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## 1.1 Introduction

Graph Plotter is a package you can use to plot data and fit curves to plotted data. It can save you a lot of work by plotting graphs quickly and reliably. It also provides facilities to enter, edit and manipulate data.

Like other packages running under *Windows*, Graph Plotter allows you to create a number of windows, to rearrange these on the screen as you would documents on your desk, and to have considerable freedom in deciding what the program does next. The commands in the menus are automatically enabled/disabled according to the status of the program. If you are already an experienced *Windows* user, you will probably find some of the features of Graph Plotter familiar, such as the **File**, **Edit**, **Window** and **Help** menus.

## 1.2 The data table

Fundamental to Graph Plotter is the idea of the data table. The process of collecting scientific data usually involves measuring the values of one or more variables on a set of objects, or at points in space or time. An object could be a person, plant, geographical area, rock sample etc. A variable could be a measurement such as height, weight, temperature, count etc. The data table is the arrangement of these values in a table such that the rows of the table correspond to the objects or points in space or time, and the columns of the table correspond to the variables. (The terms variable and column are used interchangeably in the following.) This implies that the data table is rectangular, i.e. all the columns are the same length as each other, and all the rows are the same length as each other. Although this is usually true of the original data, you may want to produce new columns that are not the same length. Graph Plotter allows columns of different lengths in the same data table.

Individual values in a column must all be numbers in the range  $-1.7E308$  to  $1.7E308$ . By default, they are stored to a precision of five significant figures, but you can change this using the **Data precision** command.

It is usual to name the columns of the data table, which you can do using the **Rename variable** command. Column names can be any combination of up to 12 characters. The default names of the columns in Graph Plotter are V1, V2, V3, etc. Note that the case of letters in a variable name is important: e.g. "Length" is not the same as "length".

The data table, including its variable names, is stored on a file of type GPD and loaded into Graph Plotter when it is needed. Graph Plotter actually works with a temporary copy of the file so that any changes you make to the data table while running Graph Plotter are not made to the file on disk. The original data table file is changed only if you save the changed data table using the **Save** or **Save as** command.

## 1.3 The Graph Plotter screen

When you start running Graph Plotter the application window should fill the screen.

At the top of the screen is the Graph Plotter title bar reading "S103 Graph Plotter - untitled data table". This text will change to show the name of the data table file after you load a data table into Graph Plotter.

Below the title bar is the menu bar showing the menu names: **File**, **Edit**, **Plot**, **Window** and **Help**. These menus contain the commands of Graph Plotter.

Along the bottom of the screen is the status bar which displays a brief helpful message. Initially the message is "Type data into the Data window, or use the File menu to open a data file.", which is a hint as to what to do next. If you drag the mouse pointer down the menus you will see the message change to give a brief description of what each command does.

The area below the menu bar and above the status bar is the Graph Plotter desktop. Windows will appear in this desktop area as you execute Graph Plotter commands. Initially the desktop is filled by an empty data table window.

## 1.4 A typical Graph Plotter session

Having started the program by double-clicking on the Graph Plotter program icon, a typical run of Graph Plotter would proceed along the following lines.

1. You type your data into the empty data table window. You give the columns suitable names by using the **Rename variable** command.
2. You choose a command from the **Plot** menu. This produces a dialogue box for you to provide the information that the command needs - such as which variables to use.
3. You complete the dialogue box by selecting the variables and options you want and clicking on the OK button. This causes the command to be performed and output to be produced as a new graphical window.
4. Steps 2 and 3 are repeated producing more graphical windows. Eventually the **Window** menu may be used to tidy up the desktop, or some windows that are not needed may be minimized to icons or permanently closed. Some windows may be printed to save their results.
5. You use the **Save as...** command to save the data table to a GPD file.
6. Having completed the plotting, you exit Graph Plotter or start a new data table.

## 2.1 Type my own data into Graph Plotter?

Choose **New** from the **File** menu. (If you are already working with a data table and have changed the data you will see a dialogue box asking whether you want to save the changed data table: click on Yes or No as appropriate.) You will then see a dialogue box for entering the number of rows and columns. Type the number of rows into the "Number of rows" box. Now move the flashing cursor to the "Number of columns" box by clicking on it or by pressing the TAB key. (*Do not press ENTER as this will close the dialogue box.*) Now type in the number of columns you want in your data table. You should allow extra columns for new variables that you might want to create from the original data. With both numbers correctly typed, click on OK or press ENTER.

