Fonts (Continued)*

For example to use the PostScript font Palatino Bold Italic, you could use either of the following DEVICE commands:

```
DEVICE, SET_FONT = 'Palatino*Bold*Italic'
DEVICE, /PALATINO, /BOLD, /ITALIC
```

## Changing the PostScript Font Assigned to an Index

You can change the PostScript font assigned to a given font index using the FONT_INDEX keyword to the DEVICE procedure. Font indices and their use are discussed in "Embedded Formatting Commands" on page 3971.

Changing the font index assigned to a font can be useful when changing PostScript fonts in the middle of a text string. For example, the following statements map Palatino Bold Italic to font index 4, and then output text using that font and the Symbol font:

```
; Map the font selected by !4 to be PalatinoBoldItalic:
DEVICE, /PALATINO, /BOLD, /ITALIC, FONT_INDEX=4
; Output "Alpha :" in PalatinoBoldItalic followed by an
; Alpha character:
XYOUTS, .3, .5, /NORMAL, "!4Alpha: !9a", FONT=0, SIZE=5.0
```

## Adding Your Own PostScript Fonts

Because the 35 PostScript fonts included with IDL are built in to a PostScript printer's memory, the IDL distribution includes only the font metric files, which provide positioning information. In addition, the `.afm` files used by IDL are specially processed to provide the information in a format IDL expects.

You can add your own PostScript fonts to the list of fonts known to IDL if you have access to the PostScript font file (usually named *font*`.pfb`) to load into your printer and to the *font*`.afm` file supplied by Adobe. You can convert the standard `.afm` file into a file IDL understands using the IDL routine PSAFM. Consult the file `README.TXT` in the `resource/fonts/ps` subdirectory of the IDL directory for details on adding PostScript fonts to your system.

# Choosing a Font Type

Some of the issues involved in choosing between vector, TrueType, and device fonts are explained below.

## Appearance

Vector-drawn characters are of medium quality, suitable for most uses. TrueType characters are of relatively high quality, although at some point sizes the triangulation process (described in "About TrueType Fonts" on page 3957) may cause characters to appear slightly jagged. The appearance of device characters varies from mediocre (characters found in many graphics terminals) to publication quality (PostScript).

## Three-Dimensional Transformations

Vector or TrueType fonts should always be used with three-dimensional transformations. Both vector and TrueType characters pass through the same transformations as the rest of the plot, yielding a better looking plot. See "Three-Dimensional Graphics" in Chapter 18 of the *Using IDL* manual for an example of vector-drawn characters with three-dimensional graphics. Device characters are not subject to the three-dimensional transforms.

## Portability

The vector-drawn fonts work using any graphics device and look the same on every device (within the limitations of device resolution) on any system supported by IDL.

TrueType fonts are available only on the `X`, `WIN`, `PRINTER`, `PS`, and `Z` Direct Graphics devices, and in IDL's Object Graphics system. If you use only the fonts supplied with IDL, TrueType fonts also look the same on every supported device (again within the limits of the device resolution). If you use TrueType fonts other than those supplied with IDL, your font may not be installed on the system which runs your program. In this case, IDL will substitute a known font for the missing font.

The appearance, size, and availability of device fonts varies greatly from device to device. Many, if not most, of the positioning and font changing commands recognized by the vector-drawing routines are ignored when using device fonts. The exception to this rule is the Direct Graphics `PS` device; if you use one of the PostScript fonts supported by IDL, the PostScript output from the `PS` device will be identical between platforms.

## Computational Time

Device fonts are generally rendered the most quickly, since the hardware device or operating system handles all computations and caching.

It takes more computer time to draw characters with line vectors and generally results in more input/output. However, this is not an important issue unless the plot contains a large number of characters or the transmission link to the device is very slow.

The initial triangulation step used when displaying TrueType fonts for the first time can be computationally expensive. However, since the font shapes are cached, subsequent uses of the same font are relatively speedy.

## Flexibility

Vector-drawn fonts provide a great deal of flexibility. There are many different typefaces available, as shown in the tables at the end of this chapter. In addition, such fonts can be arbitrarily scaled, rotated, and transformed.

TrueType fonts support fewer embedded formatting commands than do the vector fonts, and cannot be scaled, rotated, or transformed.

The abilities of hardware-generated characters differ greatly between devices so it is not possible to make a blanket statement on when they should be used—the best font to use depends on the available hardware. In general, however, the vector or TrueType fonts are easier to use and often provide superior results to what is available from the hardware. See the discussion of the device you are using in Appendix A, “IDL Graphics Devices” for details on the hardware-generated characters provided by that device.

## Print Quality

For producing publication-quality output, we recommend using either the TrueType font system or the Direct Graphics PS device and one of the PostScript fonts supported by IDL.

# Embedded Formatting Commands

When you use vector, TrueType, and some device fonts, text strings can include embedded formatting commands that facilitate subscripting, superscripting, and equation formatting. The method used is similar to that developed by Grandle and Nystrom (1980). Embedded formatting commands are always introduced by the exclamation mark, ( ! ). (The string " ! ! " is used to produce a literal exclamation mark.)

**Note**

Embedded formatting commands prefaced by the exclamation mark have no special significance for hardware-generated characters unless the ability is provided by the particular device in use. The IDL PostScript device driver accepts many of the standard embedded formatting commands, and is described here. If you wish to use hardware fonts with IDL Direct Graphics devices other than the PostScript device, consult the description of the device in Appendix A, "IDL Graphics Devices" before trying to use these commands with hardware characters.

You can determine whether embedded formatting commands are available for use with device fonts on your current graphics device by inspecting bit 12 of the *Flags* field of the !D System Variable. Use the IDL statement:

```
IF (!D.FLAGS AND 4096) NE 0 THEN PRINT, 'Bit is set.'
```

to determine whether bit 12 of the *Flags* field is set for the current graphics device.

## Changing Fonts within a String

You can change fonts one or more times within a text string using the embedded font commands shown in the table below. The character following the exclamation mark can be either upper or lower case.

Examples of commands used to change fonts in mid-string are included in "Formatting Command Examples" on page 3975.

| Command | Vector Font | TrueType Font | PostScript Font |
|---|---|---|---|
| !3 | Simplex Roman (default) | Helvetica | Helvetica |
| !4 | Simplex Greek | Helvetica Bold | Helvetica Bold |
| !5 | Duplex Roman | Helvetica Italic | Helvetica Narrow |

*Table H-4: Embedded Font Selection Commands*

| Command | Vector Font | TrueType Font | PostScript Font |
|---|---|---|---|
| !6 | Complex Roman | Helvetica Bold Italic | Helvetica Narrow Bold Oblique |
| !7 | Complex Greek | Times | Times Roman |
| !8 | Complex Italic | Times Italic | Times Bold Italic |
| !9 | Math/special characters | Symbol | Symbol |
| !M | Math/special characters (change effective for one character only) | Symbol | Symbol |
| !10 | Special characters | Symbol * | Zapf Dingbats |
| !11(!G) | Gothic English | Courier | Courier |
| !12(!W) | Simplex Script | Courier Italic | Courier Oblique |
| !13 | Complex Script | Courier Bold | Palatino |
| !14 | Gothic Italian | Courier Bold Italic | Palatino Italic |
| !15 | Gothic German | Times Bold | Palatino Bold |
| !16 | Cyrillic | Times Bold Italic | Palatino Bold Italic |
| !17 | Triplex Roman | Helvetica * | Avant Garde Book |
| !18 | Triplex Italic | Helvetica * | New Century Schoolbook |
| !19 | | Helvetica * | New Century Schoolbook Bold |
| !20 | Miscellaneous | Helvetica * | Undefined User Font |
| !X | Revert to the entry font | Revert to the entry font | Revert to the entry font |

* The font assigned to this index may be replaced in a future release of IDL.

*Table H-4: Embedded Font Selection Commands (Continued)*

# Positioning Commands

The positioning and other font-manipulation commands are described in the following table. Examples of commands used to position text are included in “Formatting Command Examples” on page 3975.

| Command | Action |
|---|---|
| !A | Shift above the division line . |
| !B | Shift below the division line . |
| !C | “Carriage return,” begins a new line of text. Shift back to the starting position and down one line. This command also performs an implicit “!N” command, returning to the normal level and character size at the beginning of the new line. |
| !D | Shift down to the first level subscript and decrease the character size by a factor of 0.70. |
| !E | Shift up to the exponent level and decrease the character size by a factor of 0.44. |
| !I | Shift down to the index level and decrease the character size by a factor of 0.44. |
| !L | Shift down to the second level subscript. Decrease the character size by a factor of 0.62. |
| !N | Shift back to the normal level and original character size. |
| !R | Restore position. The current position is set from the top of the saved positions stack. |
| !S | Save position. The current position is saved on the top of the saved positions stack. |
| !U | Shift to upper subscript level. Decrease the character size by a factor of 0.70. |
| !X | Return to the entry font. |

*Table H-5: Vector-Drawn Positioning and Miscellaneous Commands*

| Command | Action |
|---|---|
| !Z($u_0$,$u_1$,...,$u_n$) | Display one or more character glyphs according to their unicode value. Each $u_i$ within the parentheses will be interpreted as a 16-bit hexadecimal unicode value. If more than one unicode value is to be included, the values should be separated by commas. |
| !! | Display the ! symbol. |

*Table H-5: Vector-Drawn Positioning and Miscellaneous Commands*

# Formatting Command Examples

The figure below illustrates the relative positions and effects on character size of the level commands. In this figure, the letters "!N" are normal level and size characters.

