GRACE

What is Grace?

Grace is a WYSIWYG 2D plotting and exploratory data analysis tool, written for X and Motif. Grace runs on practically any version of Unix-like OS and has been successfully ported to VMS, OS/2, and Win9*/NT/2000/XP. Ported versions still require an X/Motif environment. It is free software.

General

- Point & click Motif interface
- WYSIWYG design
- Complete control over all graph features
- Unlimited number of graphs and data sets
- Fast: graphs refresh almost instantaneously
- Data read from files and/or pipes

Output Formats

- PS, EPS, MIF, PDF, PNG, JPG, WMF, PNM, SVG

Graphing

- Graph types:
  - XY, Bar, Stacked Bar, Boxplots, Pie charts, Polar plots, Vector maps, Hi/Low/Close, ...
- Graphs may be conveniently stacked in rows and/or columns
- Axis types: linear, reciprocal, logarithmic, logit, date/time, lat/long
- Error bars: X and/or Y directions, equal or unequal on either side
- Numerous symbol types, hollow and filled; skyline plots; histograms; impulse
- User-defined scaling, tick marks, labels, symbols, line styles, colors
- Annotations: text (mixed fonts & styles), lines, arrows, ovals, boxes
- Data set operations: kill, copy, move, reverse, sort, drop, join, coalesce, write, swap, edit
- Mouse-powered point editing
- All aspects controllable via command language
- Batch mode for unattended printing

Analysis Tools

- Dozens of mathematical functions available for transformations
- Integration / differentiation
- Histograms and Fourier transforms
- Interpolation and splines
- Cross/auto-correlation
- Running means, medians, maxima, minima, std. dev., sums

Curve Fitting

- Regression: power, exponential, logarithmic, inverse, and polynomials up to 10th-order
- Arbitrarily complex, user-defined non-linear fitting functions, with user-specified constraints

Resources

On-site Resources

The following resources are all available from the Help menu during an interactive Grace session:

- User's Guide
- Frequently Asked Questions
- Tutorial
- Example plots

On-line Resources

- http://plasma-gate.weizmann.ac.il/Grace/
  - Mailing list archives
  - To-Do list / Bug Reports / Suggestions
    (Do NOT submit a bug report or suggestion without first reading the manual and the FAQ and searching the mailing-list archives. Also, ask local folks first.)
  - Latest source code and binaries
  - Screenshots

Configuration / Invocation

Environment Variables / Path

The environment variables GRACE and GRACE_HOME must be set up in your $HOME/.cshrc file. Add these lines to the end of that file if they are not set:

```
setenv GRACE_HOME /usr/opt/xmgr/grace
setenv GRACE $GRACE_HOME/src
set path = ($path /usr/opt/xmgr/util $GRACE)
```

X Resources

To make your Grace session look and work better, add the following lines to your $HOME/.Xdefaults file:

```
XMgrace*mainWin.width:872
XMgrace*mainWin.height:698
XMgrace*fontList:-adobe-helvetica-bold-r-normal-*-14-*-*-*-*-*-*-*
XMgrace*tabFontList:-adobe-helvetica-bold-r-normal-*-14-*-*-*-*-*-*-*
XMgrace*monText.fontList:-adobe-courier-medium-r-normal-*-14-*-*-*-*-*-*-*
XMgrace.consoleDialog*text.fontList:-adobe-courier-medium-r-normal-*-14-*-*-*-*-*-*-*
XMgrace*openProjectFSB.pattern:*.gr
XMgrace*saveProjectFSB.pattern:*.gr
XMgrace*readSetsFSB.pattern:*
XMgrace*writeSetsFSB.pattern:*
```

Note that a <tab> must follow each ":". Log out and back in to make the changes effective.

Invocation

Grace may be invoked in several different ways. All commands are typed at the unix prompt.

- "xmgrace" — interactive session with graphical user interface
- "gracebat" — batch mode
- "grace" — command line mode (advanced users only)

Command Line Options

Grace may be invoked with many different command-line options. For a list, type

```
xmgrace -help
```

at any unix prompt.