You will then see the Data window showing the data table of the size you have specified in the dialogue. All the cells are initially blank.

Click on the first cell in the first row and type in your first data value. Press the TAB key to move to the second value in the first row. Enter your data value and press TAB again. Continue entering values in this way. Alternatively, if you prefer to type in columns rather than rows, press ENTER or RETURN instead of TAB after entering a value. This will move the cursor to the next cell in the column.

Press ENTER after typing in the final value in the data table. You can go back and edit any value by clicking on it. You can also move back through columns by pressing the UP ARROW key.

When you are satisfied that you have typed in all your data correctly, you can save it in a Graph Plotter data file. To do this, choose **Save as...** from the **File** menu. This will display the Save dialogue box. Click on the File name box and use the LEFT ARROW key to move the cursor back to just after the asterisk. Use the BACKSPACE key to delete the asterisk and type in a suitable name for your new data file. Note that the file type should be GPD.

If you are typing in a substantial amount of data, it is a good idea to periodically save the data table as you type in data. Use the **Save as...** command, as described above, after typing some of the data, then periodically use the **Save** command.

Alternatively, you may prefer to type your data using some other application, such as a text editor, word processor or spreadsheet package, and save it as a text file that can be read into Graph Plotter - see Section 2.2.

## 2.2 Transfer data from other applications into Graph Plotter?

Your data may exist on a file created by some other application, such as a spreadsheet, word processor or database package. Such applications generally have their own special form of files that cannot be read by Graph Plotter. However, it is usually possible to save data as text (ASCII) files that can be read by Graph Plotter. These text files must consist of blank, comma or tab delimited data. That is, each value in a row must be separated by one or more spaces, or by a comma, or by a tab character. There must be the same number of values in each row.

To read a text file into Graph Plotter, choose **Open** from the **File** menu. In the Open dialogue, click on the "List Files of Type:" box and click on "Text(\*.txt)". If necessary, browse to the folder where the text file was saved. The name of your text file should then be listed in the dialogue box. Click on the name and click on OK. Note that the text file should consist only of data values: there should be no variable names or other information. Graph Plotter will use the default names V1, V2, ... .

Exactly how the text file is created depends on the application, but in a *Windows* application the option to save a text file will invariably be from the **File** menu, usually under Export or **Save as...** . Make sure the saved file has type TXT: e.g. the file name might be MYDATA.TXT.

Another way of transferring data into Graph Plotter is via the *Windows* clipboard. Most *Windows* applications have an **Edit** menu that includes a **Copy** command that allows you to copy selected (highlighted) data to the clipboard. You can then run Graph Plotter and choose **Paste** from the **Edit** menu to copy the data into the data table. ***Note that the copied data must represent a rectangular data table, i.e. have rows and columns of equal length.***

## 2.3 Transfer data from Graph Plotter to other applications?

You may wish to use the data in a Graph Plotter GPD file in some other application, such as a spreadsheet, word processor or database package. Such applications cannot read GPD files, but they usually can read tab-delimited text files. The transfer process is therefore the reverse of the procedure described in Section 2.2. To save data as a tab-delimited text file, choose **Save as...** from the Graph Plotter **File** menu. In the Save dialogue, click on the "List Files of Type:" box and click on "Text(\*.txt)". Edit the File name box to give the file the name you want with the TXT type. Note that the text file will consist only of data values: no variable names will be saved.

Exactly how the text file is read into the other application depends on the application, but in a *Windows* application the option to read a text file will invariably be from the **File** menu, usually under Import or **Open** .

## 2.4 Change the data values?

You can change individual values by editing them in the data table. Click on the value you want to edit. The value will be highlighted. If you start typing while the value is highlighted, then the whole value is replaced by what you type. If you want to just edit part of the value, then use the left or right arrow key to move to the characters you want to change. The value should then not be highlighted. Delete the characters you want to change using the BACKSPACE key (usually towards the top-right part of the keyboard with a left arrow on it) or the DELETE key that delete the character to the left or right of the cursor respectively.

