GLE 3.3

User Manual

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Extended Version

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TeX	Donald E. Knuth, A Typesetting System.
LaTeX	Leslie Lamport, A Document Preparation System.
PKUNZIP	Data decompression software from PKWARE Inc.
WordPerfect	WordPerfect Corporation.
PostScript	Page Description Language, Adobe Systems Inc.
EPSON	Seiko Epson Corporation.
HPGL	Hewlett Packard.
HP2XX	Heinz Werntges, GNU LIBRARY GENERAL PUBLIC LICENSE.

Contents

Abstract

GLE is a high quality graphics package for scientists, combining a user friendly interface with a full range of facilities for producing publication quality graphs, diagrams, posters and slides.

GLE provides LaTeX quality fonts together with a flexible graphics module which allows the user to specify any feature of a graph (down to the line width of the subticks, for example)

Complex pictures can be drawn with user defined subroutines and simple looping structures.

Current device drivers support DECWINDOWS, REGIS, TEK4010, all PC graphics cards, VT100s, HP-Plotters, PostScript Printers, EPSON Printers and LaserJet Printers.

GLE runs on both VAXes and PCs, giving an identical user interface on both platforms.

Typographic Conventions

The following conventions will be used in command descriptions:

[option]	Specifies an optional keyword or parameter, the brackets should not be typed.
option1 | option2	Pick one of the options listed.
keyword	Keywords are represented in a bold typewriter font.
exp,x,y,x1,y1	Represent numbers or expressions. E.g. 2.2 or 2*5. Parameters to be entered by the user are given in italics.

Pathways

For those in a hurry:

1. Read chapter 1, GLE Tutorial, (beginners only).
2. Examine the examples at the end of the manual.
3. Browse through Chapter 3, The Graph Module.
4. Read the notes in Chapter 5 on your planned output device.

For those with time:

Chapter 1, GLE Tutorial: Covers installation and drawing a simple graph, highly recommended if you have never used GLE before.

Chapter 2, GLE Primitives: A detailed description of the commands used for creating slides and annotating graphs.

Chapter 3, The Graph Module: A detailed description of the commands for drawing graphs.

Chapter 4, The Key Module: This is for producing keys for graphs. Skip this section until you actually want to draw a key.

Chapter 5, Advanced features of GLE: Covers programming, filling and clipping. The individual device drivers are also described in this section.

Chapter 6, GLE Utilities: Describes FITLS and MANIP.

Chapter 7, SURFACE: A detailed description of the commands drawing three-dimensional graphs.

Examples: Have a look through these to get an idea of what GLE can do. Most of these are included on the distribution disk and can be used as templates.

Chapter 1

GLE Tutorial

1.1 GLE Installation on a PC

To install GLE, put the distribution disk into drive a: and type:

```
a:install
```

GLE requires at least 800K of disk space for a minimal installation and 3.3M for a full installation (including all device drivers and fonts).

GLE also requires 530K or more of free memory. Use the DOS command CHKDSK to check this figure. If you don't have enough then take copies of your AUTOEXEC.BAT and CONFIG.SYS files and then remove as much as possible from these files.

GLE may work with less memory depending on what you are drawing.

The installation disk contains a version of CGLE which will make use of epanded memory. This version can run with 70K less memory but if you don't have expanded memory then it has to use your hard disk instead which is a great deal slower.

1.2 Running GLE

To get GLE running interactively you must be on a VAXstation, graphics terminal, or PC. If you are using a PC you should make certain you have an up to date copy of GLE (ask via VAX-mail to GRV::SRGHCXP or InterNET srghcxp@grv.dsir.govt.nz)

1.3 Running GLE on a PC

The command to run GLE is:

```
C:\GLE> cgle myfile.gle
```

Note: the command is 'CGLE' not 'GLE' but the directory is 'GLE', this is for historical reasons.

To print a GLE file to the laser printer you would type:

```
C:> psgle myfile
C:> print myfile.ps
```

To produce an .eps file for inclusion in WordPerfect you would type:

```
C:> psgle myfile /eps
```

This will create a file called myfile.EPS.

WordPerfect can also understand a special file format which contains both an EPS file for printing to PostScript printers and a bitmap TIFF image for displaying on the screen. GLE can create this sort of file with the command:

```
C:> wpgle myfile
```

This will create a file called MYFILE.EPF which you can include into WordPerfect.

If your PC is connected to a VAX computer which has a PostScript printer you may copy MYFILE.PS to the VAX using a standard file transfer program (e.g. FTP, KERMIT, VDISK)

The best way to see what GLE can do is to have a play with it, simply start it up and try out some of the examples:

```
Press F3       (Load file)
Press <enter>  (for a menu of GLE files)
Use arrow keys to select example, then press <enter>
Press F10 to draw the picture
Press ESC to get back to the GLE editor.
...
When you find a graph try pressing F9 and modifying
one of the fields (use F1 for an explanation of each
field).
```

Used symbols for PC:

```
GLE_NOCONTROLD TRUE  (Stops ^D being added to ps files)
(this is the default for unix)

GLE_ADDBGI ...       (high resolution BGI-Driver)
(see Device Drivers)
```

1.4 32bit DOS Version of GLE

Axel Rohde has compiled a 32bit DOS version of GLE in 1994 (email: rohde@physik.uni-kiel.d400.de)
On any 386 or better machine this version of GLE should run without problems, it's main features are these: 1) No 640K memory restrictions. 2) Much faster.

Properties of GLE 32:

```
- All programs are running in the 386-protected-mode and therefore there is
  neither a limited 640kB adress-range nor a 64kB segmentation.
- 32-bit programs are running faster than their 16-bit-counterparts.
- There exists a multitude of GRX-graphics-drivers, e.g. for
  TSENG ET4000(W32), S3, 8514A, Cirrus Logic GD 542x, Trident 8900,
  Diamond Viper, ATI Ultra, ATI VGA and EGA. These drivers are highly
  configureable and can use flicker-free high resolution modes.
```

Installation Quick guide:

```
1) FTP the binary distribution
       ftp tui.marc.cri.nz
       cd pub/gle/gle32
       binary
       mget gle32bi*.zip
2) Unzip them keeping the directory structure
       cd c:\
       pkunzip gle32bi1.zip -d
       pkunzip gle32bi2.zip -d
       pkunzip gle32bi3.zip -d
       pkunzip gle32bi4.zip -d
       pkunzip gle32bi5.zip -d
       pkunzip gle32bi6.zip -d
3) Edit the batch file which tells gle where to find it's fonts
   and also what sort of graphics card you have.
       edit setgle32.bat
   (change the disk and directory as appropriate)
4) Run the batch script
       setgle32
5) Try out the new version
        gle_vga
6) Note most of the programs have been renamed to avoid conflicts!!!
```

To avoid name-conflicts between a 16-bit and a 32-bit version of GLE, all the programs and the environment-variables were renamed. All GLE-programs have now unix-style names like `gle_ps` (='psgle'- Postscript-output), `gle_vga` (='cgle' - VGA-Preview) etc. The names of the utilities end with '32' - `manip32`, `contou32` ...

Restrictions and Bugs:

1. The vector-fonts of the 32-bit-version are NOT compatible to their 16-bit-counterparts. They may be compatible to fonts that were created under other 32-bit operating-systems.

2. The on-line-help of `gle_vga` is usable but may sometimes look different compared to the original.

3. Makefmt and fbuild are missing. DJGPP's Library lacks ecvt(). Both programs are used to calculate vector-fonts in the Unix-version from the source-distribution. Both programs are NOT included in the 16-bit DOS-version, too. This package includes all (allready calculated) fonts from the Unix-source distribution. They were calculated under Linux, a free Unix-implementation for i386-PC's and higher.

4. The DVI-drivers are not testet!

5. Surface (`surf_vga`) hanged under unknown circumstances while loading one data-file. `surf_vga` can be stopped by pressing Control-Pause. If this happens, load the data-file into an editor, save it, and try it again.

In `gle32b.txt` are the more detailed instructions provided by Axel Rohde. Read these carefully if you have any problems.

1.5 Running GLE on a VAX

The command to run GLE is:

```
$ cgle myfile.gle
$ cgle myfile.gle /dev=regis
$ cgle myfile.gle /dev=x
```

See the directory CGLE_EXAMPLES: for examples and templates. To get access to these files from the GLE menus use the commands:

```
$ define workarea sys$login:,cgle_examples:
$ set default workarea:
$ cgle stack4b.gle      ! or any other example
```

If your keyboard doesn't have the function keys F9 thru F14 you can use GOLD (PF1) followed by the numbers 9,0,1,2,3,4 (on the top of the QWERTYUIOP keypad).