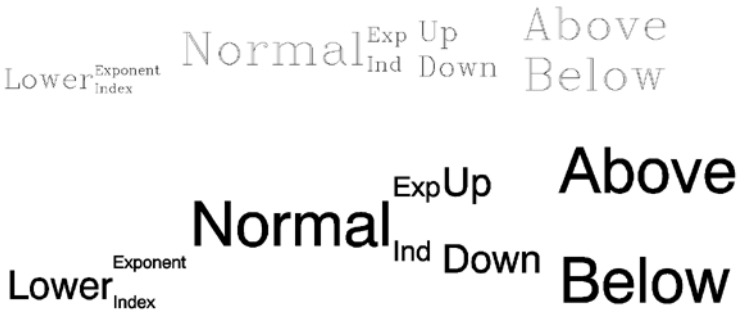



*Figure H-1: Positioning Commands With Vector Fonts (Top) and TrueType Fonts (Bottom)*

The positioning shown was created with the following command:

```
XYOUTS, 0.1, 0.3, $
'!LLower!S!EExponent!R!IIndex!N  Normal!S!EExp!R!IInd!N!S!U Up
!R!D Down!N!S!A Above!R!B Below'
```

Note that the string argument to the XYOUTS procedure must be entered on a single line rather than the two lines shown above.

# A Complex Equation

Embedded positioning commands and the vector font system can be used to create the integral shown below:

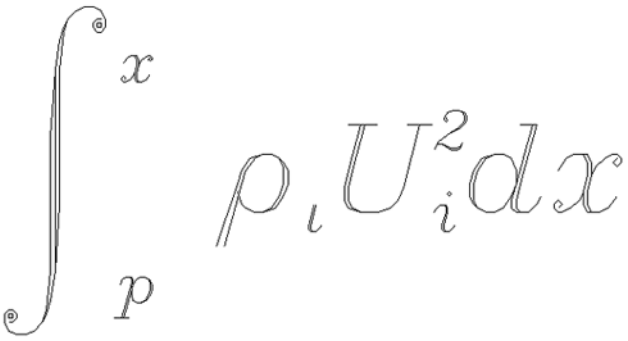


*Figure H-2: An integral created with the vector fonts.*

The command string used to produce the integral is:

```
XYOUTS, 0, .2, $
   '!MI!S!A!E!8x!R!B!Ip!N !7q!Ii!N!8U!S!E2!R!Ii!Ndx', $
   SIZE = 3, /NORMAL
```

Remember that the case of the letter in an embedded command is not important. The string may be broken down into the following components:

### !MI

Changes to the math set and draws the integral sign, uppercase I.

### !S

Saves the current position on the position stack.

### !A!E!8x

Shifts above the division line and to the exponent level, switches to the Complex Italic font (Font 8), and draws the "*x*."

### !R!B!Ip

Restores the position to the position immediately after the integral sign, shifts below the division line to the index level, and draws the "*p*."

### !N !7q

Returns to the normal level, advances one space, shifts to the Complex Greek font (Font 7), and draws the Greek letter rho, which is designated by "*q*" in this set.

### !Ii!N

Shifts to the index level and draws the "*i*" at the index level. Returns to the normal level.

### !8U

Shifts to the Complex Italic font (Font 8) and outputs the upper case "*U*."

### !S!E2

Saves the position and draws the exponent "2."

### !R!Ii

Restores the position and draws the index "*i*."

### !N dx

Returns to the normal level and outputs "dx."

**Note**

The equation shown in the figure above could not be created so simply using the TrueType font system, because the large integral symbol is broken into two or more characters in the TrueType fonts.

## Vector-Drawn Font Example

IDL uses vector-drawn font when the value of the system variable !P.FONT is -1. This is the default condition. Initially, all characters are drawn using the Simplex Roman font (Font 3). When plotting, font changing commands may be embedded in the title strings keyword arguments (XTITLE, YTITLE, and TITLE) to select other fonts. For example, the following statement uses the Complex Roman font (Font 6) for the *x*-axis title:

```
PLOT, X, XTITLE = '!6X Axis Title'
```

This font remains in effect until explicitly changed. The order in which the annotations are drawn is main title, *x*-axis numbers, *x*-axis title, *y*-axis numbers, and *y*-axis title. Strings to be output also may contain embedded information selecting subscripting, superscripting, plus other features that facilitate equation formatting.

The following statements were used to produce the figure below. They serve as an example of a plot using vector-drawn characters and of equation formatting.

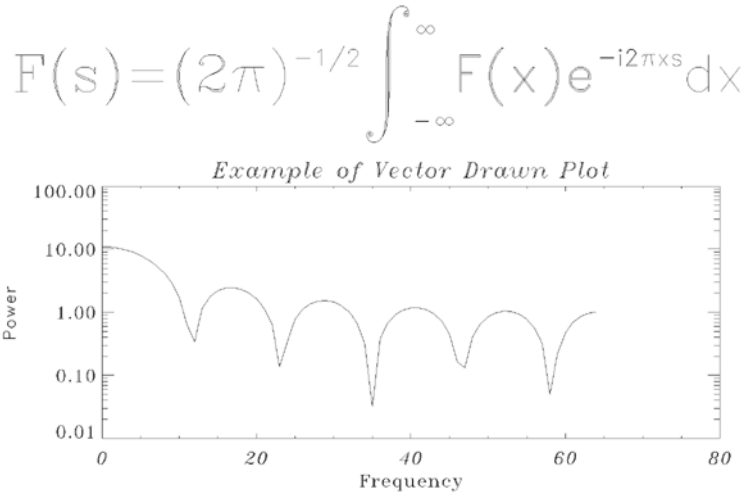



*Figure H-3: Example of a Vector-drawn Plot*

```
; Define an array:
X = FLTARR(128)
; Make a step function:
X[30:40] = 1.0
; Take FFT and magnitude:
X = ABS(FFT(X, 1))
; Produce a log-linear plot. Use the Triplex Roman font for the
; x title (!17), Duplex Roman for the y title (!5), and Triplex
; Italic for the main title (!18). The position keyword is used to
; shrink the plotting window:
PLOT, X[0:64], /YLOG, XTITLE = '!17Frequency', $
   YTITLE = '!5Power', $
   TITLE = '!18Example of Vector Drawn Plot', $
   POSITION = [.2, .2, .9, .6]
SS = '!6F(s) = (2!4p)!e-1/2!n !mi!s!a!e!m $
     !r!b!i ' + '-!m $
```

```
; String to produce equation:
     !nF(x)e !e-i2!4p!3xs!ndx'
XYOUTS, 0.1, .75, SS, SIZE = 3, $
; Output string over plot. The NOCLIP keyword is needed because
; the previous plot caused the clipping region to shrink:
     /NORMAL, /NOCLIP
```

# TrueType Font Samples

The following figures show roman versions of the four TrueType font families included with IDL. The character sets for the bold, italic, and bold italic versions of these fonts are the same as the roman versions.

The SHOWFONT command was used to create these figures. For example, to display the following figure on the screen, you would the command:

```
SHOWFONT, 'Helvetica', 'Helvetica', /TT_FONT
```

For more information, see “SHOWFONT” on page 1788.

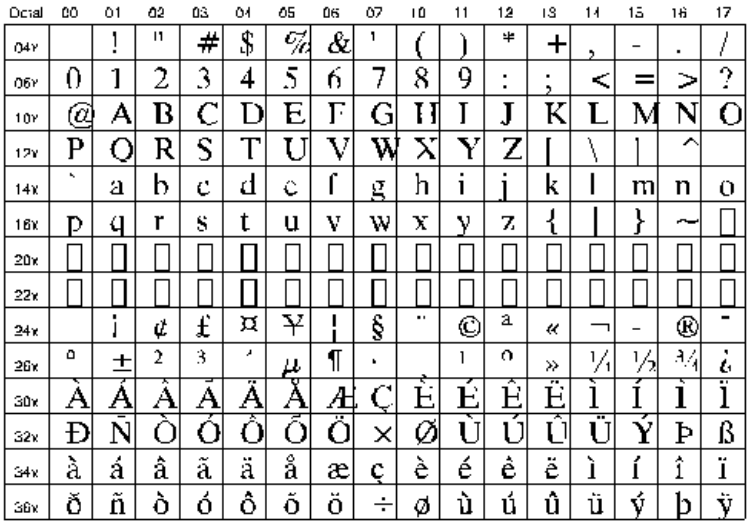
**Note**

The following font charts are numbered in octal notation. To read the octal number of a character, add the column index (along the top) to ten times the row index. For example, the capital letter “A” is octal 101, and the copyright symbol is octal 251.

Font Helvetica

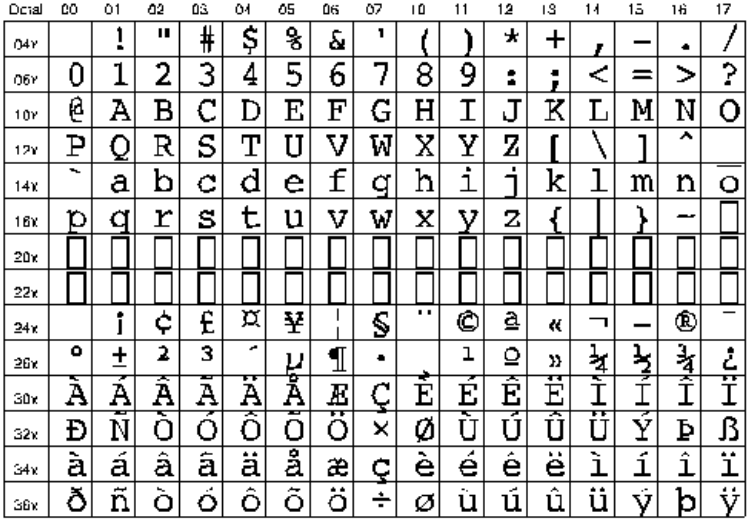
| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | " | # | $ | % | & | ' | ( | ) | * | + | , | - | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 10x | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 12x | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ |
| 14x | ` | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o |
| 16x | p | q | r | s | t | u | v | w | x | y | z | { | \| | } | ~ | □ |
| 20x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 22x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 24x | | ¡ | ¢ | £ | ¤ | ¥ | ¦ | § | ¨ | © | ª | « | ¬ | - | ® | ¯ |
| 26x | ° | ± | 2 | 3 | ´ | µ | ¶ | · | ¸ | 1 | º | » | ¼ | ½ | ¾ | ¿ |
| 30x | À | Á | Â | Ã | Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í | Î | Ï |
| 32x | Ð | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û | Ü | Ý | Þ | ß |
| 34x | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï |
| 36x | ð | ñ | ò | ó | ô | õ | ö | ÷ | ø | ù | ú | û | ü | ý | þ | ÿ |