Changed values are not written to the data file until you use the **Save** or **Save as...** commands in the **File** menu.

## 2.5 Create new variables?

You can simply type new values into an empty column of the Data window. Use the **Rename variable** command in the **Edit** menu to give the new column a name.

It is common to create new variables that are mathematical functions of existing variables. For example, if you have columns MASS1 and MASS2 you might want to create a new column called DIFF that is MASS1 minus MASS2. To evaluate expressions like these you use the **Calculate** command in the **Edit** menu. In this example you would enter "MASS1" - "MASS2" in the "Calculations on variables" dialogue. When you click on OK, every value in the MASS2 column is subtracted from the corresponding value in the MASS1 column and the results stored in corresponding rows of the next vacant column of the data table. This new column will be named using the first 12 characters of the expression you typed, but you can give the new column the name DIFF by choosing **Rename variable** from the **Edit** menu.

The **Calculate** command offers a wide range of mathematical functions for creating new data - see Section 4.3.

## 2.6 Plot a graph?

You can plot a graph of any two columns of variables from the data table by using the **Graph** command from the **Plot** menu. The Graph dialogue box displays the variables in the data table in three lists. Select the variable that you want to plot on the horizontal (X) axis by clicking on the variable name in the list on the left, and select the variable that you want to plot on the vertical (Y) axis by clicking on the variable name in the list in the middle. If you want to plot vertical error bars on your data points, then select the variable that you want to use for the error bars (E) by clicking on the list on the right. Note that the values in the column of data selected in the right box will represent the length of the error bar either side of the plotted point, i.e. the top of the error bar will be plotted at  $Y + E$  and the bottom at  $Y - E$ . Click on the 'Axes through origin' checkbox if you want the origin ( $X = 0, Y = 0$ ) to appear on the graph regardless of the range of X and Y values. Clicking on OK causes the Graph window to appear.

## 2.7 Plot a histogram?

You can plot a histogram of the values in any column of variables from the data table by using the **Histogram** command from the **Plot** menu. The Histogram dialogue box displays a list of variables in the data table. Select the variable for which you want to display a histogram by clicking on the variable name. You can specify where the first interval for the first bar of the histogram starts, and the width of each interval, by editing the boxes. The Graph Plotter will then calculate the frequencies of the values of the selected variable for each interval. Alternatively you can leave AUTO showing in the box for width of intervals, so that Graph Plotter chooses the interval automatically. Clicking on OK causes the Histogram window to appear.

## 2.8 Print a window?

Before running Graph Plotter, make sure your printer is connected and installed under *Windows*: see your *Windows* documentation under Print Manager.

To print a window from Graph Plotter, activate the window you want to print by clicking on its title bar or choosing its title from the **Window** menu. Choose **Print** from the **File** menu.

## 2.9 Save a graph and use it in another package?

Activate the graph window you want to save: i.e. click on the window or select its title from the **Window** menu. Choose **Save** or **Save as...** from the **File** menu. You will then see the Save plot dialogue. The default file type is WMF. Delete the asterisk in the filename box and type a suitable name for the graph file. The default directory for Graph Plotter files is c:\S103\gp\data, but you can select an alternative directory in which to save the file if you wish. Click on OK to save the file. WMF stands for *Windows* Meta File, which is a standard graphical format that can be read by some other *Windows* programs such as drawing packages, word processors and other plotting packages. For example, if you have saved a Graph Plotter graph window in a file called PLOT1.WMF, you can insert the plot into a Microsoft Word document by choosing **Picture** from Word's **Insert** menu and selecting file PLOT1.WMF in the Insert Picture dialogue.

## 3.1 Introduction

Windows in Graph Plotter are like sheets of paper on a scientist's desk. One window shows the data and there may be several graphical windows showing various plots. Like sheets of paper they can be moved around and overlap each other, with the window of interest usually being on top. Unlike sheets of paper, the Data window can be scrolled through and the graphical windows can be re-sized. Windows are created by choosing commands from the menus: commands in the **Plot** menu each create different kinds of plots. The number of graphical windows that can be created is limited only by the memory of your computer.

All windows have a title bar, control-menu, border, minimize and maximize buttons. The Data window also has scroll bars.