Keyboard Mappings:

VT100	VT200	PC	Meaning
GOLD 1	F11	F1	Help
GOLD 2	F12	F2	Save
GOLD 3	F13	F3	Load
GOLD 4	F14	F4	Save-as
GOLD 9	F9	F9	Graph-menu
GOLD 0	F10	F10	Draw-it
Control+Z	Control+Z	Control+Z	Exit/Escape
		Alt+X	Exit/Escape
Control+E	Control+E		Calls VAX EDT
Control+F	Control+F		Toggle fast/slow text
Control+R	Control+R	F5	Shows errors
		Control+S	Shells to DOS

Supported devices: VT100, REGIS (VT125, VT240), TEK4010, VWS, XWindows.

Supported output: PostScript, HPGL, Epson, Epson 24pin, HP Deskjet.

To create a PostScript output file (.PS) and automatically print it to the LASER queue you would type:

```
$ cgle myfile /print
```

To produce an .eps file for inclusion in LaTeX you would type:

```
$ cgle myfile /dev=eps
```

To produce a .ps file suitable for printing to a laser writer type:

```
$ cgle myfile /dev=ps
```

The DCL symbol GLE_NOCONTROLD should be set to "TRUE" to kill the `^D` on vms systems.

If you set the DCL symbol GLE_EDITOR to TPU then you will get TPU instead of EDT when you press `^E`.

1.6 It didn't work, bugs!!!

If the installation fails, or one of the example GLE files fails to work then the most likely reason is a shortage of memory due to too many memory resident programs/drivers. To fix this remove these utilities from your autoexec.bat and config.sys files temporarily.

There may well be a bug in your GLE file, try using the trace option to find the bug.
On a PC:

```
C:\GLE> psgle myfile /trace
```

On a VAX:

```
$ cgle myfile /dev=ps /trace
```

Another reason for a failure is a bug in GLE, **Please** report bugs to Chris Pugmire (Internet srghcxp@grv.dsir.govt.nz, grv::srghcxp) so they can be fixed. If possible, try and find a way of repeating the problem, then send relevant GLE and data files with an outline of what is wrong.

1.7 Drawing a Line on a Page

Let's start with drawing a line on the page. GLE has to know what size piece of paper you are working with. You can tell it by giving a `size` command:

```
size 18 27
```

This specifies a piece of paper 18cm wide and 27cm high. Now you must define a **current point** by moving to somewhere on the page:

```
amove 2 4
```

The origin (0,0) is at the bottom left hand corner of the page. Now suppose we wish to draw a line from this point across 1 cm and up 2 cm:

```
size 18 27
amove 2 4
rline 1 2
```

That was a **relative** movement as the x and y values were given as distances from the **current point**, alternatively we could have used **absolute** coordinates:

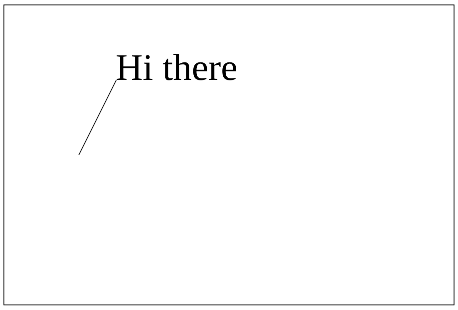
```
size 18 27
amove 2 4
aline 3 6               ! absolute.
```

Now if you want to draw some text on this page at the current point you would use the `text` command:

```
text Hi there
```

So we have now constructed an entire GLE program as follows, with the results illustrated below:

```
size 12 8 box
amove 2 4
rline 1 2
text Hi there
```



1.8 Drawing a Simple Graph

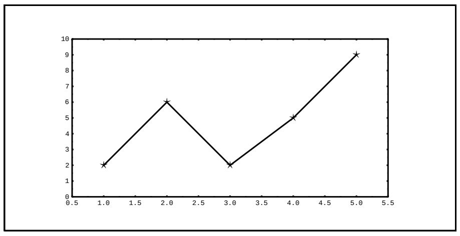
This section will describe how to go about drawing a simple graph.

The following data points are contained in a file called TUT.DAT

```
x   y
-----  (These top two lines do not appear in the file)
1   2
2   6
3   2
4   5
5   9
```

The data is in two columns with white space separating each column of numbers. The following commands will draw a simple line graph of the data.

```
size 6 3
begin graph
  size 6 3
  data tut.dat
  yaxis min 0
  d1 line marker star msize .2
end graph
```



The first `size` command defines the size of the piece of paper which may contain several graphs. The second defines the size of this particular graph. The actual graph axes are by default 0.7 of these dimensions. The ratio can be changed with the `vscale` and `hscale` commands.

Without the "yaxis min 0" command the yaxis would start at 2.0, because that is the minimum y value in the data. This makes the graph easier to interpret.

Changing the above d1 command to:

```
d1 line marker circle
```

will mark each data point with a circle instead of a star. See appendix A for a list of other marker names.

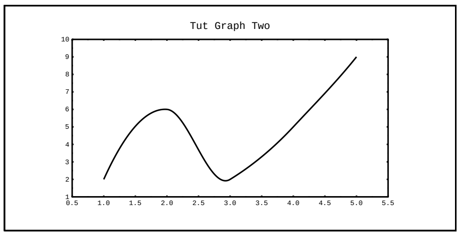
A smooth line can be drawn between the data points by changing the d1 command to:

```
d1 line smooth
```

The order of the commands is not important, except that circle is a parameter for the qualifier marker and therefore must come straight after it. E.g.,

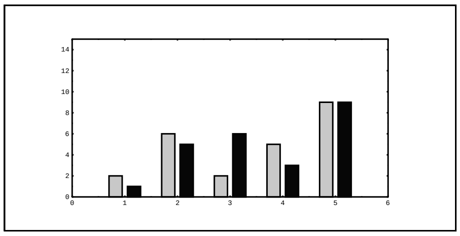
```
d1  [marker circle]  [line smooth]  [color blue]
```

```
size 6 3
begin graph
   size 6 3
   title "Tut Graph Two"
   data tut.dat
   d1 line smooth
end graph
```



It is simple to change to a bar graph and include last year's measurements:

```
begin graph
   size 6 3
   xaxis min 0 max 6
   yaxis min 0 max 15
   data tut.dat
   data tut2.dat
   bar d1,d2 fill grey10,grey90
end graph
```



Adding min and max values on the axis commands is highly recommended because by default GLE won't start from y=0 unless the data happens to be very close to zero. It is also impossible to compare graphs unless they all have the same axis ranges.

Chapter 2

GLE Primitives

A GLE command is a sequence of keywords and values separated by white space (one or more spaces or tabs). Each command must begin on a new line. Keywords may not be abbreviated, the case is not significant. All coordinates are expressed in centimetres from the bottom left corner of the page.

GLE uses the concept of a **current point** which most commands use. For example, the command `aline 2 3` will draw a line from the **current point** to the coordinates (2,3).

The current graphics state also includes other settings like line width, colour, font, 2d transformation matrix. All of these can be set with various GLE commands.

2.1 Graphics Primitives (a summary)

! *comment*
@*xxx*
aline *x y* [arrow start] [arrow end] [arrow both]
amove *x y*
arc *radius a1 a2*
arcto *x1 y1 x2 y2 rad*
begin box [fill *pattern*] [add *gap*] [nobox] [name *xyz*]
begin clip
begin origin
begin path [stroke] [fill *pattern*] [clip]
begin rotate *angle*
begin scale *x y*
begin table
begin text [width *exp*]
begin translate *x y*
bezier *x1 y1 x2 y2 x3 y3*
bigfile *filename.gle*
box *x y* [justify *jtype*] [fill *color*] [name *xxx*] [nobox]
circle *radius* [fill *pattern*]
closepath
curve *ix iy* [*x1 y1 x y x y ... xn yn*]*ex ey*
define marker *markername subroutine-name*
for *var* = *exp1* to *exp2* [step *exp3*] *command [...]* next *var*
grestore
gsave
if *exp* then *command [...]* else *command [...]* end if
include *filename*
join *object1.just sep object2.just*
marker *marker-name* [*scale-factor*]
postscript *filename.eps width-exp height-exp*
rbezier *x1 y1 x2 y2 x3 y3*
return *exp*
reverse
rline *x y* [arrow end] [arrow start] [arrow both]
rmove *x y*
save *objectname*
set cap butt — round — square
set color *col*
set dashlen *dashlen-exp*
set font *font-name*
set fontlwidth *line-width*
set hei *character-size*
set join mitre — round — bevel
set just left — center — right — tl — etc...
set lstyle *line-style*
set lwidth *line-width*
sub *sub-name paramter1 paramter2 etc*
text *unquoted-text-string*
write *string$*

2.2 Graphics Primitives (in detail)

! *comment*

Indicates the start of a comment. GLE ignores everything from the exclamation point to the end of the line.