Input

Formats

Grace reads data from text files or unix pipes. Some text characters have special meanings:

#	comment
&	set delimiter (blank lines also delimit sets)
@	parameter specification (advanced topic)

Data can be read from a file in several ways:

- one set following another, sequentially, in a text file

```
1 1
2 3
&
3 4
5 5
```

- several sets sharing common X values, with Y values in columns

```
1 1 2
2 5 3
5 7 9
```

- block data, from which you may choose columns to plot

```
1 1 2 4
2 5 3 6
5 7 9 2
```

The various data set types have different formats:

XY, XYDX, XYDY, XYDXDX, XYDYDY, XYDXDY, XYDXDXDYDY,
BAR, BARDY, BARDYDY, XYHILO, XYZ, XYR, XYSIZE, XYCOLOR,
XYCOLPAT, XYVMAP, XYBOXPLOT

Filters

- ADAPS data: automatically filtered as date/time data if file name ends in ".adaps" or ".DAT"
- Gzipped files: any file ending in ".gz" is compressed/uncompressed on the fly with gzip
- Date/time data:
  Any data at the beginning of the line that matches any of the following patterns will be recognized as date/time data:
  - MM/DD/YYYY YYYY/MM/DD
  - MM/DD/YYYY HH:MM YYYY/MM/DD HH:MM
  - MM/DD/YYYY HH:MM:SS YYYY/MM/DD HH:MM:SS
  - MM/DD/YYYY HH:MM:SS.ss YYYY/MM/DD HH:MM:SS.ss

  Any occurrence of an "/" may be replaced by a "-". A two-digit year (YY) also will work, but only if the "date wrap" option is turned on, either manually (Edit/Preferences) or from the command line:

```
xmgrace -pexec "date wrap on" &
```

Grace Dimensions

World Coordinates

Data points are defined and plotted in the “world” coordinate system. This is necessary for the data, and can be handy for assigning positions to various annotations. If annotations are defined in world coordinates, they will move with the data when a graph is moved, rescaled, panned, or zoomed.

Viewport Coordinates

The coordinates used to position graphs on the canvas are “viewport” coordinates. Viewport coordinates most commonly are used to position and size the graphs; these coordinates are entered in the Plot/Graph_appearance menu. Viewport coordinates are defined such that the shortest dimension on the canvas (paper) goes from 0 to 1. The other dimension is scaled appropriately. For example, a portrait plot on US Letter size paper (8.5x11.0) results in a X viewport coordinates that range from 0 to 1, and Y viewport coordinates that range from 0 to 1.29 (11/8.5). This may sound strange, but it is handy when trying to ensure that square plots come out square, and circles come out as circles rather than ovals. For an exactly square plot, use the same viewport dimensions for both X and Y.

Annotations can be made in either world or viewport coordinates. Using viewport coordinates will ensure that the annotation stays at the same place on the page, regardless of changes in graph placement or scaling.

Box Plots

gracebox

Grace does not calculate the percentile statistics needed to generate boxplots. Rather, you must tell Grace what those percentiles are. Fortunately, a script has been written for you that generates the needed stats and feeds them to Grace.

gracebox is an awk script that calculates boxplot statistics from a sorted data file, creates a graph file for Grace, and starts up Grace with that file. gracebox is patterned after an awk script called “g2box”, written years ago by Jeff E. Miller (jemiller, USGS), that calculated boxplot stats for use with g2. Later, Stewart Rounds rewrote that script for use with XMgr, the predecessor to Grace.

gracebox can create both Tukey and “1090” boxplots. Outlier points are included for both types of boxplots. The data to be used by gracebox can come from a file or from a pipe.

gracebox lives in /usr/opt/xmgr/util, which should be in your path automatically; so, you can invoke gracebox from any unix prompt.

The following is taken from the comments in the gracebox script, and should be sufficient to illustrate its usage.