New windows are created with a default size and position such that they overlap in a cascading arrangement on your screen, but you are free to resize and arrange all the windows to suit yourself. The **Window** menu (see Section 4.5) is useful for arranging windows. Note that graphical windows (histograms and graphs) automatically rescale themselves to fit the plot into the window but the Data window will not show all the data if the size of the window is too small.

Some windows have pop-up menus that appear when you click on the window with the right mouse button. These menus control options that are relevant to that particular window. To use a pop-up menu, make sure the window is active (by clicking on it or choosing it from the **Window** menu). Position the mouse pointer within the window and press the right mouse button. The pop-up menu should then appear (if not, then that window does not have a pop-up menu associated with it). Keeping the right mouse button pressed, move the pointer through the menu until the option you want is highlighted and release the button. If you decide you do not want to choose any of the menu options, move the mouse pointer outside the menu and release the button when no options are highlighted.

If your mouse has only one button, you can obtain the pop-up menus by pressing the shift key while clicking. You will need to click again to choose the option in the pop-up menu.

## 3.2 Data window

The Data window allows you to view or edit the data table or type in new values. This window shows the names of the variables at the top of the columns and numbers of the rows on the left.

The Data window for all variables is automatically displayed when you open a new data table or GPD file. There can be only one Data window showing, corresponding to the current data table.

A value is edited/entered by moving the mouse pointer to the appropriate cell and clicking on it. You should then see the value highlighted and a flashing cursor. The existing value can be edited using the usual editing keys (BACKSPACE, DELETE, left and right arrows), and the required value typed in. If you start typing before using one of the editing keys, then the old value completely disappears and is replaced by what you type.

If you are typing in rows of data, press the TAB key after typing a value to move to the next cell in the row. If you are typing in columns of data, press the ENTER or RETURN key after typing a value to move to the next cell in the column. You can also move backwards through a row by pressing SHIFT-TAB and move up and down columns by pressing the up and down arrow keys.

This window can be scrolled vertically and horizontally to view all of the data values when there are too many rows or columns to fit on the screen.

The values you type into a cell must be numbers in the range  $-1.7E308$  to  $1.7E308$ . By default, they are stored to an precision of five significant figures, but you can change this using the **Data precision** command. You can also type mathematical expressions that will automatically be evaluated and entered into the cell to the current precision. For example, if you type  $1/3$  and the current precision is 5, then the value 0.33333 will appear in the cell. If you enter an expression that cannot be interpreted as a number, you will see an error message when you try to move to a new cell.

Data can also be pasted into the data table from the *Windows clipboard*. This provides a mechanism for transferring data from other *Windows* applications. To paste data from the clipboard, activate the Data window and choose **Paste** from the **Edit** menu. (The **Paste** command is enabled only if there is data in the clipboard.) The data should appear in the first empty columns of the data table. The success of this operation, however, depends on the contents of the clipboard being in a suitable form for Graph Plotter. The data must be ASCII text (not graphical) and the values must be separated by spaces, commas or tab characters. ***The data must form a rectangular table of values.***

### 3.3 Histogram window

This window displays the histogram for a column of data. It has a pop-up menu that allows you to change the style of the plot from bars to a line graph, or vice versa. To display the pop-up menu, position the mouse pointer anywhere in the window and press the right mouse button. The current style of the plot is indicated by a tick. Click on the other style if you want to change it.

## 3.4 Graph window

This window displays the graph for two variables.

Clicking on this window with the right mouse button produces a pop-up menu that enables the different plotting symbols - plus, cross, asterisk, circle, square, diamond or pixel - to be chosen. Points plotted using pixels may individually be quite small and difficult to see, depending on your screen resolution, but collectively may give a better picture when there is a large number of points. The Connected option joins the points with straight lines to give a line graph. The points are automatically connected if years are plotted on the horizontal axis.

The best-fit straight line or exponential curve can be drawn on the graph by choosing the **Fit straight line** or **Fit exponential curve** command from the **Plot** menu while this window is active.

Clicking on this window with the left mouse button when there is no best-fit curve drawn has the following effect. The pointer changes to cross-hairs and the current coordinates (X,Y) are displayed in the status bar. These coordinates change as you drag the cross-hairs around the window.