@*xxx*

Executes subroutine *xxx*.

aline *x y* [arrow start] [arrow end] [arrow both]

Draws a line from the current point to the absolute coordinates *(x,y)*, which then becomes the new current point. The arrow qualifiers are optional, they draw arrows at the start or end of the line, the size of the arrow is proportional to the current font height.

amove *x y*

Changes the current point to the absolute coordinates *(x,y)*.

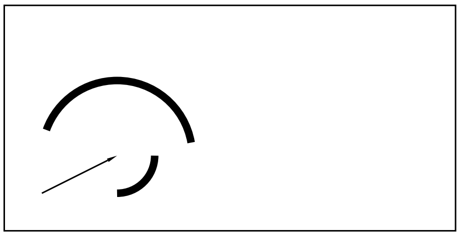
arc *radius a1 a2*

Draws an arc of a circle in the anti-clockwise direction, centered at the current point, of radius *radius*, starting at angle *a1* and finishing at angle *a2*. Angles are specified in degrees. Zero degrees is at three o'clock and Ninety degrees is at twelve o'clock.

```
arc 1.2 20 45
```

The command narc is identical but draws the arc in the clockwise direction. This is important when constructing a path.

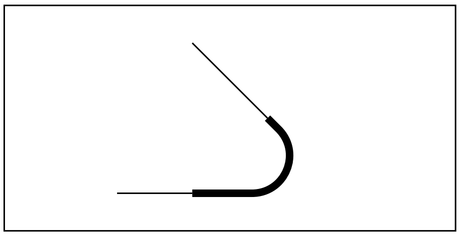
```
amove .5 .5
rline 1 .5 arrow end
arc 1 10 160
arc .5 -90  0
```



arcto *x1 y1 x2 y2 rad*

Draws a line from the current point to *(x1,y1)* then to *(x2,y2)* but fits an arc of radius *rad* joining the two vectors instead of a vertex at the point *(x1,y1)*.

```
amove 1.5 .5
rline 1 0
set lwidth .1
arcto 2 0 -1 1 .5
set lwidth 0
rline -1 1
```



begin *block_name ... end block_name*

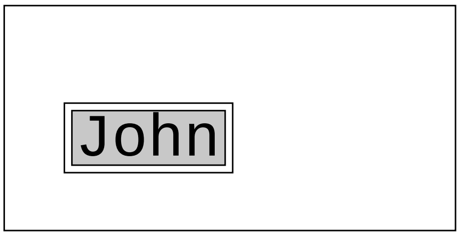
There are several block structured commands in GLE. Each begin must have a matching end. Blocks which change the current graphics state (e.g. scale, rotate, clip etc) will restore whatever they change at the end of the block. Indentation is optional but should be used to make the GLE program easier to read.

begin box [fill *pattern*] [add *gap*] [nobox] [name *xyz*]

Draws a box around everything between begin box and end box. The option add adds a margin of margin cm to each side of the box to make the box slightly larger than the area defined by the graphics primitives in the begin box ... end box group (to leave a gap around text for example). The option nobox stops the box outline from being drawn.

The name option saves the coordinates of the box for later use with the join command.

```
amove 1 1
begin box add .1
  begin box fill grey10 add .1
    text John
  end box
  text John
end box
```



begin clip

This saves the current clipping region. A clipping region is an arbitrary path made from lines and curves which defines the area on which drawing can occur. This is used to undo the effect of a clipping region defined with the begin path command. See the example CLIP.GLE in appendix B at the end of the manual.

begin origin

This makes the current point the origin. This is good for subroutines or something which has been drawn using amove,aline. Everything between the begin origin and end origin can be moved as one unit. The current point is also saved and restored.

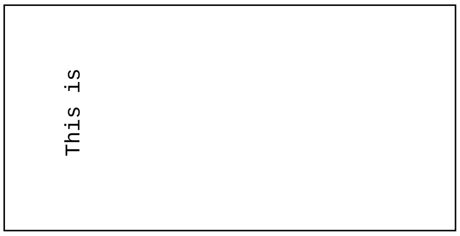
begin path [stroke] [fill *pattern*] [clip]

Initialises the drawing of a filled shape. All the lines and curves generated until the next end path command will be stored and then used to draw the shape. stroke draws the outline of the shape, fill paints the inside of the shape in the given colour and clip defines the shape as a clipping region for all future drawing. Clipping and filling will only work on PostScript devices.

begin rotate *angle*

The coordinate system is rotated anti-clockwise about the current point by the angle *angle* (in degrees). For example, to draw a line of text running vertically up the page (as a Y axis label, say), type:

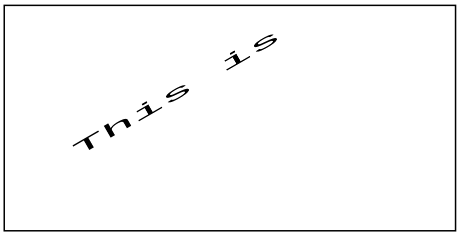
```
amove 1 1
begin rotate 90
   text This is
end rotate
```



begin scale *x y*

Everything between the begin and end is scaled by the factors x and y. E.g., *scale 2 3* would make the picture twice as wide and three times higher.

```
amove 1 1
begin scale 3 1
  begin rotate 30
    text This is
  end rotate
end scale
```

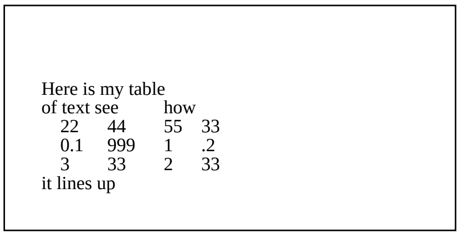


begin table

This module is an alternative to the TEXT module. It reads the spaces and tabs in the source file and aligns the words accordingly. A single space between two words is treated as a real space, not an alignment space.

With a proportionally spaced font columns will line up on the left hand side but not on the right hand side. However with a fixed pitch font, like tt, everything will line up.

```
amove .5 .5
set hei .25 just bl
begin table
   Here is my table
   of text see  how
     22   44    55  33
     0.1  999   1   .2
     3    33    2   33
   it lines up
end table
```



begin text [**width** *exp*]

This module displays multiple lines/paragraphs of text. The block of text is justified according to the current justify setting. See the set just command for a description of justification settings.

If a width is specified the text is wrapped and justified to the given width. If a width is not given, each line of text is drawn as it appears in the file. Remember that GLE treats text in the same way that LaTeX does, so multiple spaces are ignored and some characters have special meaning. E.g, `\ ^ _ & { }`

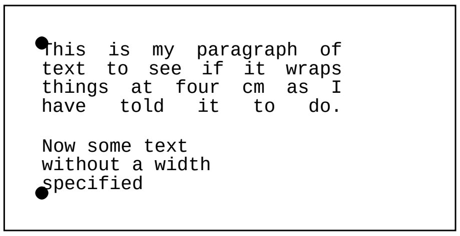
To include Greek characters in the middle of text use a backslash followed by the name of the character. E.g., `3.3\Omega S` would produce "3.3ΩS".