## Font Times



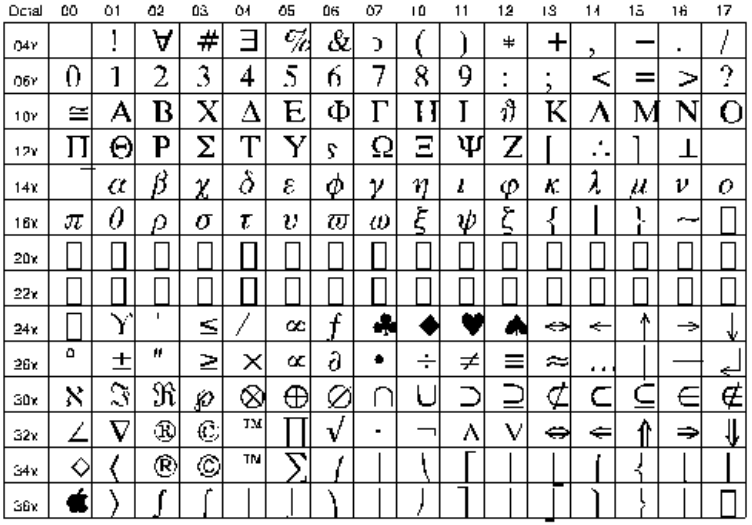
| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | " | # | $ | % | & | ' | ( | ) | * | + | , | - | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 10x | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 12x | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | |
| 14x | ` | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o |
| 16x | p | q | r | s | t | u | v | w | x | y | z | { | \| | } | ~ | □ |
| 20x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 22x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 24x | | ¡ | ¢ | £ | ¤ | ¥ | ¦ | § | ¨ | © | ª | « | ¬ | - | ® | ¯ |
| 26x | ° | ± | 2 | 3 | ´ | µ | ¶ | · | ¸ | 1 | º | » | ¼ | ½ | ¾ | ¿ |
| 30x | À | Á | Â | Ã | Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í | Î | Ï |
| 32x | Ð | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û | Ü | Ý | Þ | ß |
| 34x | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï |
| 36x | ð | ñ | ò | ó | ô | õ | ö | ÷ | ø | ù | ú | û | ü | ý | þ | ÿ |

## Font Courier



| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | " | # | $ | % | & | ' | ( | ) | * | + | , | - | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 10x | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 12x | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | |
| 14x | ` | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o |
| 16x | p | q | r | s | t | u | v | w | x | y | z | { | \| | } | ~ | □ |
| 20x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 22x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 24x | | ¡ | ¢ | £ | ¤ | ¥ | ¦ | § | ¨ | © | ª | « | ¬ | - | ® | ¯ |
| 26x | ° | ± | 2 | 3 | ´ | µ | ¶ | · | ¸ | 1 | º | » | ¼ | ½ | ¾ | ¿ |
| 30x | À | Á | Â | Ã | Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í | Î | Ï |
| 32x | Ð | Ñ | Ò | Ó | Ô | Õ | Ö | × | Ø | Ù | Ú | Û | Ü | Ý | Þ | ß |
| 34x | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï |
| 36x | ð | ñ | ò | ó | ô | õ | ö | ÷ | ø | ù | ú | û | ü | ý | þ | ÿ |

## Font Symbol



| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | ∀ | # | ∃ | % | & | ∋ | ( | ) | * | + | , | − | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 10x | ≅ | Α | Β | Χ | Δ | Ε | Φ | Γ | Η | Ι | ϑ | Κ | Λ | Μ | Ν | Ο |
| 12x | Π | Θ | Ρ | Σ | Τ | Υ | ς | Ω | Ξ | Ψ | Ζ | [ | ∴ | ] | ⊥ | |
| 14x | ‾ | α | β | χ | δ | ε | φ | γ | η | ι | φ | κ | λ | μ | ν | ο |
| 16x | π | θ | ρ | σ | τ | υ | ϖ | ω | ξ | ψ | ζ | { | \| | } | ~ | □ |
| 20x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 22x | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |
| 24x | □ | ϒ | ′ | ≤ | ⁄ | ∞ | ƒ | ♣ | ♦ | ♥ | ♠ | ↔ | ← | ↑ | → | ↓ |
| 26x | ° | ± | ″ | ≥ | × | ∝ | ∂ | • | ÷ | ≠ | ≡ | ≈ | … | \| | — | ↵ |
| 30x | ℵ | ℑ | ℜ | ℘ | ⊗ | ⊕ | ∅ | ∩ | ∪ | ⊃ | ⊇ | ⊄ | ⊂ | ⊆ | ∈ | ∉ |
| 32x | ∠ | ∇ | ® | © | ™ | ∏ | √ | · | ¬ | ∧ | ∨ | ⇔ | ⇐ | ⇑ | ⇒ | ⇓ |
| 34x | ◊ | ⟨ | ® | © | ™ | ∑ | ⌠ | \| | \ | ⎡ | \| | \| | ⌠ | { | \| | \| |
| 36x | | ⟩ | ⌡ | ⌡ | \| | \| | \ | \| | ⌡ | ⎤ | \| | ⌡ | ⟩ | } | \| | □ |

# Vector Font Samples

The following figures show samples of various vector-drawn fonts. The SHOWFONT command was used to create these figures. For example, to display the following figure on the screen, you would the command:

```
SHOWFONT, 3, 'Simplex Roman'
```

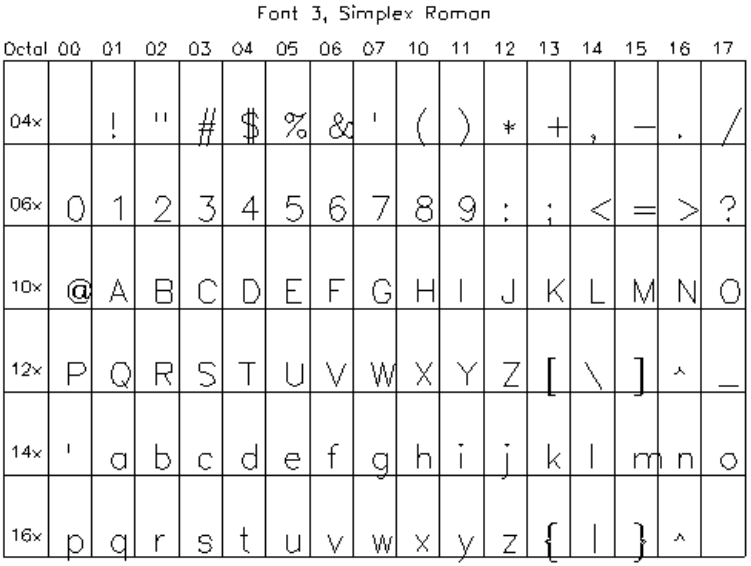
To output this figure to a postscript file, you would use the following commands:

```
SET_PLOT, 'PS'
SHOWFONT, 3, 'Simplex Roman'
DEVICE, /CLOSE
```

For more information, see “SHOWFONT” on page 1788.

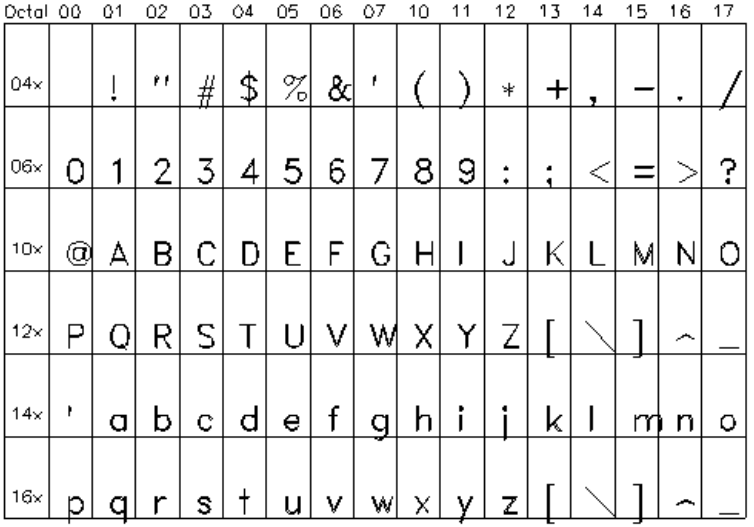
**Note**

The following font charts are numbered in octal notation. To read the octal number of a character, add the column index (along the top) to ten times the row index. For example, the capital letter “A” is octal 101, and the “$” symbol is octal 44.