Clicking on this window with the left mouse button when there is a best-fit line drawn has a similar effect to the above plus the following. A vertical dashed line is drawn from X on the X-axis to the best-fit curve and a horizontal dashed line drawn from that point to Y\* on the Y-axis where Y\* is predicted by the fitted equation. The status bar displays the (X,Y) position of the mouse pointer and Y\*. The last (X,Y) and predicted Y\* stay in the status bar after you stop dragging.

## 4.1 Introduction

The menu names are shown in the menu bar near the top of the screen. The menu items represent commands that initiate actions/operations to be performed.

Note that commands are disabled (faint) if the current status of the program would not allow you to use them. For example, most commands are disabled until you type some data into the Data window or open a data table file.

In most cases, choosing a command from the menus produces a dialogue box that has to be completed to provide sufficient information for the command to be executed. These dialogues vary according to the command, but for plots they require you to select the variables to plot and the options that affect the plot. While a dialogue box is on screen you are prevented from doing anything else in Graph Plotter. You must click on either the OK button (or press ENTER) or Cancel button. The OK button tells Graph Plotter to execute, or finish executing, the command. The Cancel button quits the command without doing anything.

Commands can be chosen without using the mouse. A menu can be chosen by pressing the ALT key and its underlined letter (e.g. F for the **File** menu), and then a command can be chosen by pressing its underlined letter (e.g. O for **Open**).

Note that the Graph Plotter menus follow the *Windows* menu conventions in the use of symbols to the right of the command names. An ellipsis (...) indicates that a dialogue box appears when you choose the command. A triangle indicates that a cascading menu appears when you choose the command.

The following sections describe each command in detail. They are arranged in the order they appear in the menus.

## 4.2 File menu

This menu has commands to open and save data files, print and close windows, and exit the package.

### More:

New

Open

Save

Save as...

Close

Print

Print setup

Exit

## **New**

Creates and opens a new data table named UNTITLED with all cells in the Data window empty. Use this command when you need to type a new data table into the package.

If you are already working with a data table which has been changed, you will see a dialogue box asking whether you want to save the changed data table: click on Yes if you want to save the changed data table; click on No if you want to preserve the original data table; click on Cancel if you do not want to create a new data table.

You will have to complete a dialogue box specifying how many rows and columns are in the new data table. Type the number of rows into the "Number of rows" box. Now move the flashing cursor to the "Number of columns" box by clicking on it or by pressing the TAB key. *(Do not press ENTER as this will close the dialogue box.)* Now type in the number of columns you want in your data table. With both numbers correctly typed, click on OK or press ENTER.

A Data window will appear with the specified numbers of rows and columns.

## Open

This command is used to read data from a file. This file may be of the special GPD type created by Graph Plotter, or may be a text (ASCII) file created by some other application.

If you are already working with a data table which has been changed, you will see a dialogue box asking whether you want to save the changed data table: click on Yes if you want to save the changed data table; click on No if you want to preserve the original data table; click on Cancel if you do not want to create a new data table.

You will then see a dialogue box titled Open. This is the standard *Windows* dialogue for opening files that you will see in other *Windows* applications.

By default, the Open dialogue lists all the files of type GPD in the current directory, C:\S103\GP\DATA, which is where data files for this course will be installed. If the file you want is not on the C drive, select the drive you want from the Drives list. The Directories box allows you to list files in other directories by double-clicking on the directory. You can list all text data files in the current directory by clicking on the down arrow in the List Files of Type box and selecting type Text(\*.txt).

Select the file you want by clicking on it in the list of files. The name of the file should then become highlighted and should also appear in the File Name box. Click on OK to open the file. The Open dialogue will then disappear, and there may then be a short pause while Graph Plotter reads the file.

The **Open** command will successfully open a text file only if that file conforms to the following rules.

1. The file contains only data values that are acceptable to Graph Plotter (see Section 1.2).
2. The data values are arranged in a rectangular table: i.e. there must be the same number of values in each row.
3. Each row is terminated by a newline character.
4. Within rows, the values are separated by one or more spaces, or by a comma, or by a tab character.

## Save

If the active window is the Data window, this command updates the current GPD file, saving the current data table and column names. This protects new data from being accidentally lost. Note, however, that the current GPD file is overwritten: if you want to preserve the original data table, then use the **Save as...** command to save your current data to a file with a new name.