==========

This script expects an input file that contains two fields delimited with one or more spaces or single tabs. These can be simple ASCII files or rdb tables. The first field is the box name (variable that subsets the data). The box name cannot start with a "#" symbol...these are considered comment lines (as are used in rdb tables). The box name can be a string or a numeric. The second field is the data to be evaluated for plotting boxes. The data MUST BE SORTED by box name (this can be done with the unix sort command).

syntax:

```
gracebox DATA.FILE [prefix=NAME] [type=1090] [yaxis=LOG] [label=number] [flags=gr_options]
```

example command lines:

```
gracebox DATA.FILE
```

where DATA.FILE is the input file name. In this case a default boxplot (Tukey’s schematic plot) is drawn. Output is to a Grace project file named "box.gr".

```
gracebox DATA.FILE prefix=NAME
```

where DATA.FILE is the input file name and prefix=NAME provides a prefix string to be used on output. In this case a default boxplot (Tukey’s schematic plot) is drawn and the prefix string will be used to name the output file "NAME.gr". This option allows multiple runs of the gracebox script without overwriting the output file.

```
gracebox DATA.FILE type=1090
```
where DATA.FILE is the input file name and type=1090 changes the default boxplot to a box graph with whiskers drawn to the 10th and 90th percentiles. Output is to a Grace project file named "box.gr".

```
gracebox DATA.FILE type=1090 prefix=NAME
```
where DATA.FILE is the input file name and type=1090 changes the default boxplot to a box graph with whiskers drawn to the 10th and 90th percentiles. Prefix=NAME provides a prefix string causing the output file to be named "NAME.gr" instead of "box.gr".

```
gracebox DATA.FILE yaxis=LOG
```
where DATA.FILE is the input file name and yaxis=LOG changes the Grace y-axis default from linear to logarithmic. Output is to an grace project file named "box.gr".

```
gracebox DATA.FILE label=number
```
where DATA.FILE is the input file name and label=number causes Grace to recognize the box labels as numbers rather than just labels. Output is to a Grace project file named "box.gr".

```
gracebox DATA.FILE flags="-hardcopy -hdevice PostScript"
```
where DATA.FILE is the input file name. In this case a default boxplot (Tukey's schematic plot) is drawn. Output is to a Grace project file named "box.gr". The flags option allows command line options to be passed to the session of Grace that this script will spawn. In this case, the flags -hardcopy and -hdevice PostScript will cause Grace to print the graph using the postscript device driver. The -hardcopy option prevents an interactive session of Grace from starting. See Grace's documentation for a description of all command line options.

The program does the following things:
1. prints statistics to standard out
2. creates a Grace project file called box.gr or NAME.gr
3. executes xmgrace with the newly created file

To execute: First, type the appropriate command line as given above. Second, use Grace to edit the resulting plot to your satisfaction. Save the results.
==========

Grace Dates

Grace stores and uses date/time data as real numbers counted from a reference date. The default reference date is "-4713-01-01 12:00:00". That's right, January 1st at noon in the year 4713 BC. That's a long time ago. This is a common reference date used for astronomical time scales. It was chosen by Joseph-Juste Scaliger in 1583 when he was working on a revision to the standard calendar. He decided to use "-4713-01-01 12:00:00" as a reference date because it was at the same time a Monday, first of January of a leap year, there was an exact number of 19 years Meton cycle between this date and year 1 (for Easter computation), and it was at the beginning of a 15-year Roman indiction cycle. The day number counted from this reference is traditionally called a Julian day, but it has really nothing to do with the Julian calendar.

Grace comes with a handy utility that allows you to compute back and forth between Julian dates and MM/DD/YY notations. The utility is called "convcal" and is available from the unix prompt. Here are a few examples:

```
convcal 1/31/2003
2452670.50000000

convcal 2452670.5
2003-01-31T00:00:00.000
```

When using this utility, pay special attention to the input format. To specify dates in a US format, add the "-i us" option. Otherwise, the European format is the default, and 3/4/2003 gets interpreted as the third of April.

```
convcal 3/4/2003
2452732.50000000

convcal -i us 3/4/2003
2452702.50000000

convcal 2452702.50000000
2003-03-04T00:00:00.000
```

Tips for using Grace dates within the user interface are given in the tips section of this handout. More information on Grace dates is available in section 7.4 of the User Guide.

Tips and Tricks

Check out the available example plots and read the User Guide and the FAQ. Play with the program to see what it can do. Some tips are given in the User Guide, but here are several particularly useful tricks:

Reading in Data Files

Data import is from the Data/Import/Ascii menu. Don't ask me why this is buried so deeply.