To put a space between the Omega and the S add a backslash space at the end. E.g., `3.3\Omega\ S` produces "3.3Ω S"

Sometimes the space control characters (e.g. `\:`) are also ignored, this may happen at the beginning of a line of text. In this case use the control sequence `\glass` which will trick GLE into thinking it isn't at the beginning of a line. E.g.,

```
text \glass \:\: Indented text
```

```
amove .5 2.5
set hei .25 just tl font tt
begin text width 4
  This is my paragraph of text to see
  if it wraps things at four cm as I have
  told it to do.
end text
amove .5 .5
set justify bl
begin text
  Now some text without
       a width
  specified
end text
```



There are several LaTeX like commands which can be used within text, they are:

`\ \’ \v \u \= \^` `\. \H \~ \"`	Implemented TeX accents
`^{}`	Superscript
`_{}`	Subscript
`\\`	Forced Newline
`\_`	Underscore character
`\,`	.5em (em = width of the letter ‘m’)
`\:`	1em space
`\;`	2em space
`\char{22}`	Any character in current font
`\chardef{a}{hello}`	Define a character as a macro
`\def\v{hello}`	Defines a macro
`\movexy{2}{3}`	Moves the current text point
`\glass`	Makes move/space work on beginning of line
`\rule{2}{4}`	Draws a filled in box, 2cm by 4cm
`\setfont{rmb}`	Sets the current text font
`\sethei{.3}`	Sets the font height (in cm)
`\setstretch{2}`	Scales the quantity of glue between words
`\lineskip{.1}`	Sets the default distance between lines of text
`\linegap{-1}`	Sets the minimum required gap between lines

begin translate *x y*

Everything between the begin and end is moved x units to the right and y units up.

bezier *x1 y1 x2 y2 x3 y3*

Draws a Bézier cubic section from the current point to the point *(x3,y3)* with Bézier cubic control points at the coordinates *(x1,y1)* and *(x2,y2)*. For a full explanation of Bézier curves see the PostScript Language Reference Manual.

bigfile *filename.gle*

This command reads the file one line at a time, compiles each line and executes it. This means it can read any sized file. However, complex multi-line commands cannot be used. Subroutines can be used but not defined, inside the bigfile. Note: there is also a bigfile option in the graphing module for large datasets.

box *x y* [justify *jtype*] [fill *color*] [name *xxx*] [nobox]
Draws a box, of width *x* and height *y*, with its bottom left corner at the current point. If the justify option is used, the box will be positioned relative to the specified point. E.g., TL = top left, CC = center center, BL = bottom left, CENTRE = bottom centre, RIGHT = bottom right, LEFT = bottom left. See set just for a description of justification settings.

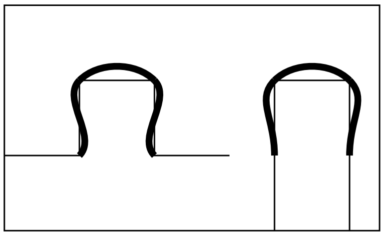
If a fill pattern is specified, the box will be filled. Remember that white fill is different from no fill pattern - white fill will erase anything that was inside the box.

circle *radius* [fill *pattern*]
Draws a circle at the current point, with radius *radius*. If a fill pattern is specified the circle will be filled.

closepath
Joins the beginning of a line to the end of a line. I.e., it does an aline to the end of the last amove.

curve *ix iy* [*x1 y1 x y x y ... xn yn*] *ex ey*
Draws a curve starting at the current point and passing through the points *(x1,y1)* ... *(xn,yn)*, with an initial slope of *(ix,iy)* to *(x1,y1)* and a final slope of *(ex,ey)*. All the vectors are relative movements from the vector before.

```
amove 1 1
curve 1 0 0 1 1 0 0 -1 1 0
amove 3.6 1
curve 0 1 0 1 1 0 0 -1 0 -1
```



define marker *markername subroutine-name*
This defines a new marker called *markername* which will call the subroutine *subroutine-name* whenever it is used. It passes two parameters, the first is the requested size of the marker and the second is a value from a secondary dataset which can be used to vary size or rotation of a marker for each point plotted.

To define a character from the postscript ZapDingbats font as a marker you would use, e.g.

```
sub subnamex size mdata
        gsave                              ! save font and x,y
        set just left font pszd hei size
        t$ = "\char{102}"
        rmove -twidth(t$)/2 -theight(t$)/2  ! Centers marker
        write t$
        grestore                           ! restores font and x,y
end sub
```

The second parameter can be supplied using the *MDATA* command when drawing a graph, this gives the marker subroutine a value from another dataset to use to draw the marker. For example the marker could vary in size, or angle, with every one plotted.

```
d3 MARKER myname MDATA d4
```

define *markername fontname scale dx dy*

This command defines a new marker, from any font, it is automatically centered but can be adjusted using dx,dy. e.g.

```
defmarker hand pszd 43 1 0 0
```

for *var* = *exp1* to *exp2* [step *exp3*] *command [...]* next *var*

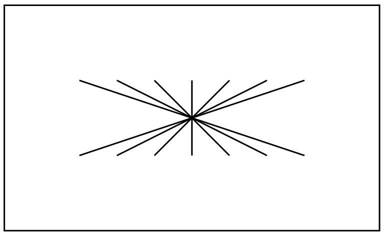
The for ... next structure lets you repeat a block of statements a number of times.

GLE sets var equal to *exp1* and then repeats the following steps.

- If var is greater than *exp2* then GLE commands are skipped until the line after the next statement.
- The value *exp3* is added to var.
- The statements between the for and next statement are executed.

If *exp1* is greater than *exp2* then the loop is not executed.

```
for xx = 1 to 4 step .5
   amove xx 1
   aline 5-xx 2
next xx
```



grestore

Restores the most recently saved graphics state. This is the simplest way to restore complicated transformations such as rotations and translations. It must be paired with a previous gsave command.

gsave

Saves the current graphics transformation matrix and the current point and the current colour, font etc.

if *expression* then *command [...]* else *command [...]* end if

If *expression* evaluates to true, then execution continues with the statements up to the corresponding else, otherwise the statements following the else and up to the corresponding end if are executed.

```
amove 3 3
if xpos()=3 then
   text We are at x=3
else
   text We are elsewhere
end if
```

Note: end if is not spelt endif.

include *filename*

The commands in *filename* are read just as if they were in the current GLE file. With a large include file GLE may run out of memory. If this happens, use the bigfile command instead of include. Note: there is also a bigfile option in the graphing module.

join *object1.just sep object2.just*

Draws a line between two named objects. An object is simply a point or a box which was given a name when it was drawn.

The justify qualifiers are the standard GLE justification abbreviations (e.g. TL=top left, see set just for details)

If *sep* is written as -, a line is drawn between the named objects e.g.

```
join fred.tr - mary.tl
```

Arrow heads can be included at both ends of the line by writing *sep* as `<->`. Single arrow heads are produced by `<-` and `->`. Note that *sep* must be separated from object1.just and object2.just by white space.

If the justification qualifiers are omitted, a line will be drawn between the centres of the two objects (clipped at the edges of the rectangles which define the objects).

See Chapter 5 for an example of joining objects.

marker *marker-name* [*scale-factor*]

Draws marker *marker-name* at the current point. The size of the marker is proportional to the current font size, scaled by the value of *scale-factor* if present. Markers are referred to by name, eg. square, diamond, triangle and fcircle. Markers beginning with the letter f are usually filled variants. Markers beginning with w are filled with white so lines are not visible through the marker. For a complete list of markers refer to Appendix A.1.

```
line 1 1
marker diamond 1
rmove .6 -.4
set font rm hei .7
text Diamond
```

postscript *filename.eps width-exp height-exp*

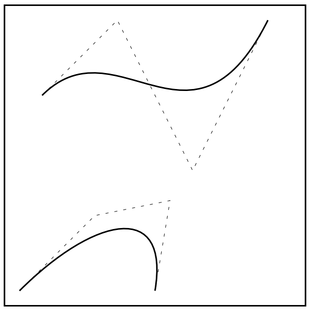
Includes an encapsulated postscript file into a GLE picture, the postscript picture will be scaled up or down to fit the width given. On the screen you will just see a rectangle.

Only the *width-exp* is used to scale the picture so that the aspect ratio is maintained. The height is only used to display a rectangle of the right size on the screen.

rbezier *x1 y1 x2 y2 x3 y3*

This command is identical to the BEZIER command except that the points are all relative to the current point.

```
amove .5 2.8
rbezier 1 1  2 -1  3 1
amove .2 .2
rbezier 1 1  2 1.2  1.8 0
```



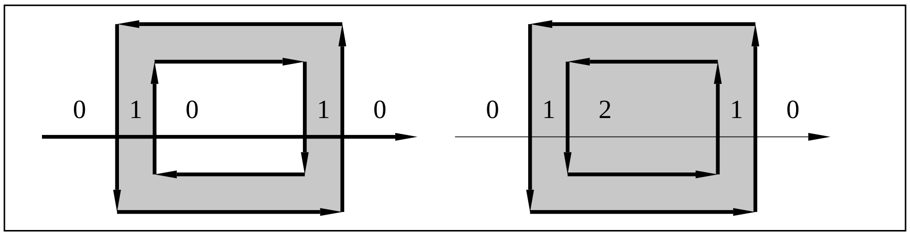
return *exp*

The return command is used inside subroutines to return a value.

reverse

Reverses the direction of the current path. This is used when filling multiple paths in order that the Non-Zero Winding Rule will know which part of the path is 'inside'.