If you have not previously used the **Save as...** command to create a GPD file for an untitled data table, then this command will display the Save dialogue for naming a file, as in the **Save as...** command.

If the active window is a Graph window, this command updates the current WMF file, saving any modifications to the graph. If you want to preserve the original graph, then use the **Save as...** command to save the current graph to a file with a new name.

If you have not previously used the **Save as...** command to create a WMF file for the graph, then this command will display the 'Save plot' dialogue for naming a file, as in the **Save as...** command.

## Save as...

If the active window is the Data window, this command will save the data table in a new file. It displays the Save dialogue which allows you to select the drive, directory and name of the file to which the data is saved. This command is useful if you've changed the current data table and want to save it without overwriting the original GPD file. Note that if you choose the name of an existing file it will be overwritten.

The Save dialogue is very similar to the Open dialogue. The default file type is GPD. If you want to save the data table in a text file that some other application may be able to read, select "Text[\*].txt]" from the Save File as Type list so that the file type is TXT. The text file will store only the data values (no variable names or other information). Values are separated by tab characters within rows and by newline characters at the end of each row. Note that if you choose the name of an existing file it will be overwritten.

If the active window is a Graph window, this command will save the graph in a new file. A 'Save plot' dialogue box opens with the file name field highlighted. Enter a name for the file, with the .WMF extension. The default directory where the file will be saved is displayed in the middle of the box, and you can change the destination of the file if you wish. WMF stands for Windows Meta File, and files of this type can be read by applications such as Microsoft Draw (which is part of Microsoft Works) and Microsoft Word.

## **Close**

Permanently closes and deletes the active window.

## **Print**

If you have connected and installed a printer under *Windows*, this command prints the active window.

## **Print setup**

This command displays the dialogue for configuring your printer.

## **Exit**

Quits the package. If you have changed the current data table you will see a dialogue box asking whether you want to save the changed data table: click on Yes if you want to save the changed data table; click on No if you want to quit without changing the original data table; click on Cancel if you decide you do not want to quit.

## 4.3 Edit menu

This menu is concerned with editing actions on the data table.

### **More:**

Cut

Copy

Paste

Clear

Rename variable

Calculate

Data precision

## Cut

Cuts all data from columns you select in the dialogue. Select more than one column by dragging down the list of variable names, or by pressing the SHIFT or CTRL key while clicking. The cut columns are copied to the *Windows* clipboard. The data can be retrieved from the clipboard using the **Paste** command in Graph Plotter or in some other *Windows* application.

## Copy

Copies all data from columns you select in the dialogue. Select more than one column by dragging down the list of variable names, or by pressing the SHIFT or CTRL key while clicking. The data are copied to the *Windows clipboard*. The copied data can be retrieved from the clipboard using the **Paste** command in Graph Plotter or in some other *Windows application*.

## **Paste**

Pastes the contents of the *Windows* clipboard into the active window. The data may have been cut or copied in some other *Windows* application. The data must consist of valid numbers and form a rectangular data table for them to be successfully pasted into the Data window.

## **Clear**

Deletes all data from columns you select in the dialogue. Select more than one column by dragging down the list of variable names, or by pressing the SHIFT or CTRL key while clicking. The cleared columns are not copied to the *Windows* clipboard.

## **Rename variable**

This command displays a dialogue box that allows you to change the name that appears in a column heading. Select the name you want to change by clicking on it in the list of names. The current name then appears in the edit box at the top of the list. If you want to edit the current name, click on the name. If you want to type in a new name entirely, start typing in the new name without clicking on the original name. A variable name can be up to 12 characters long. Click on OK or press ENTER when you have completed the new name. Click on Cancel if you decide not to change the original name.

## Calculate

This command creates a new variable - in the next free column - by evaluating an expression involving one or more of the existing variables. The expression can involve all the usual arithmetical operators and mathematical functions. The command displays a dialogue box resembling a desk calculator. You can type the expression directly into the edit box at the top of the calculator, but you will probably find it easier to enter the expression by clicking on the buttons and names of variables on the calculator.

To enter one of the variables in the expression to be calculated, first click on the name of the variable in the list on the left, and then click on "Enter selected variable".