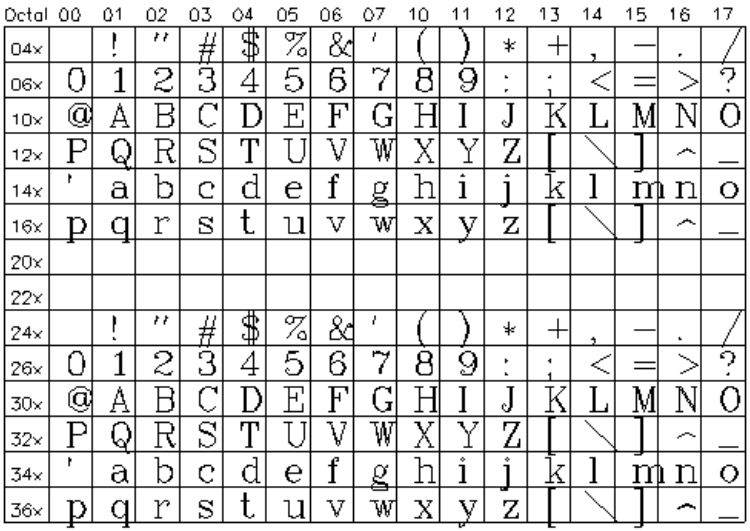


Font 4, Simplex Greek


Font 5, Duplex Roman



Font 6, Complex Roman

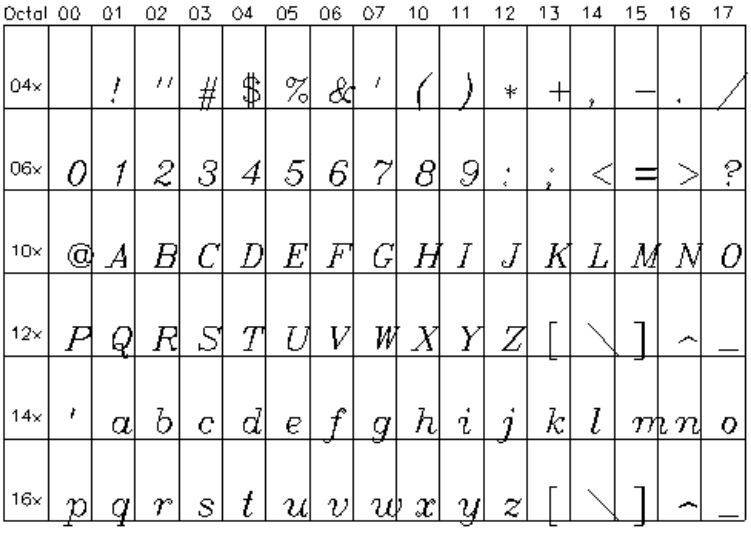


| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | " | # | $ | % | & | ' | ( | ) | * | + | , | — | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 10x | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 12x | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ |
| 14x | ' | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o |
| 16x | p | q | r | s | t | u | v | w | x | y | z | [ | \ | ] | ^ | _ |
| 20x | | | | | | | | | | | | | | | | |
| 22x | | | | | | | | | | | | | | | | |
| 24x | | ! | " | # | $ | % | & | ' | ( | ) | * | + | , | — | . | / |
| 26x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 30x | @ | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 32x | P | Q | R | S | T | U | V | W | X | Y | Z | [ | \ | ] | ^ | _ |
| 34x | ' | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o |
| 36x | p | q | r | s | t | u | v | w | x | y | z | [ | \ | ] | ^ | _ |

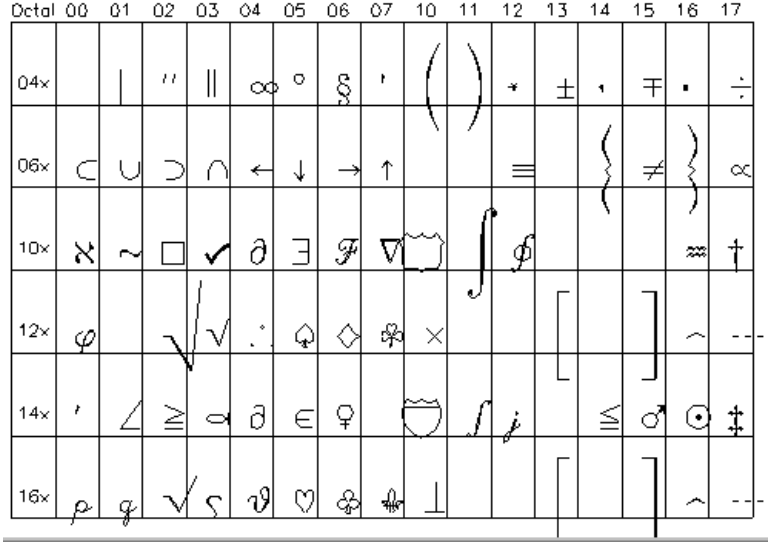
Font 7, Complex Greek

| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | " | # | $ | % | & | ' | ( | ) | * | + | , | — | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 10x | @ | A | B | Γ | Δ | E | Z | H | Θ | I | K | Λ | M | N | Ξ | O |
| 12x | Π | P | Σ | T | ϒ | Φ | X | Ψ | Ω | ∞ | ℓ | [ | \ | ] | ^ | _ |
| 14x | ' | α | β | γ | δ | ϵ | ζ | η | θ | ι | κ | λ | μ | ν | ξ | ο |
| 16x | π | ρ | σ | τ | υ | ϕ | χ | ψ | ω | ∞ | ℓ | [ | \ | ] | ^ | _ |