With the Non-Zero Winding Rule an imaginary line is drawn through the object. Every time a line of the object crosses it from left to right, one is added to the counter; every time a line of the object crosses it from right to left, one is subtracted from the counter. Everywhere the counter is non-zero is considered to be the 'inside' of the drawing and is filled.



rline *x y* [arrow end] [arrow start] [arrow both]

Draws a line from the current point to the relative coordinates *(x,y)*, which then become the new current point. If the current point is (5,5) then rline 3 -2 is equivalent to aline 8 3. The optional qualifiers on the end of the command will draw arrows at one or both ends of the line, the size of the arrow head is proportional to the current font size.

rmove *x y*

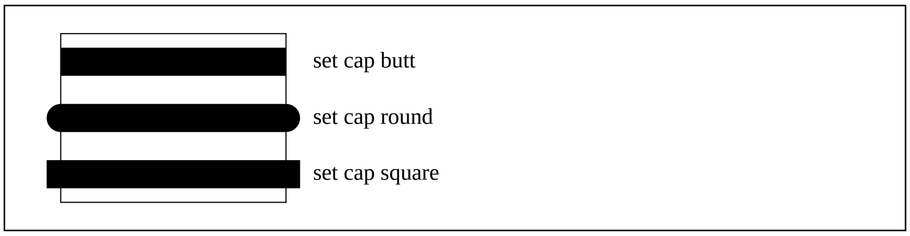
Changes the current point to the relative coordinate *(x,y)*. If the current point is (5,5) then rmove 3 -2 is equivalent to amove 8 3.

save *objectname*

This command saves a point for later use with the join command.

set cap butt — round — square

Defines what happens at the end of a wide line.



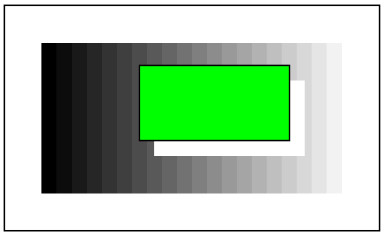
set color *col*

Sets the current colour for all future drawing operations. There are several pre-defined colours which can be specified by name.

black, white, red, green, blue, cyan, magenta, yellow, grey10, grey20 ... grey90, shade1 ... shade5, grid1 ... grid5

It is also possible to specify a grey scale as an expression with 0.0 = black and 1.0 = white.

```
mm$ = "green"
amove .5 .5
for c = 0 to 1 step .05
  box .2 2 fill (c) nobox
  rmove .2 0
next c
amove 2 1
box 2 1 fill white nobox
rmove -.2  .2
box 2 1 fill mm$
```



set dashlen *dashlen-exp*

Sets the length of the smallest dash used for the line styles. This command MUST come before the set lstyle command. This may be needed when scaling a drawing by a large factor.

set font *font-name*

Sets the current font to *font-name*. Valid *font-name*s are listed in Appendix A.2.

There are three types of font: PostScript, LaTeX and Plotter. They will all work on any device, however LaTeX fonts are drawn in outline on a plotter, and so may not look very nice. PostScript fonts will be emulated by LaTeX fonts on non-PostScript printers.

set fontlwidth *line-width*

This sets the width of lines to be used to draw the stroked (Plotter fonts) on a PostScript printer. This has a great effect on their appearance.

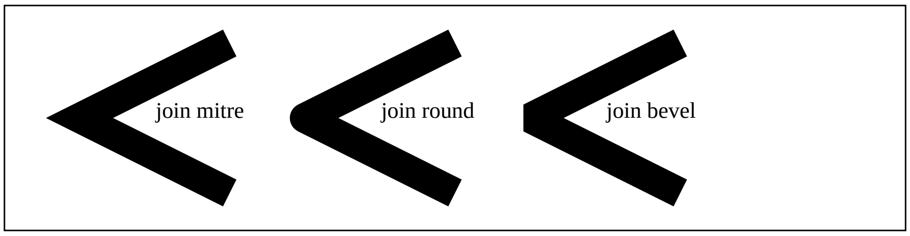
```
set font pltr
amove .2 .2
text Tester
set fontlwidth .1
set cap round
rmove 0 1.5
text Tester
```

set hei *character-size*

Sets the height of text. For historical reasons, concerning lead type and printing conventions, a height of 10cm actually results in capital letters about 6.5cm tall.

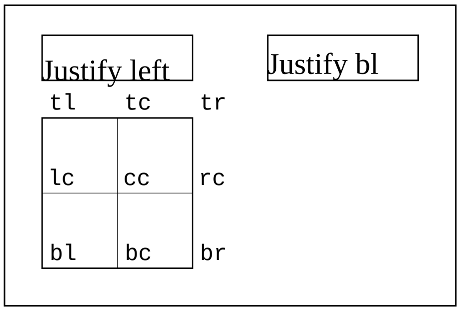
set join mitre — round — bevel

Defines how two wide lines will be joined together. With mitre, the outside edges of the join are extended to a point and then chopped off at a certain distance from the intersection of the two lines. With **round**, a curve is drawn between the outside edges.



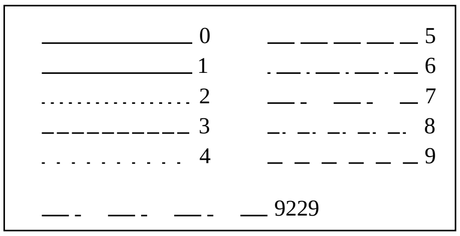
set just left — center — right — tl — etc...
Sets the justification which will be used for **text** commands.

```
amove .5 3
set just left
box 1.5 .6
text Justify left
rmove 2 0
set just bl
box 1.5 .6
text Justify bl
```



set lstyle *line-style*
Sets the current line style to line style number line-style. There are 9 predefined line styles (1–9). When a line style is given with more than one digit the first digit is read as a run length in black, the second a run length in white, the third a run length in black, etc.

```
set hei .3
set just left
amove .5 2.5
for z = 0 to 4
   set lstyle z
   rline 2 0
   rmove .1 0
   write z
   rmove -2.1 -.4
next z
```



set lwidth *line-width*
Sets the width of lines to *line-width* cm. A value of zero will result in the device default of about 0.02 cm, so a lwidth of .0001 gives a thinner line than an lwidth of 0.

sub *sub-name parameter1 parameter2 etc*
Defines a subroutine. The end of the subroutine is denoted with end sub. Subroutines must be defined before they are used.

Subroutines can be called inside any GLE expression, and can also return values. The parameters of a subroutine become local variables. Subroutines are reentrant.

```
sub tree x y a$
   amove x y
   rline 0 1
   write a$
   return x/y
end sub
@tree 2 4 "mytree"         (Normal call to subroutine)
slope = tree(2,4,"mytree")  (Using subroutine in an expression)
```

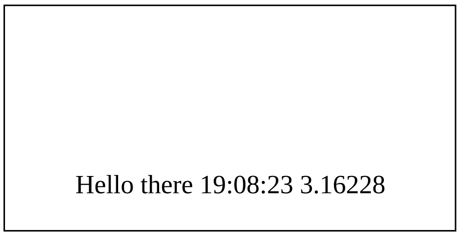
text *unquoted-text-string*
This is the simplest command for drawing text. The current point is unmodified after the text is drawn so following one text command with another will result in the second line of text being drawn on top of the first. To generate multiple lines of text, use the begin text ...end text construct.

```
text "Hi, how's tricks", said Jack!
```

write *string$*

This command is similar to text except that it expects a quoted string, string variable, or string expression as a parameter.

```
set hei .35 font rm
set just center
amove 3 .5
a$ = "Hello there "
xx = sqrt(10)
t$ = time$()
c$ = a$+t$
write a$+t$ xx
```



The built in functions sqrt() and time$() are described in appendix A.3.

2.3 Expressions

Wherever GLE is expecting a number it can be replaced with an expression. For example

```
rline 3 2
```

and

```
rline 9/3 sqrt(4)
```

will produce the same result.