Missing Values

Currently, Grace cannot handle missing values in an optimal fashion. Avoid missing data. If you have an ADAPS file with missing data (-123456E20) and the file name ends in ".adaps" or ".DAT", then have no fear because the automatic input filter will ignore your missing data and break your data into separate data sets, each of which has no missing values. To perform that operation outside of Grace, use the adaps2grace.pl filter:

```
adaps2grace.pl datafile > newfile
```

For time series data with small data gaps, you can also cut out the missing data and fill in the gaps via one of Grace's interpolation schemes (linear or spline). Ask one of the Grace gurus how to do this; it isn't hard, but it helps to see it done the first time.

Windows Metafiles

To create a Windows Metafile, which is probably the BEST way to import a Grace graph into something like PowerPoint, choose Metafile as the output device from the File/Print_setup menu. By default, Grace will create a Grace metafile, which is not what you want. However, you will get a Windows Metafile if you specify a file name with a ".wmf" extension rather than the default ".gmf" extension. Tricky, tricky! This is actually implemented through an output filter, but this trick is the easiest way to make it happen. Windows Metafiles are the most useful in PowerPoint because they are fully editable, whereas PNGs and JPGs are not.

Date/Time data

When specifying date/time data in Grace, rather than entering the Julian date (2452699.5 for March 1, 2003), you can type

```
date("3/1/2003")
```

in the Grace entry field. Grace will do the conversion for you. Similarly, if you wanted to specify noon on March 1, 2003, you would have entered:

```
date("3/1/2003 12:00")
```

Graph and Set Numbers

Remember that Grace numbers graphs and datasets starting at 0 rather than 1. Grace specifies graphs with a lower case "g" followed by its number; so graph 0 is designated "g0". Similarly, datasets are designated with a lower case "s". Therefore, set 0 in graph 0 may be designated as g0.s0. This stuff is handy when applying mathematical transformations to your datasets. The X values in set 0 of graph 0 are designated as g0.s0.x and the Y values as g0.s0.y. Get it?

Right Click for more Options

In many instances, you can pop up a useful menu for set or graph operations by selecting a set or graph in the appropriate menu, then right-clicking your mouse.

Tick Labels

Tick labels are stored in the $t variable. So, if you have data in degrees C and you want to plot the data against two different Y axes, one of which is degrees C and the other is degrees F, do the following. First, activate an alternate Y axis by selecting the Plot/Axis_properties menu and choosing to edit the alternate Y axis. Click the "Active" toggle at the top of the window. Next, go to the "Tick labels" tab, change the placement from "normal" to "opposite," then enter the following formula in the "Axis transform" entry:

```
$t*1.8+32
```

Click the "Apply" button at the bottom of the window. Now you have a second Y axis with a degrees Fahrenheit scale!

Locator Properties

When working with date/time data, it is handy to change the locator properties to a date/time format. This is available from the Edit/Locator_props menu.

Legend Placement

Ctrl-L allows you to grab a graph legend and move it. Right-click to get out of this mode.

Spreadsheet Editor

You may edit or create data sets in either the supplied "spreadsheet" editor (not really a spreadsheet) or in the editor of your choosing. By default, the text editor is vi. You can change this by setting or changing the GRACE_EDITOR environment variable. Of course, you can always create a data set in a file external to Grace, then read it in.

Double Clicks on the Canvas

Double-clicking the left mouse button inside a graph will pop up the Set Properties window, with the set nearest to your mouse-click location selected. Double-clicking the left mouse button above a graph will pop up the Graph Properties window. Double-clicking the left mouse button on a graph axis will pop up the Axis Properties window. Double-clicking the left mouse button on a set selection (in the set properties window) will open the dataset for editing with the spreadsheet editor. For more key and mouse shortcuts, see sections 4.1 and 4.2 of the User Guide.

Rescaling Plots

When changing the size of the canvas (paper) in the File/Print_setup menu, you can rescale your graphs at the same time by selecting the "Rescale plot on page size change" under the Options menu. Otherwise, the viewport coordinates of your plots will not be rescaled when you change, for example, from landscape to portrait. As a result, your graph may no longer be completely on the paper!