Font 8, Complex Italic

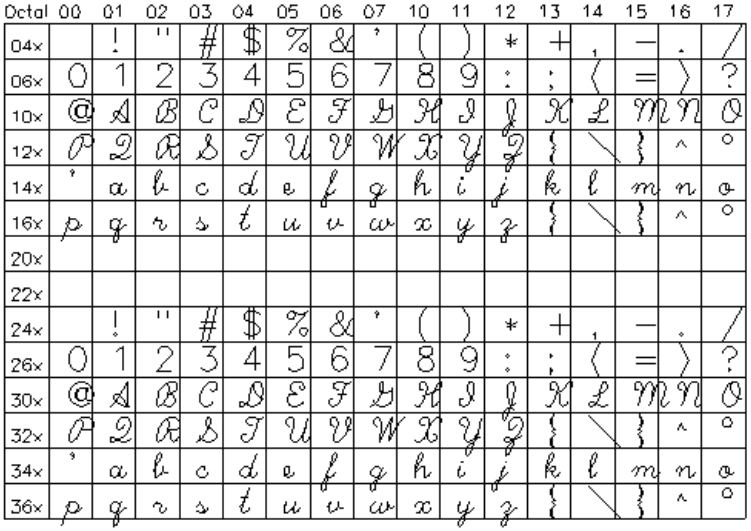



Font 9, Math and Special

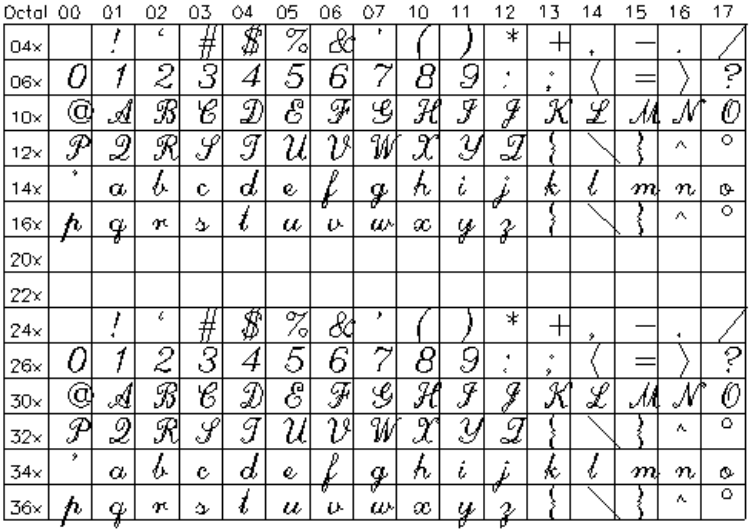


Font 11, Gothic English

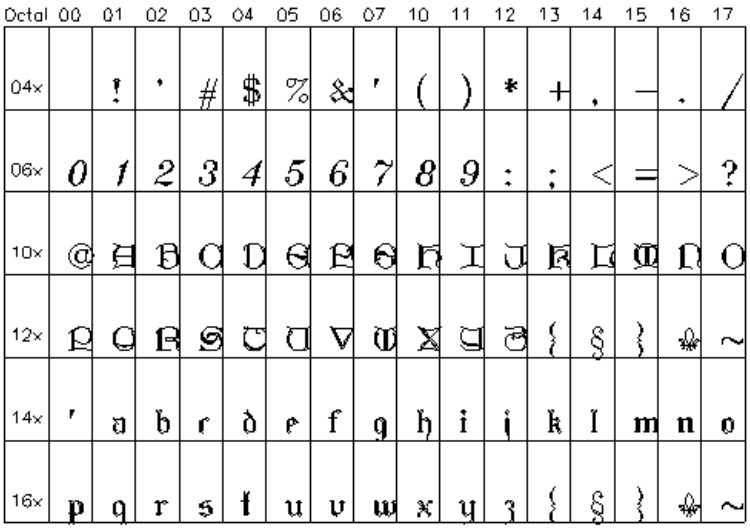
Font 12, Simplex Script



Font 13, Complex Script



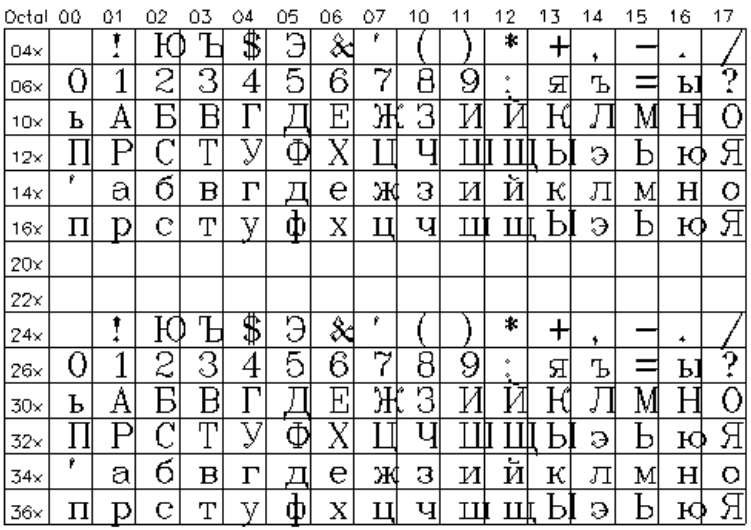

Font 14, Gothic Italian



Font 15, Gothic German

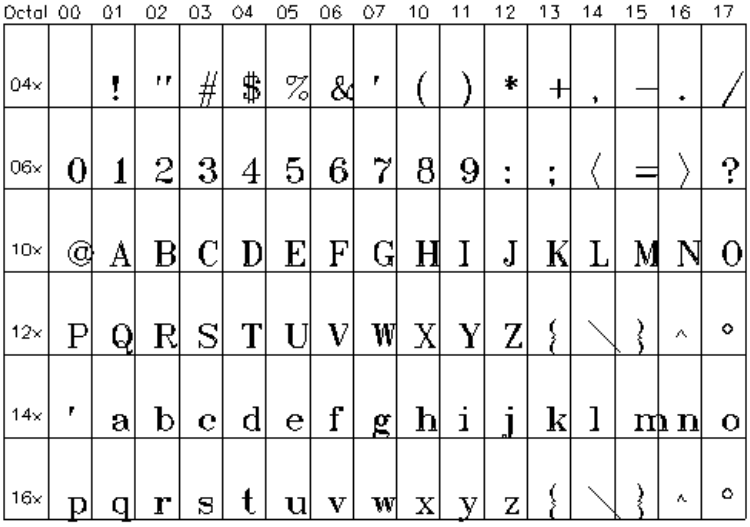
| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | " | # | $ | % | & | ' | ( | ) | * | + | , | - | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | ; | < | = | > | ? |
| 10x | ß | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
| 12x | P | Q | R | S | T | U | V | W | X | Y | Z | [ | ß | ] | ß | ~ |
| 14x | ' | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o |
| 16x | p | q | r | s | t | u | v | w | x | y | z | { | ß | } | ß | ~ |

Font 16, Cyrillic

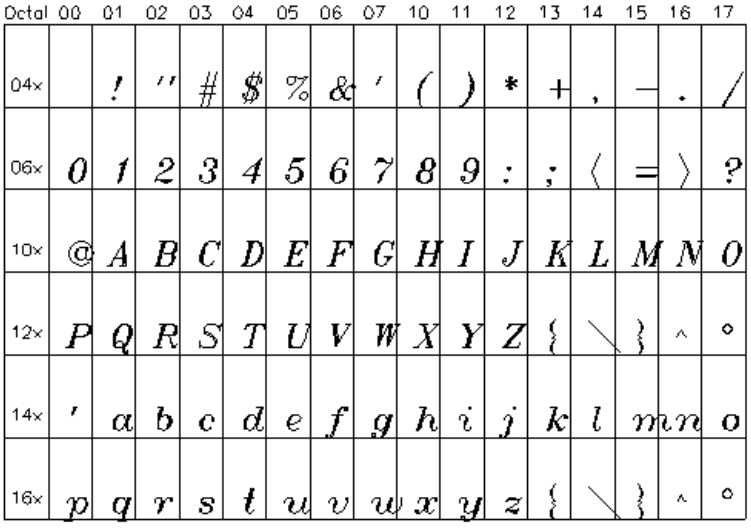


| Octal | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04x | | ! | Ю | Ъ | $ | Э | & | ' | ( | ) | * | + | , | - | . | / |
| 06x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | я | ъ | = | ы | ? |
| 10x | ь | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| 12x | П | Р | С | Т | У | Ф | Х | Ц | Ч | Ш | Щ | Ы | э | Ь | ю | Я |
| 14x | ' | а | б | в | г | д | е | ж | з | и | й | к | л | м | н | о |
| 16x | п | р | с | т | у | ф | х | ц | ч | ш | щ | ы | э | ь | ю | я |
| 20x | | | | | | | | | | | | | | | | |
| 22x | | | | | | | | | | | | | | | | |
| 24x | | ! | Ю | Ъ | $ | Э | & | ' | ( | ) | * | + | , | - | . | / |
| 26x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | : | я | ъ | = | ы | ? |
| 30x | ь | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| 32x | П | Р | С | Т | У | Ф | Х | Ц | Ч | Ш | Щ | Ы | э | Ь | ю | Я |
| 34x | ' | а | б | в | г | д | е | ж | з | и | й | к | л | м | н | о |
| 36x | п | р | с | т | у | ф | х | ц | ч | ш | щ | ы | э | ь | ю | я |

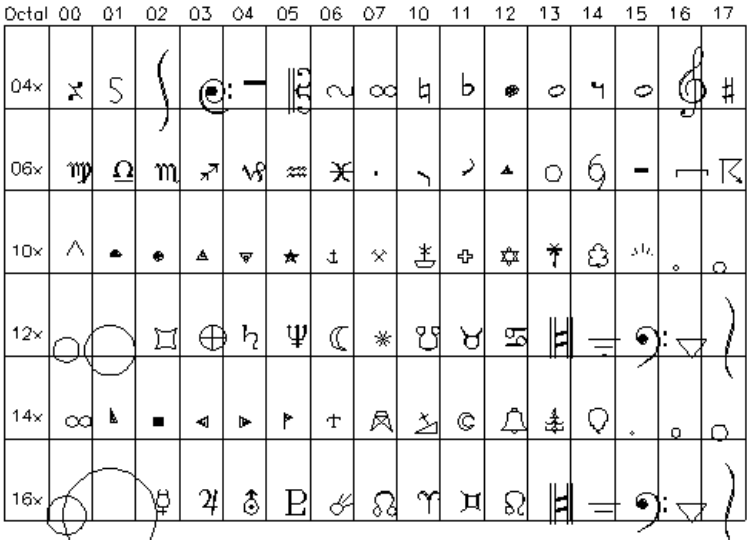
Font 17, Triplex Roman

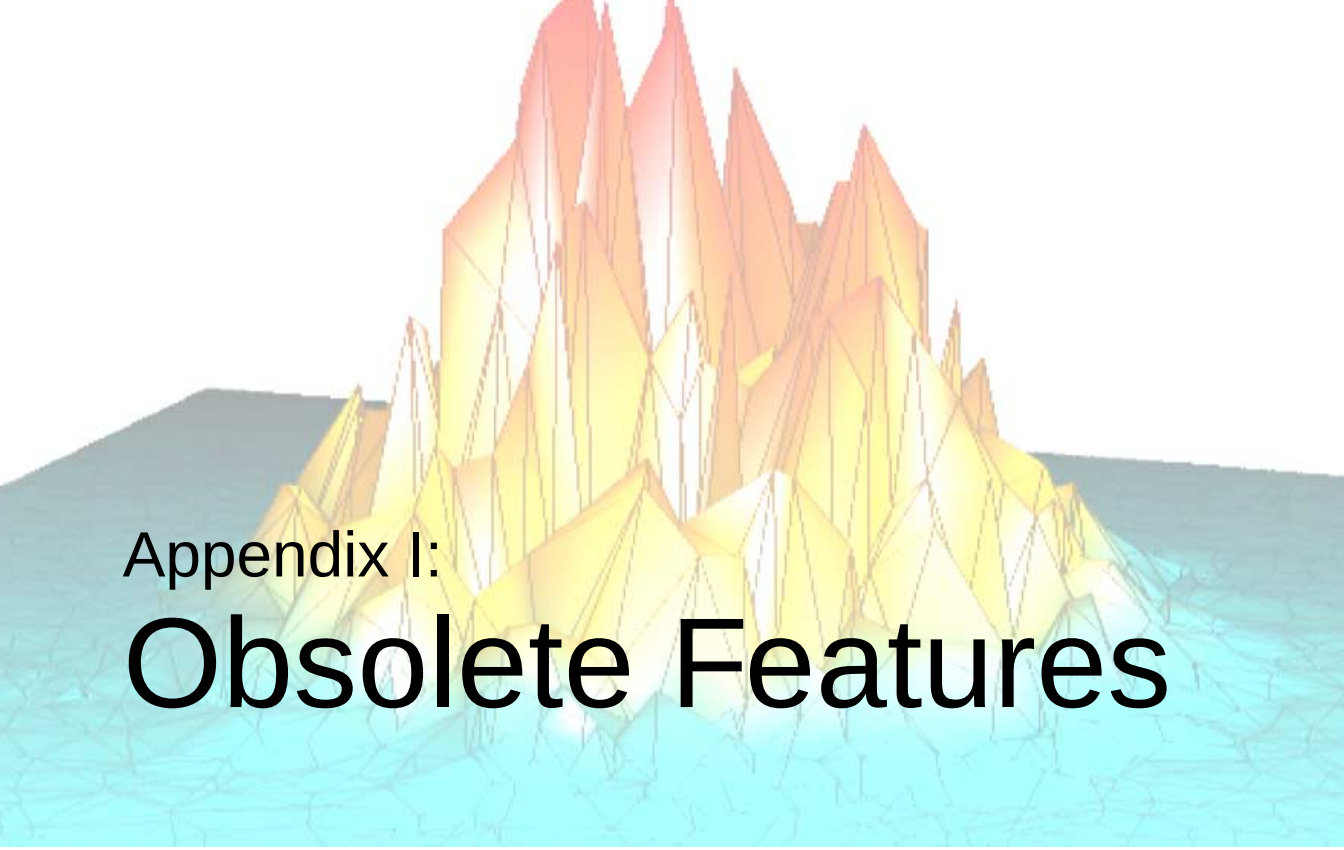



Font 18, Triplex Italic



Font 20, Miscellaneous





# Appendix I: Obsolete Features

The following topics are covered in this appendix:

# What Are Obsolete Features?

To improve the overall quality and functionality of IDL, Research Systems, Inc. occasionally replaces existing routines with new, improved routines. In many cases, existing routines are improved without changing their existing behavior—through improvements of the underlying algorithms, for example, or by adding keyword functionality. In some cases, however, the improved methods are incompatible with the old. In these situations, we consider the routines that we have replaced to be *obsolete*.