An expression in GLE is delimited by white space, so it may not contain any spaces - 'rline 3*3 2' is valid but 'rline 3 * 3 2' will not work.

Or 'let d2 = 3+sin(d1)' will work and 'let d2= 3 + sin(d1) ' won't.

Expressions may contain numbers, arithmetic operators (+, -, *, /, ^ (to the power of)), relational operators (¿, ¡, =¿, ¡=, =, ¡¿) boolean operators (AND, OR), variables and built-in functions.

When GLE is expecting a colour or marker name (like 'green' or 'circle') it can be given a string variable, or an expression enclosed in braces).

GLE provides a large number of built in functions, these are listed in Appendix A.3.

2.4 Functions Inside Expressions

xg(), yg()

With these functions it is possible to move to a position on a graph using the graph's axis units. To draw a filled box on a graph, at position x=948, y=.004 measured on the graph axis:

```
begin graph
   xaxis min 100 max 2000
   yaxis min -.01 max .01
   ...
end graph
amove xg(948) yg(.004)
box 2 2 fill grey10
```

twidth(), theight(), tdepth()

These functions return the width, depth and height of a string, IF it was printed in the current font and size.

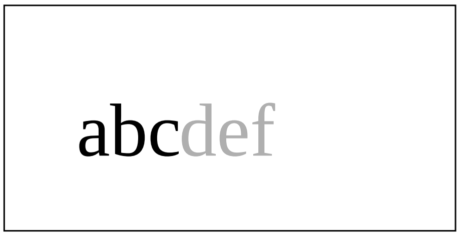
xend(), yend()

These functions return the end point of the last thing drawn. This is of particular interest when drawing text.

```
text abc
set color blue
text def
```

This would draw the def on top of the abc. To draw the def immediately following the abc simply do the following (Note that absolute move is used, not relative move):

```
set hei 1 font rm
set just left
amove 1 1
text abc
set color grey20
amove xend() yend()
text def
```



xpos(), ypos()

Returns the current x and y points.

Chapter 3

The Graph Module

A graph should start with `begin graph` and end with `end graph`. The data to be plotted are organised into datasets. A dataset consists of a series of (X,Y) coordinates, and has a name based on the letter "d" and a number between 1 and 99, eg. `d1`

The name `dn` can be used to define a default for all datasets. Many graph commands described below start with d*n*. This would normally be replaced by a specific dataset number e.g.,

```
d3 marker diamond
```

For each `xaxis` command there is a corresponding `yaxis`, `y2axis` and `x2axis` command for setting the top left and right hand axes. These commands are not explicitly mentioned in the following descriptions.

3.1 Graph Commands (a summary)

data *filename* [*d1 d2 d3 ...*] [*d1=c1,c3*]
dn bigfile "all.dat,xc,yc" [marker mname] [line]
dn bigfile *xxx$* [autoscale]
dn err *d5* errwidth *width-exp* errup *nn%* errdown *d4*
dn herr *d5* herrwidth *width-exp* herrleft *nn%* errright *d4*
dn key *"Dataset title"*
dn line
dn lstyle *line-style* lwidth *line-width* color *col*
dn marker *marker-name* [msize *marker-size*] [mdata *dn*]
dn nomiss
dn smooth — smoothm
dn xmin *x-low* xmax *x-high* ymin *y-low* ymax *y-high*
fullsize
hscale exp
key pos *tl* nobox hei *exp* offset *xexp yexp*
let ds = *exp* [from *low* to *high* step *exp*]
nobox
size *x y*
title *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]
vscale exp
x2labels on
xaxis — yaxis — x2axis — y2axis
xaxis color *col* font *font-name* hei *exp-cm* lwidth *exp-cm*
xaxis dsubticks *sub-distance*
xaxis grid
xaxis log
xaxis min *low* max *high* dpoints *n*
xaxis nofirst nolast
xaxis nticks *number* dticks *distance*
xaxis off
xaxis shift *cm-exp*
xlabels font *font-name* hei *char-hei* color *col*
xnames *"name" "name" ...*
xplaces *pos1 pos2 pos3 ...*
xside color *col* lwidth *line-width* off
xsubticks lstyle *num* lwidth *exp* length *exp* off
xticks lstyle *num* lwidth *exp* length *exp* off
xtitle *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]
y2title *"text-string"* [rotate] yaxis negate

bar *dx,...* dist *spacing*
bar *dx,...* from *dy,...*
bar *dn,...* width *xunits,...* fill *col,...* color *col,...*

fill x1,*d3* color *green* xmin *val* xmax *val*
fill *d4*,x2 color *blue* ymin *val* ymax *val*
fill *d3,d4* color *green* xmin *val* xmax *val*
fill *d4* color *green* xmin *val* xmax *val*

3.2 Graph Commands (in detail)

data *filename* [*d1 d2 d3 ...*] [*d1=c1,c3*]

Specifies the name of a file to read data from. By default, the data will be read into the next free datasets unless the optional specific dataset names are specified.

A dataset consists of a series of (X,Y) coordinates, and has a name based on the letter d and a number between 1 and 99, e.g. d1 or d4. Up to 99 datasets may be defined.

From a file with 3 columns the command 'data xx.dat' would read the first and second columns as the x and y values for dataset 1 (d1) and the first and third columns as the x and y values for dataset 2 (d2). The next data command would use dataset 3 (d3).

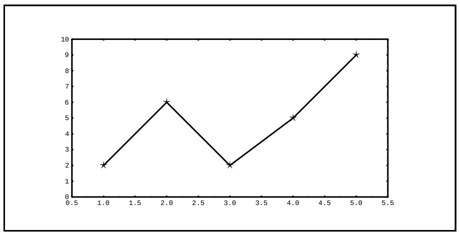
A data file for two datasets looks like this (*=missing value):

```
1  2.7   3
2  5     *
3  7.8   7
4  9     4
```

The first coordinate of dataset **d1** would then be (**1,2.7**) and the first coordinate of dataset **d2** would be (**1,3**).

The option d3=c2,c3 allows particular columns of data to be read into a dataset, d3 would read x values from column 2 and y values from column 3.

```
size 6 3
begin graph
  size 6 3
  data tut.dat
  yaxis min 0
  d1 line marker star msize .2
end graph
```



dn bigfile "all.dat,xc,yc" [marker mname] [line]

The bigfile option allows a dataset to be read as it is drawn, (rather than being complete read into memory before it is drawn) this means that very large datasets can be drawn on a PC without running out of memory. The axis minimum and maximum must be specified (using the command xaxis min *exp* max *exp*.

By default the first two columns of the data file will be read in, but other columns may be specified. E.g., all.dat,3,2 would read x values from column 3 and y values from column 2. Or, to read the 4th dataset, specify the file as all.dat,1,5

If the x column is specified as '0' then GLE will generate the x data points. E.g., 1,2,3,4,5...

Bigfile also accepts variables in place of the file name, e.g.

```
xxx$ = "test.dat,2,3"
d1 bigfile xxx$
```

The AUTOSCALE option pre-reads the file to scale the axis, which is slow but sometimes required, e.g.:

```
d1 bifile a.dat line autoscale
```

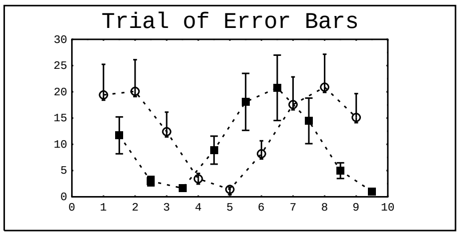
Many (but not all) of the normal dn commands can be used with the bigfile command. E.g., marker, lstyle, xmin, xmax, ymin, ymax, color and lwidth. You cannot use commands like let or bar with the bigfile command.

dn err *d5* errwidth *width-exp* dn errup *nn%* errdown *d4*

For drawing error bars on a graph. The error bars can be specified as an absolute value, as a percentage of the y value, or as a dataset. The up and down error bars can be specified separately e.g.,

```
d3 err .1
d3 err 10%
d3 errup 10% errdown d2
d3 err d1 errwidth .2
```

```
begin graph
        size 6 3
        title "Trial of Error Bars"
        yaxis min 0 max 30
        dn lstyle 2 msize 1.5
        d1 marker circle errup 30%
            errdown 1
        d2 marker fsquare  err 30%
            errwidth .1
end graph
```



dn herr *d5* herrwidth *width-exp* dn herrleft *nn%* errright *d4*

These commands are identical to the error bar commands above except that they will draw bars in the horizontal plane.

dn key *"Dataset title"*

If a dataset is given a title like this a key will be drawn. Use the key command (below, after hscale) to set the size and position of the key. Use the key module (Chapter 4) to draw more complex keys.

dn line

This tells GLE to draw lines between the points of the dataset. By default GLE will not draw lines or markers, this is often the reason for a blank graph.