Arguments of the functions (operators) can be any of the following: variables: V1, V2,... or variable names bracketed by " (double quotes); constants: PI, any valid integer, real or E-notation number; expressions enclosed in brackets ().

An expression can consist of any valid combination of the following operators.

+	addition
-	subtraction
*	multiplication
/	division
mod	modulus: remainder from division
^	exponentiation
EXP	exponential function
LN	natural log function
LOG	base 10 log function
SQRT	square root function
SIN	sine function
COS	cosine function
TAN	tangent function
ASIN	arcsine function
ACOS	arccosine function
ATAN	arctangent function

### Example expressions

$V5*(V1+V2+V3+V4)/4$

multiplies the row means of columns V1 to V4 by the values in V5.

$SQRT("weight1" * "weight2")$

Multiplies values in rows weight1 and weight2 together and takes the square roots of the results. Note that this is not the same as

$SQRT "weight1" * "weight2"$

Since the precedence of the SQRT function is higher than that of multiplication, this would take the

square root of weight1 first and then multiply the result by weight2.

Variable names in expressions must be exactly the same as they appear in the Data window. Note that names are case-sensitive: e.g. "Weight1" would be invalid in the expression above.

Appropriate error messages are displayed if errors occur in the expression that is entered. You can edit the expression to correct the errors. Where the expression cannot be evaluated, corresponding cells of the new column are left blank.

By default, calculated values have a precision of five significant figures. You can change this by choosing the **Data precision** command.

A new variable is not created if no variables appear in the expression (only constants). In this case the single number result is displayed in an alert box. Hence this command can be used as a numerical calculator.

## **Data precision**

This command displays a dialogue for changing the precision of data values displayed in the Data window. You can type a number between 3 and 15, and the data will then be displayed to that number of significant figures.

## 4.4 Plot menu

This menu provides commands that produce plots. When a command is successful, a window is created showing the plot. If the command cannot execute successfully on the variables you have selected, you will see an appropriate error message. ***Note that the plots are not updated if you change data in the Data window, so if you change the values in the data table after plotting a graph, then you may need to plot the graph again.***

### **More:**

Histogram

Graph

Fit straight line

Fit exponential curve

## **Histogram**

This command creates a Histogram window for a column of data that you select from the list of column names in the dialogue. You can specify where the first interval for the first bar of the histogram starts and the width of each interval by editing the boxes. Graph Plotter will then use your intervals to calculate the frequencies. Alternatively, you can leave AUTO showing in the box for width of intervals, so that Graph Plotter chooses intervals automatically. Clicking on OK causes the Histogram window to appear.

## Graph

This command creates a Graph window for a pair of variables. You select the variable to be plotted on the horizontal axis (X) and the variable to be plotted on the vertical axis (Y). Click on the "Axes through origin" check box if you want the origin ( $X=0$ ,  $Y=0$ ) to appear on the graph regardless of the range of X and Y. Optionally, you can select a third column of data (E) to be used to plot symmetrical vertical error bars. Clicking on OK causes the Graph window to appear. Note that this command ignores rows of the data table for which X or Y (or E if selected) is missing.

## Fit straight line

This command draws the best-fit straight line on the active Graph window. The best-fit straight line has the equation  $Y = kX + c$  where  $k$  is the gradient of the line and  $c$  is its intercept with the Y axis. The coefficients  $k$  and  $c$  are calculated such that the total sum of squared deviations of the data points from the fitted line is minimized. The values of  $k$  and  $c$  are displayed in the equation at the top of the window.

## Fit exponential curve

This command draws the best-fit exponential curve on the active Graph window. The best-fit curve has the equation  $Y = a \exp(bX)$  where the coefficients  $a$  and  $b$  are calculated such that the total sum of squared deviations of the data points from the fitted curve is minimized. The values of  $a$  and  $b$  are displayed in the equation at the top of the window. Note that the equation  $Y = a \exp(bX)$  gives the decay or growth curve for appropriate data.

## 4.5 Window menu

The commands in this menu allow you to manage Graph Plotter windows or window icons. In addition to these commands, the titles of windows are added to the end of this menu as they are created, and deleted from this menu as they are closed. Clicking on the title of a window activates it.