For similar reasons, arguments and keywords to existing routines may occasionally become obsolete. In many cases, the functionality activated by the obsolete argument or keyword can be achieved more efficiently using a new argument or keyword. If this is the case, existing code using the obsolete argument or keyword will generally continue to function as it always has, although performance may be better using the new, replacement argument or keyword. In cases where the obsolete argument or keyword activated functionality that is no longer available (perhaps as a result of an operating system upgrade or change), IDL will either quietly ignore the presence of the argument or keyword (if doing so does not affect the resulting output) or warn that an invalid parameter has been specified.

This chapter lists the routines that have become obsolete in each version of IDL. These routines are not documented in the online help. To view reference information for routines obsoleted in IDL version 5.0 and later, see the `obsolete.pdf` file in the `docs` subdirectory of the IDL distribution. Routines obsoleted in IDL 4.0 and earlier are not documented in the `obsolete.pdf` file. If a `.pro` file for the routine exists, it is located in the `lib/obsolete` subdirectory of the IDL distribution. You can read the documentation header of a routine in the `obsolete` directory either by opening the `.pro` file or using the DOC_LIBRARY routine.

# Routines Obsoleted in IDL 6.0

The following routines were present in IDL Version 5.6 but became obsolete in IDL Version 6.0.

**Note**

For information about routines replaced by the iTools system, see the *iTools User's Guide*.

| Routine | Replaced by | .pro File? |
|---|---|---|
| LIVE_CONTOUR | ICONTOUR | |
| LIVE_CONTROL | iTools system | |
| LIVE_DESTROY | iTools system | |
| LIVE_EXPORT | iTools system | |
| LIVE_IMAGE | IIMAGE | |
| LIVE_INFO | iTools system | |
| LIVE_LINE | iTools system | |
| LIVE_LOAD | iTools system | |
| LIVE_OPLOT | IPLOT | |
| LIVE_PLOT | IPLOT | |
| LIVE_PRINT | iTools system | |
| LIVE_RECT | iTools system | |
| LIVE_STYLE | iTools system | |
| LIVE_SURFACE | ISURFACE | |
| LIVE_TEXT | iTools system | |

*Table I-1: Routines Obsoleted in IDL 5.6*

# Routines Obsoleted in IDL 5.6

The following routines were present in IDL Version 5.5 but became obsolete in IDL Version 5.6.

| Routine | Replaced by | .pro File? |
|---|---|---|
| HDF_VD_GETNEXT | HDF_VG_GETNEXT | |
| VAX_FLOAT | VAX_FLOAT keyword to OPEN | |

*Table I-2: Routines Obsoleted in IDL 5.6*

# Routines Obsoleted in IDL 5.5

The following routines were present in IDL Version 5.4 but became obsolete in IDL Version 5.5.

| Routine | Replaced by | .pro File? |
|---|---|---|
| DELETE_SYMBOL | n/a | |
| DELLOG | n/a | |
| DO_APPLE_SCRIPT | n/a | |
| ERRORF | ERF | |
| GET_SYMBOL | n/a | |
| LJLCT | n/a | |
| REWIND | n/a | |
| SET_SYMBOL | n/a | |
| SETLOG | n/a | |
| SKIPF | n/a | |
| TAPRD | n/a | |
| TAPWRT | n/a | |
| TRNLOG | n/a | |
| WEOF | n/a | |

*Table I-3: Routines Obsoleted in IDL 5.5*

# Routines Obsoleted in IDL 5.4

The following routines were present in IDL Version 5.3 but became obsolete in IDL Version 5.4.

| Routine | Replaced by | .pro File? |
|---|---|---|
| POLYFITW | POLY_FIT, MEASURE_ERRORS keyword | `polyfitw.pro` |
| RIEMANN | RADON | |

*Table I-4: Routines Obsoleted in IDL 5.4*

# Routines Obsoleted in IDL 5.3

The following routines were present in IDL Version 5.2 but became obsolete in IDL Version 5.3.

| Routine | Replaced by | .pro File? |
|---|---|---|
| HDF_DFSD_* Routines | HDF_SD_* Routines | |
| RSTRPOS | STRPOS, /REVERSE_SEARCH | `rstrpos.pro` |
| STR_SEP | STRSPLIT for single character delimiters<br>STRSPLIT, /REGEX for longer delimiters | `str_sep.pro` |

*Table I-5: Routines Obsoleted in IDL 5.3*

# SDF Routines Obsoleted in IDL 5.3

HDF_DFSD_* routines have been obsoleted in IDL 5.3.

## What is DFSD and Why Are We Obsoleting It?

DFSD is an SD (Scientific Data Model). DFSD is the older, single-file SD form. The newer SD format, MFSD, is referred to in the IDL API as HDF_SD_*. New IDL code should use HDF_SD_* routines rather than HDF_DFSD_* routines.

Version HDF4.1r2 of HDF has obsoleted the DFSD interface, somewhat forcing us to do so as well. IDL 5.3 uses HDF4.1r3 (Version 4.1, revision 3). It is recommended that users convert their old HDF files to the 4.1r3 format.

The following HDF routines have been obsoleted in IDL 5.3.

- HDF_DFSD_ADDDATA
- HDF_DFSD_DIMGET
- HDF_DFSD_DIMSET
- HDF_DFSD_ENDSLICE
- HDF_DFSD_GETDATA
- HDF_DFSD_GETINFO
- HDF_DFSD_GETSLICE
- HDF_DFSD_PUTSLICE
- HDF_DFSD_READREF
- HDF_DFSD_SETINFO
- HDF_DFSD_STARTSLICE

# Routines Obsoleted in IDL 5.2

The following routines were present in IDL Version 5.1 but became obsolete in IDL Version 5.2.

| Routine | Replaced by | .pro File? |
|---|---|---|
| DEMO_MODE | LMGR | `demo_mode.pro` |

*Table I-6: Routines Obsoleted in IDL 5.2*

# Routines Obsoleted in IDL 5.1

The following routines were present in IDL Version 5.0 but became obsolete in IDL Version 5.1.

| Routine | Replaced by | .pro File? |
|---|---|---|
| SLICER | SLICER3 | `slicer3.pro` |

*Table I-7: Routines Obsoleted in IDL 5.1*

# Routines Obsoleted in IDL 5.0

The following routines were present in IDL Version 4.0 but became obsolete in IDL Version 5.0.

| Routine | Replaced by | .pro File? |
|---|---|---|
| DDE Routines | n/a | |
| GETHELP | OUTPUT keyword to HELP | |
| HANDLE_CREATE | PTR_NEW | |
| HANDLE_FREE | PTR_FREE | |
| HANDLE_INFO | PTR_VALID | |
| HANDLE_MOVE | n/a | |
| HANDLE_VALUE | dereference operator | |
| INP, INPW, OUTP, OUTPW | n/a | |
| PICKFILE | DIALOG_PICKFILE | |
| Old RPC API | New RPC API | |
| .SIZE Executive Command | No longer needed | |
| TIFF_DUMP | n/a | |
| TIFF_READ | READ_TIFF | |
| TIFF_WRITE | WRITE_TIFF | |
| WIDED | n/a | |
| WIDGET_MESSAGE | DIALOG_MESSAGE | |

*Table I-8: Routines Obsoleted in IDL 5.0*

# Routines Obsoleted in IDL 4.0 or Earlier

The following routines became obsolete in IDL version 4.0 or earlier. These routines are not documented in the `obsolete.pdf` file. If a `.pro` file for the routine exists, it is located in the `obsolete` subdirectory of the `lib` directory of the IDL distribution. You can read the documentation header of a routine in the `obsolete` directory either by opening the `.pro` file or using the DOC_LIBRARY routine.

| Routine | Replaced by | .pro File? |
|---|---|---|
| ADDSYSVAR | DEFSYSV | `addsysvar.pro` |
| ADJCT | XPALETTE | `adjct.pro` |
| ANOVA | KW_TEST | `anova.pro` |
| ANOVA_UNEQUAL | KW_TEST | `anova_uneqal.pro` |
| BETAI | IBETA | `betai.pro` |
| C_EDIT | XPALETTE | `c_edit.pro` |
| CALL_VMS | CALL_EXTERNAL | |
| CHI_SQR | CHISQR_CVF | `chi_sqr.pro` |
| CHI_SQR1 | CHISQR_PDF | `chi_sqr1.pro` |
| COLOR_EDIT | XPALETTE | `color_edit.pro` |
| CONTINGENT | CTI_TEST | `contingent.pro` |
| CORREL_MATRIX | CORRELATE | `correl_matrix.pro` |
| COSINES | n/a | `cosines.pro` |
| CW_BSELECTOR | WIDGET_DROPLIST | `cw_bselector.pro` |
| CW_LOADSTATE | NO_COPY keyword to WIDGET_CONTROL | `cw_loadstate.pro` |
| CW_SAVESTATE | NO_COPY keyword to WIDGET_CONTROL | `cw_savestate.pro` |
| DIFFEQ_23 | RK4 | `diffeq_23.pro` |

*Table I-9: Routines Obsoleted in IDL 4.0 or Earlier*

| Routine | Replaced by | .pro File? |
|---|---|---|
| DIFFEQ_45 | RK4 | diffeq_23.pro |
| DISP_TEXT | XYOUTS | disp_text.pro |
| EIGEN_II | EIGENVEC | eigen_ii.pro |
| EQUAL_VARIANCE | FV_TEST | equal_variance.pro |
| F_TEST | F_CVF | f_test.pro |
| F_TEST1 | F_PDF | f_test1.pro |
| FILLCONTOUR | FILL keyword to CONTOUR | fillcontour.pro |
| FORRD | READU | |
| FORRD_KEY | READU | |
| FORWRT | WRITEU | |
| FRIEDMAN | KW_TEST | friedman.pro |
| GAUSS | GAUSS_CVF | gauss.pro |
| GOODFIT | XSQ_TEST | goodfit.pro |
| HELP_VM | MEMORY keyword to HELP | help_vm.pro |
| HSV_TO_RGB | COLOR_CONVERT | hsv_to_rgb.pro |
| JOIN | CLUSTER | join.pro |
| KMEANS | CLUSTER | kmeans.pro |
| KRUSKAL_WALLIS | KW_TEST | kruskal_wallis.pro |
| LATLON | n/a | latlon.pro |
| LEGO | LEGO keyword to SURFACE | lego.pro |
| LISTREP | n/a | listrep.pro |
| LISTWISE | n/a | listwise.pro |