If a dataset has missing values GLE will not draw a line to the next real value, which leaves a gap in the curve. To avoid this behavior simply use the nomiss qualifier on the dn command used to define the line. This simply throws away missing values so that lines are drawn from the last real value to the next real value.

dn lstyle *line-style* lwidth *line-width* color *col*

These qualifiers are all fairly self explanatory. See the lstyle command in Chapter 2 for details of specifying line styles.

dn marker *marker-name* [msize *marker-size*] [mdata *dn*]

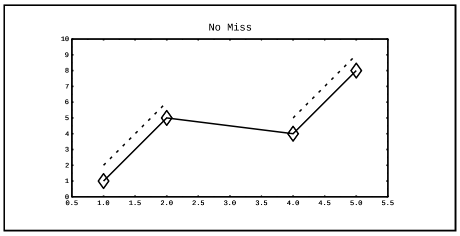
Specifies the marker to be used for the dataset. There is a set of pre-defined markers (refer to Appendix A.1 for a list) which can be specified by name (e.g., circle, square, triangle, diamond, cross, ...). Markers can also be a user-defined subroutine (See the define marker command in Chapter 2). The mdata option allows a secondary dataset to be defined which will be used to pass another parameter to the marker subroutine, this allows each marker to be drawn at a different angle,size or colour.

The msize qualifier sets the marker size for that dataset. The size is a character height in cm, so that the actual size of the markers will be about 0.7 of this value.

dn nomiss

If a dataset has missing values, GLE will not draw a line to the next real value, which leaves a gap in the curve. To avoid this behavior simply use the nomiss qualifier on the dn command used to define the line. This simply ignores missing values.

```
size 6 3
begin graph
        title "No Miss"
        data tut3.dat
        yaxis min 0
        d2 nomiss lstyle 1
        marker diamond msize .2
end graph
```



dn smooth — smoothm

This will make GLE draw a smoothed line through the points. A third degree polynomial is fitted piecewise to the given points.

The smoothm alternative will work for multi valued functions, i.e., functions which have more than one y value for each x value.

dn xmin *x-low* **xmax** *x-high* **ymin** *y-low* **ymax** *y-high*

These commands map the dataset onto the graph's boundaries. The data will be drawn as if the X axis was labelled from *x-low* to *x-high* (regardless of how the axis is actually labelled). A point in the dataset at X = *x-low* will appear on the left hand edge of the graph.

fullsize

This is equivalent to vscale 1, hscale 1, noborder. It makes the graph size command specify the size and position of the axes instead of the size of the outside border.

hscale exp

Scales the length of the yaxis. See vscale. The default value is 0.7.

key pos *tl* **nobox hei** *exp* **offset** *xexp yexp*

This command allows the features of a key to be specified. The pos qualifier sets the position of the key. E.g., tl=topleft, br=bottomright, etc.

let ds = *exp* **[from** *low* **to** *high* **step** *exp***]**

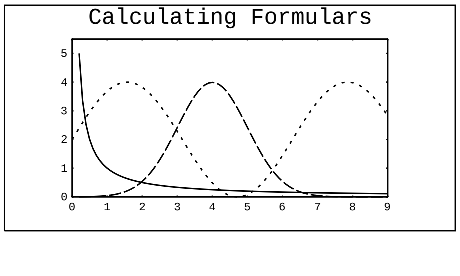
This command defines a new dataset as the result of an expression on the variable x over a range of values. It also allows the use of other datasets. E.g., to generate an average of two datasets:

```
data aa.dat d1 d2
let d3 = d1+d2/2
```

Or to generate data from scratch:

```
let d1 = sin(x)+log(x) from 1 to 100 step 1
```

```
2pi = 2*3.14
begin graph
        size 6 3
        let d1 = 1/x from 0.2 to 10
        let d2 = sin(x)*2+2 from 0.2 to 10
        let d3 = 10*(1/sqrt(2pi))*
         exp(-2*(sqr(x-4)/sqr(2))))
          from 0.2 to 10 step .1
        dn line
        d2 lstyle 2
        d3 lstyle 3
end graph
```



If the xaxis is a LOG axis then the step option is read as the number of steps to produce rather than the size of each step.

NOTE: The spacing around the '=' sign and the lack of spaces inside the expression are necessary.

nobox
: This removes the outer border from the graph.

size *x y*
: Defines the size of the graph in cm. This is the size of the outside box of a graph. The default size of the axes of the graph will be 70% of this, (see vscale and hscale). This command is required.

title *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]
: This command gives the graph a centred title. The list of optional keywords specifies features of it. The dist command is used for moving the title up or down.

vscale exp
: This sets the width of the axis relative to the width of the graph. For example with a 10cm wide graph and a vscale of .6 the x axis would be 6cm long. A setting of 1.0 makes the xaxis the same length as the width of the graph, which is useful for positioning some graphs. The default value is 0.7.

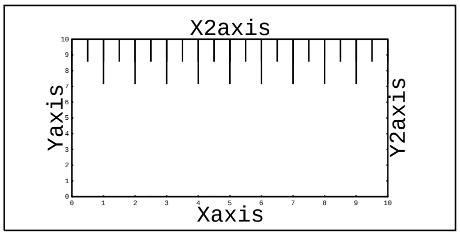
x2labels on
: This command 'activates' the numbering of the x2axis. There is a corresponding command 'y2axis on' which will activate y2axis numbering.

xaxis — yaxis — x2axis — y2axis
: A graph is considered to have four axes: The normal xaxis and yaxis as well as the top axis (x2axis) and the right axis (y2axis).

Any command defining an xaxis setting will also define that setting for the x2axis.

The secondary axes x2 and y2 can be modified individually by starting the axis command with the name of that axis. E.g.,

```
begin graph
   size 6 3
   xtitle "Xaxis" hei .3
   ytitle "Yaxis" hei .3
   x2title "X2axis" hei .3
   y2title "Y2axis" hei .3
   x2ticks length .6
end graph
```



xaxis color *col* font *font-name* hei *exp-cm* lwidth *exp-cm*
: These axis qualifiers affect the colour, lstyle, lwidth, and font used for drawing the xaxis (and the x2axis). These can be overriden with more specific commands. E.g., 'xticks color blue' would override the axis colour when drawing the ticks. The subticks would also be blue as they pick up tick settings by default.

xaxis dsubticks *sub-distance*
: See xaxis nticks below.

xaxis grid
: This command makes the xaxis ticks long enough to reach the x2axis and the yaxis ticks long enough to reach the y2axis. When used with both the x and y axes this produces a grid over the graph. Use the xticks lstyle command to create a faint grid.

xaxis log

Draws the axis in logarithmic style, and scales the data logarithmically to match (on the x2axis or y2axis it does not affect the data, only the way the ticks and labelling are drawn)

Be aware that a straight line should become curved when drawn on a log graph. This will only happen if you have enough points or have used the smooth option.

xaxis min *low* max *high* dpoints *n*

Sets the minimum and maximum values on the xaxis. This will determine both the labelling of the axis and the default mapping of data onto the graph. To change the mapping see the dataset dn commands xmin, ymin, xmax, and ymax.

The dpoints option specifies the number of decimal points that should be displayed. e.g. with a value of 3 these numbers (0, 0.333333, 0.6666667, 1) would become (0.000, 0.333, 0.667, 1.000)

xaxis nofirst nolast

These two switches simply remove the first or last (or both) labels from the graph. This is useful when the first labels on the x and y axis are too close to each other.

xaxis nticks *number* dticks *distance*

nticks specifies the number of ticks along the axis. dticks specifies the distance between ticks and dsubticks specifies the distance between subticks. For example, to get one subtick between every main tick with main ticks 3cm apart, simply specify dsubticks 1.5.