### **More:**

Cascade

Tile

Arrange icons

Close all

Minimize all

Restore all

## **Cascade**

This command rearranges the open windows to overlap so that each title bar is visible.

## **Tile**

This command rearranges the open windows in sizes such that they fit next to each other within the Graph Plotter application window.

## **Arrange icons**

This command rearranges the window icons, representing windows that have been minimized, along the lower edge of the Graph Plotter application window.

## **Close all**

This closes and deletes all Graph and Histogram windows. It also closes the Data window, but if the data table has been changed a query box allows you to choose whether to save this before closing.

## **Minimize all**

This changes the windows into icons.

## **Restore all**

This changes all icons back into windows.

## 4.6 Help menu

The commands in this menu run the *Windows* Help program to provide on-line Help for Graph Plotter. Each command opens a Help window.

### **More:**

Contents

Search for Help on

How to use Help

Calculator

About

## **Contents**

This command provides a list of all Help topics available for Graph Plotter.

## **Search for Help on**

This command displays a dialogue box for locating information about a specific Graph Plotter topic.

## **How to use Help**

This command provides information about how to use *Windows* Help.

## **Calculator**

This command displays the *Windows* scientific calculator..

## **About**

This command displays copyright and version information about Graph Plotter.

# Glossary of terms

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## **Active**

The active window appears on top of all other overlapping windows with its title bar highlighted. A window can be activated by clicking on any part of it, or by selecting its title from the Window menu.

## **Application**

An alternative term for a computer program. *Windows* programs are commonly referred to as applications.

## **ASCII**

American Standard Code for Information Exchange, pronounced "askey".

## Check box

A check box is a small labelled square button, usually in a dialogue box, that activates some option. The check box toggles on and off when it, or its label, is clicked on. A tick in the check box indicates that the option is on (activated).

## Clipboard

The *Windows* clipboard is a common area of memory that can be accessed by any *Windows* program through commands in its Edit menu. The Copy and Cut commands put the currently selected data into the clipboard; the Paste command copies data from the clipboard into the program. The clipboard provides a means of transferring data between *Windows* applications.

## Commands

In a *Windows* program, commands are the items in the drop-down menus.

## Control menu

A menu that temporarily appears when you click on the button in the top-left corner of a window. This menu allows you to perform some standard *Windows* operations on the window such as closing or minimizing it.

## **Desktop**

The main part of the application window below the menu bar and above the status bar in which the application's windows appear.

## **Dialogue**

A dialogue box is a special kind of window for selecting variables and options. A dialogue locks the program, i.e. prevents you doing anything else, until it is closed - usually by clicking on its OK or Cancel button.

## **Dragging**

To drag the mouse means to move the mouse while keeping the left button on the mouse pressed.

## **E-notation**

E-notation is a compact way of writing very large or very small numbers: e.g.  $2.5E6$  means 2.5 times 10 to the power 6 which is 2500000;  $2.5E-6$  means 2.5 times 10 to the power -6 which is 0.0000025.

## **Export**

Exporting data is the process of creating a data file that can be read by another package.

## **Icon**

A small picture representing a minimized window. Double-clicking on the icon restores the window.

## **Import**

Importing data is the process of reading and converting data created by another package.

## **Pixels**

Pixel is a contraction of "picture-element". Pixels are the dots that make up the characters or graphics on your screen or printer.

## **Pop-up menu**

A small menu that temporarily appears when you click with the right mouse button on some windows.

## Screen resolution

Your screen display is composed of rows and columns of pixels. Resolution is the measure of the number of rows and columns.

## Status bar

The status bar is a thin grey window along the bottom of the application window used to display current information about the status of the program, descriptions of the commands or hints as to what to do next.

## **Tab-delimited**

Data values separated by tab characters. Tab-delimited data files are a common form of file for importing and exporting data files.

## **Text files**

A common format for files. Text files can be edited using a text editor such as Windows Notepad and viewed using the TYPE command in MS-DOS.

## **Word processor**

A computer program designed to prepare printed documents such as letters, reports, theses etc. Although primarily concerned with text, most *Windows* word processors can also incorporate graphical images (such as plots from Graph Plotter) into their documents.

-1.7E308 means -1.7 multiplied by 10 to the power 308. This is known as scientific or E notation.

A character is any letter, number or symbol that can be typed.