*Table I-9: Routines Obsoleted in IDL 4.0 or Earlier (Continued)*

| Routine | Replaced by | .pro File? |
|---|---|---|
| LN03 | n/a | ln03.pro |
| LUBKSB | LUSOL | |
| LUDCMP | LUDC | |
| MAKETREE | CLUSTER | maketree.pro |
| MANN_WHITNEY | RS_TEST | mann_whitney.pro |
| MENUS | WIDGET_DROPLIST, etc. | menus.pro |
| MIPSEB_DBLFIXUP | n/a | mipseb_dblfixup.pro |
| MOVIE | XINTERANIMATE | movie.pro |
| MPROVE | LUMPROVE | |
| MULTICOMPARE | Hypothesis Testing Routines | multicompare.pro |
| NR_BETA | BETA | |
| NR_BROYDN | BROYDEN | |
| NR_CHOLDC | CHOLDC | |
| NR_CHOLSL | CHOLSOL | |
| NR_DFPMIN | DFPMIN | |
| NR_ELMHES | ELMHES | nr_elmhes.pro |
| NR_EXPINT | EXPINT | |
| NR_FULSTR | FULSTR | |
| NR_HQR | HQR | nr_hqr.pro |
| NR_INVERT | INVERT | |
| NR_LINBCG | LINBCG | |
| NR_LUBKSB | LUSOL | nr_lubksb.pro |
| NR_LUDCMP | LUDC | nr_ludcmp.pro |
| NR_MACHAR | MACHAR | |

*Table I-9: Routines Obsoleted in IDL 4.0 or Earlier (Continued)*

| Routine | Replaced by | .pro File? |
|---|---|---|
| NR_MPROVE | LUMPROVE | |
| NR_NEWT | NEWTON | |
| NR_POWELL | POWELL | |
| NR_QROMB | QROMB | |
| NR_QROMO | QROMO | |
| NR_QSIMP | QSIMP | |
| NR_RK4 | RK4 | |
| NR_SPLINE | SPL_INIT | |
| NR_SPLINT | SPL_INTERP | |
| NR_SPRSAB | SPRSAB | |
| NR_SPRSAX | SPRSAX | |
| NR_SPRSIN | SPRSIN | `nr_sprsin.pro` |
| NR_SVBKSB | SVSOL | `nr_svbksb.pro` |
| NR_SVD | SVDC | `nr_svd.pro` |
| NR_TQLI | TRIQL | |
| NR_TRED2 | TRIRED | |
| NR_TRIDAG | TRISOL | |
| NR_WTN | WTN | `nr_wtn.pro` |
| NR_ZROOTS | FZ_ROOTS | |
| ONLY_8BIT | n/a | `only_8bit.pro` |
| PALETTE | XPALETTE | `palette.pro` |
| PARTIAL2_COR | P_CORRELATE | `partial2_cor.pro` |
| PARTIAL_COR | P_CORRELATE | `partical_cor.pro` |
| PHASER | n/a | `phaser.pro` |

*Table I-9: Routines Obsoleted in IDL 4.0 or Earlier (Continued)*

| Routine | Replaced by | .pro File? |
|---|---|---|
| PM | n/a | pm.pro |
| PMF | n/a | pmf.pro |
| POLYCONTOUR | FILL keyword to CONTOUR | polycontour.pro |
| PROMPT | n/a | prompt.pro |
| PWIDGET | n/a | pwidget.pro |
| REGRESS1 | REGRESS | regress1.pro |
| REGRESSION | REGRESS | regression.pro |
| RGB_TO_HSV | COLOR_CONVERT | rgb_to_hsv.pro |
| RM | n/a | rm.pro |
| RMF | n/a | rmf.pro |
| ROT_INT | ROT | rot_int.pro |
| RSI_GAMMAI | IGAMMA | rsi_gamma.pro |
| RUNS_TEST | R_TEST | runs_test.pro |
| SET_NATIVE_PLOT | n/a | set_native_plot.pro |
| SET_SCREEN | n/a | set_screen.pro |
| SET_VIEWPORT | n/a | set_viewport.pro |
| SET_XY | n/a | set_xy.pro |
| SIGMA | MOMENT | sigma.pro |
| SIGN_TEST | S_TEST | sign_test.pro |
| SIMPSON | QSIMP or QROMB | simpson.pro |
| SPEARMAN | R_CORRELATE | sprearman.pro |
| STDEV | MOMENT | stdev.pro |
| STEPWISE | REGRESS | stepwise.pro |
| STUDENT1_T | T_PDF | student1_t.pro |

*Table I-9: Routines Obsoleted in IDL 4.0 or Earlier (Continued)*

| Routine | Replaced by | .pro File? |
|---|---|---|
| STUDENT_T | T_CVF | student_t.pro |
| STUDRANGE | T_PDF | studrange.pro |
| SURFACE_FIT | SFIT | surface_fit.pro |
| SVBKSB | SVSOL | |
| SVD | SVDC | |
| TESTCONTRAST | n/a | testcontrast.pro |
| TQLI | TRIQL | |
| TRED2 | TRIRED | |
| TRIDAG | TRISOL | |
| TVDELETE | WDELETE | |
| TVRDC | CURSOR | |
| TVSET | WSET | |
| TVSHOW | WSHOW | |
| TVWINDOW | WINDOW | |
| VMSCODE | n/a | vmscode.pro |
| WILCOXON | RS_TEST | wilcoxon.pro |
| WMENU | WIDGET_DROPLIST, etc. | wmenu.pro |
| XANIMATE | XINTERANIMATE | xanimate.pro |
| XBACKREGISTER | TIMER keyword to WIDGET_CONTROL | xbackregister.pro |
| XDL | n/a | xdl.pro |
| XMANAGERTOOL | XMTOOL | xmanagertool.pro |
| XMENU | WIDGET_DROPLIST, etc. | xmenu.pro |
| XPDMENU | WIDGET_DROPLIST, etc. | xpdmenu.pro |
| ZROOTS | FZ_ROOTS | |

*Table I-9: Routines Obsoleted in IDL 4.0 or Earlier (Continued)*

# Obsolete Arguments and Keywords

The following arguments and keywords are obsolete and should not be used in new IDL code..

| Routine | Argument or Keyword | Description |
|---|---|---|
| BYTEORDER | DTOGFLOAT keyword | This keyword was available only on the VMS platform |
| | GFLOATTOD keyword | This keyword was available only on the VMS platform. |
| CALL_EXTERNAL | DEFAULT keyword | This keyword was ignored on non-VMS platforms. |
| | PORTABLE keyword | This keyword was ignored on non-VMS platforms. |
| | VAX_FLOAT keyword | This keyword was available only on the VMS platform. |
| DEVICE | DEPTH keyword | This keyword was available only on the VMS platform. |
| | FONT keyword | This keyword was replaced by the SET_FONT keyword. |
| DOC_LIBRARY | FILE keyword | This keyword was ignored on non-VMS platforms. |
| | PATH keyword | This keyword was ignored on non-VMS platforms. |
| | OUTPUTS keyword | This keyword was available only on the VMS platform. |
| EXTRACT_SLICE | CUBIC keyword | EXTRACT_SLICE does not support cubic interpolation. |
| IDLgrMPEG::Save | CREATOR_TYPE keyword | This keyword was ignored on non-Macintosh OS 9 (and earlier) platforms. |

*Table I-10: Arguments and Keywords Obsoleted in IDL 5.5*

| Routine | Argument or Keyword | Description |
|---|---|---|
| LINKIMAGE | DEFAULT keyword | This keyword was ignored on non-VMS platforms. |
| LIVE_PRINT | SETUP keyword | This keyword was ignored on non-Macintosh OS 9 (and earlier) platforms. |
| MAKE_DLL | VAX_FLOAT keyword | This keyword was ignored on non-VMS platforms. |
| ONLINE_HELP | HTML_HELP keyword | This keyword is no longer necessary; ONLINE_HELP parses the value of the BOOK keyword to determine file type. |
| OPEN | *Record_Length* argument | This argument was ignored on non-VMS platforms. |
| | BINARY keyword | Windows file I/O changed to function like UNIX file I/O. |
| | BLOCK keyword | This keyword was ignored on non-VMS platforms. |
| | DEFAULT keyword | This keyword was ignored on non-VMS platforms. |
| | EXTENDSIZE keyword | This keyword was ignored on non-VMS platforms. |
| | FIXED keyword | This keyword was ignored on non-VMS platforms. |
| | FORTRAN keyword | This keyword was ignored on non-VMS platforms. |
| | INITIALSIZE keyword | This keyword was ignored on non-VMS platforms. |
| | KEYED keyword | This keyword was ignored on non-VMS platforms. |

*Table I-10: Arguments and Keywords Obsoleted in IDL 5.5 (Continued)*

| Routine | Argument or Keyword | Description |
|---|---|---|
| OPEN, *continued* | LIST keyword | This keyword was ignored on non-VMS platforms. |
| | MACCREATOR keyword | This keyword was ignored on non-Macintosh OS 9 (and earlier) platforms. |
| | MACTYPE keyword | This keyword was ignored on non-Macintosh OS 9 (and earlier) platforms. |
| | NOAUTOMODE keyword | Windows file I/O changed to function like UNIX file I/O. |
| | NONE keyword | This keyword was ignored on non-VMS platforms. |
| | NOSDTIO | Keyword was renamed RAWIO. |
| | PRINT keyword | This keyword was ignored on non-VMS platforms. |
| | SEGMENTED keyword | This keyword was ignored on non-VMS platforms. |
| | SHARED keyword | This keyword was ignored on non-VMS platforms. |
| | STREAM keyword | This keyword was ignored on non-VMS platforms. |
| | SUBMIT keyword | This keyword was ignored on non-VMS platforms. |
| | SUPERSEDE keyword | This keyword was ignored on non-VMS platforms. |
| | TRUNCATE_ON_CLOSE keyword | This keyword was ignored on non-VMS platforms. |

*Table I-10: Arguments and Keywords Obsoleted in IDL 5.5 (Continued)*

| Routine | Argument or Keyword | Description |
|---|---|---|
| OPEN, *continued* | UDF_BLOCK keyword | This keyword was ignored on non-VMS platforms. |
| | VARIABLE keyword | This keyword was ignored on non-VMS platforms. |
| PRINT/PRINTF | REWRITE keyword | This keyword was ignored on non-VMS platforms. |
| READ_TIFF | ORDER keyword | This keyword was replaced by the ORIENTATION keyword |
| | UNSIGNED keyword | This keyword became obsolete when IDL began supporting an unsigned 16-bit integer data type. |
| READ/READF | KEY_ID keyword | This keyword was ignored on non-VMS platforms. |
| | KEY_MATCH keyword | This keyword was ignored on non-VMS platforms. |
| | KEY_VALUE keyword | This keyword was ignored on non-VMS platforms. |
| READU | KEY_ID keyword | This keyword was ignored on non-VMS platforms. |
| | KEY_MATCH keyword | This keyword was ignored on non-VMS platforms. |
| | KEY_VALUE keyword | This keyword was ignored on non-VMS platforms. |
| SAVE | XDR keyword | IDL always writes XDR files. |

*Table I-10: Arguments and Keywords Obsoleted in IDL 5.5 (Continued)*

| Routine | Argument or Keyword | Description |
|---|---|---|
| SPAWN | FORCE keyword | This keyword was incorrectly included in the SPAWN documentation. |
| | MACCREATOR keyword | This keyword was ignored on non-Macintosh OS 9 (and earlier) platforms. |
| | NOCLISYM keyword | This keyword was ignored on non-VMS platforms. |
| | NOLOGNAM keyword | This keyword was ignored on non-VMS platforms. |
| | NOTIFY keyword | This keyword was ignored on non-VMS platforms. |
| WIDGET_BASE | APP_MBAR keyword | This keyword was ignored on non-Macintosh OS 9 (and earlier) platforms. |
| WRITE_TIFF | *Order* argument | The Order argument has been replaced by the ORIENTATION keyword. Code that uses the Order argument will continue to work as before, but new code should use the ORIENTATION keyword instead. |
| WRITEU | REWRITE keyword | This keyword was ignored on non-VMS platforms. |

*Table I-10: Arguments and Keywords Obsoleted in IDL 5.5 (Continued)*

# Obsolete System Variables

The following IDL system variables became obsolete in the change from VAX IDL (IDL version 1) to IDL version 2. While it is highly unlikely that you will find references to these system variables in existing code, we include them here because they are flagged when the OBS_SYSVARS field of the !WARN structure is set equal to one. See Appendix D, “System Variables” for information on IDL system variables.

| System Variable | Replaced by |
|---|---|
| !BCOLOR | BOTTOM keyword to SURFACE |
| !COLOR | !P.COLOR |
| !CXMAX | !X.CRANGE[1] |
| !CXMIN | !X.CRANGE[0] |
| !CYMAX | !Y.CRANGE[1] |
| !CYMIN | !Y.CRANGE[0] |
| !FANCY | No direct equivalent. Use !P.FONT and !P.CHARSIZE |
| !FLIP | No equivalent. |
| !GRID | !P.TICKLEN |
| !HI | No equivalent. |
| !IGNORE | !P.NOCLIP |
| !LINETYPE | !P.LINESTYLE |
| !LO | No equivalent. |
| !MTITLE | !P.TITLE |
| !NOERAS | !P.NOERASE |
| !NORMALCONT | FOLLOW keyword to CONTOUR |
| !NSUM | !P.NSUM |

*Table I-11: Obsolete System Variables*

| System Variable | Replaced by |
|---|---|
| !PSYM | !P.PSYM |
| !SC1 | !P.POSITION[0] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !X.WINDOW[0] * !D.X_VSIZE otherwise. |
| !SC2 | !P.POSITION[2] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !X.WINDOW[1] * !D.X_VSIZE otherwise. |
| !SC3 | !P.POSITION[1] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !Y.WINDOW[0] * !D.X_VSIZE otherwise. |
| !SC4 | !P.POSITION[3] * !D.X_VSIZE if !P.POSITION[2] is nonzero, or !Y.WINDOW[1] * !D.X_VSIZE otherwise. |
| !TERM | DEVICE procedure. |
| !TYPE | !X.TYPE, !X.STYLE, !Y.TYPE, !Y.STYLE, !P.TICKLEN |
| !XMAX | !X.RANGE[1] |
| !XMIN | !X.RANGE[0] |
| !XTICKS | !X.TICKS |
| !XTITLE | !X.TITLE |
| !YMAX | !Y.RANGE[1] |
| !YMIN | !Y.RANGE[0] |
| !YTICKS | !Y.TICKS |
| !YTITLE | !Y.TITLE |

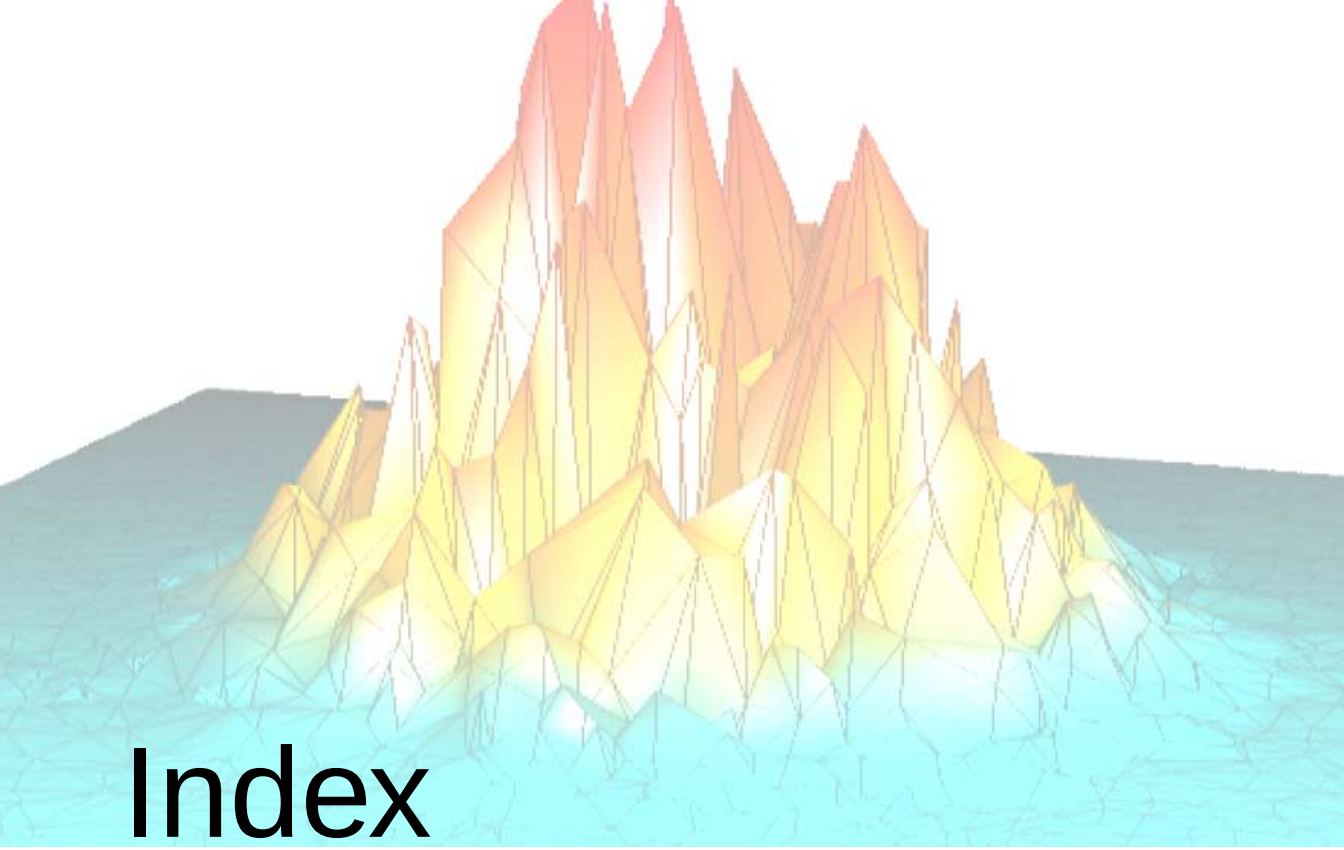
*Table I-11: Obsolete System Variables (Continued)*

# Obsolete Graphics Devices

The following arguments and keywords are obsolete and should not be used in new IDL code..

| Graphics Device | Description |
|---|---|
| The LJ Device (LJ) | The LJ device was only available in IDL for VMS. |
| The Macintosh Device (MAC) | The MAC device was only available in IDL for Macintosh versions running under OS 9 and earlier. Versions of IDL for Macintosh running under OS X and later use the X device. |

*Table I-12: Obsolete Graphics Devices*



# Index

## *Symbols*

## Numerics

## A

## *B*

## C

## *D*

## *E*

## F

## *G*

## *H*

## I

## *J*



## *K*

## *L*

## *M*

## *N*

## *O*

## *P*

## *Q*



## *R*

## S

## *T*

## *U*

## V

## *W*

## *X*

## *Y*

## *Z*