By default ticks are drawn on the inside of the graph. To draw them on the outside use the command:

```
xticks length -.2
yticks length -.2
```

xaxis off

Turns the whole axis off — labels, ticks, subticks and line. Often the x2axis and y2axis are not required, they could be turned off with the following commands:

```
x2axis off
y2axis off
```

xaxis shift *cm-exp*

This moves the labelling to the left or right, which is useful when the label refers to the data between the two values.

xlabels font *font-name* hei *char-hei* color *col*

This command controls the appearance of the axis labels but not the axis title.

xnames *"name" "name" ...*

This command replaces the numeric labelling with absolutely anything. Given data consisting of five measurements, taken from Monday to Friday, one per day then

```
xaxis min 0 max 6 dticks 1
xnames "" "Mon" "Tue" "Wed" "Thu" "Fri"  ""
```

would give the desired result. Note it is essential to define a specific axis minimum, maximum, dticks, etc., otherwise the labels may not correspond to the data.

If there isn't enough room on the line for all the names then simply use an extra xnames command.

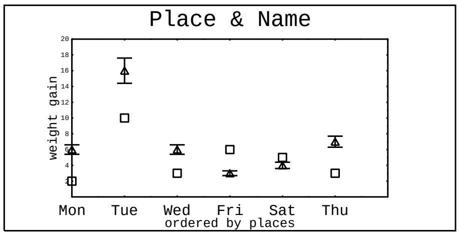
xplaces *pos1 pos2 pos3 ...*

This is similar to the xnames command but it specifies a list of points which should be labelled. This allows labelling which isn't equally spaced. The above example with days of the week could be written like this:

```
xplaces 1  2  5
xplaces 7
xnames "Mon" "Tue" "Fri" "Sun"
```

If there isn't enough room on the line for all the names then simply use an extra xplaces command.

```
begin graph
        size 6 3
        xtitle "ordered by places"
        ytitle "weight gain"
        title "Names & Places"
        xaxis min 0 max 6 dticks 1
        xplaces 0 1 2 5 3 4
   xnames "Mon" "Tue" "Wed" "Thu" "Fri" "Sat"
        yaxis min 0 max 20 nofirst
        data test.dat
        d1 marker square color blue
        d2 marker triangle color red
        d2 err 10% errwidth .5
end graph
```



xside color *col* lwidth *line-width* off

This command controls the appearance of the axis line, i.e. the line to which the ticks are attached.

xsubticks lstyle *num* lwidth *exp* length *exp* off

This command gives fine control of the appearance of the axis subticks.

xticks lstyle *num* lwidth *exp* length *exp* off

This command gives fine control of the appearance of the axis ticks. Note: To get ticks on the outside of the graph, i.e. pointing outwards, specify a negative tick length:

```
xticks length -.2
yticks length -.2
```

xtitle *"title"* [hei *ch-hei*] [color *col*] [font *font*] [dist *cm*]

This command gives the axis a centered title. The list of optional keywords specify features of it. The dist command is used for moving the title up or down.

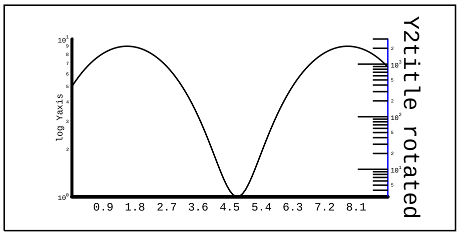
xaxis negate

This is reversed the numbering on the y axis. For use with measurements below ground, where you want zero at the top and positive numbers below the zero.

y2title *"text-string"* [rotate]

By default the y2title is written vertically upwards. The optional rotate keyword changes this direction to downwards. The rotate option is specific to the y2title command.

```
begin graph
        xaxis min 0 max 9 nofirst nolast
        xaxis hei .6 nticks 10  dsubticks .2
        xaxis lwidth .2 color red
        ytitle "log Yaxis"
        yaxis log min 1 max 10 lwidth .1
        y2axis  min 3 max 3000
        y2side color blue lwidth 0
        y2ticks length .9 lwidth 0
        y2title "Y2title rotated " hei .3 rotate
        x2axis off
        y2labels on
        let d1 = sin(x)*4+5 from 0 to 9
        dn line
end graph
```



3.3 Bar Graphs

Drawing a bar graph is a subcommand of the normal graph module. This allows bar and line graphs to be mixed. The bar command is quite complex as it allows a great deal of flexibility. The same command allows stacked, overlapping and grouped bars.

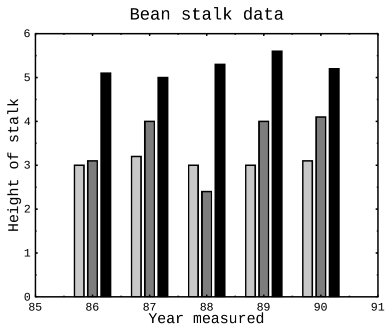
For stacked bars use separate bar commands as in the first example below:

```
bar d1 fill black
bar d2 from d1 fill grey10
```

For grouped bars put all the datasets in a list on a single bar command:

```
bar d1,d2,d3 fill grey10,grey40,black
```

```
begin graph
        nobox
        size 6.5 5
        title "Bean stalk data"
        xtitle "Year measured"
        ytitle "Height of stalk"
        xaxis min 85 max 91 dticks 1
        yaxis min 0 max 6
        data gc_bean.dat
        bar d1,d2,d3
         fill grey10,grey40,black
end graph
```



bar *dx,...* dist *spacing*
: Specifies the distance between bars in dataset(s) dx,.... The distance is measured from the left hand side of one bar to the left hand side of the next bar. A distance of less than the width of a bar results in the bars overlapping.

bar *dx,...* from *dy,...*

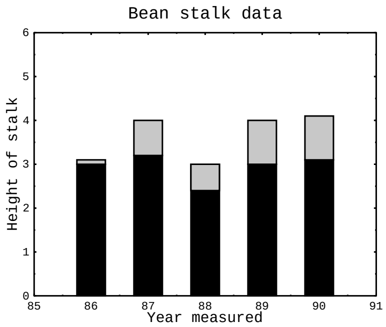
This sets the starting point of each bar in datasets dx,... to be at the value in datasets dy,..., and is used for creating stacked bar charts. Each layer of the bar chart is created with an additional bar command.

```
bar d1,d2
bar d3,d4 from d1,d2
bar d5,d6 from d3,d4
```

Note 1: It is important that the values in d3 and d4 are greater than the values in d1 and d2.

Note 2: Data files for stacked bar graphs should not have missing values, replace the * character with the number on its left in the data file.

```
begin graph
        nobox
        size 6.5 5
        title "Bean stalk data"
        xtitle "Year measured"
        ytitle "Height of stalk"
        xaxis min 85 max 91 dticks 1
        yaxis min 0 max 6
        data gc_bean.dat
        bar d1 fill black
        bar d2 from d1 fill grey10
end graph
```



bar *dn,...* width *xunits,...* fill *col,...* color *col,...*

The rest of the bar qualifiers are fairly self explanatory. When several datasets are specified, separate them with commas (with no spaces between commas).

```
bar d1,d2 width 0.2 dist 0.2 fill grey10,grey20 color red,green
```

3.4 3D Bar Graphs

3d Bar graphs are now supported, the commands are:

```
bar d1,d2  3d .5 .3  side red,green  notop
bar d3,d4  3d .5 .3  side red,green top black,white
```

Take note of comma's.

bar *dx,...* 3d *xoffset yoffset* side *color list* top *color list* [notop]

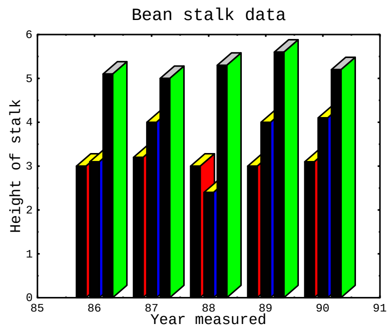
3d *xoffset yoffset*
: Specifies the x and y vector used to draw the receding lines, they are defined as fractions of the width of the bar. A negative xoffset will draw the 3d bar on the left side of the bar instead of the right hand side.

side *color list*
: The color of the side of each of the bars in the group.

top *color list*
: The color of the top part of the bar

notop
: Turns off the top part of the bar, use this if you have a stacked bar graph so you only need sides on the lower parts of each stack.

```
begin graph
        nobox
        size 6.5 5
        title "Bean stalk data"
        xtitle "Year measured"
        ytitle "Height of stalk"
        xaxis min 85 max 91 dticks 1
        yaxis min 0 max 6
        data gc_bean.dat
        bar d1,d2,d3 3d 1.5 1.3
         side red,blue,green
         top yellow,yellow,grey10
end graph
```



Note: You won't see the color of the side or top on the pc screen.

3.5 Filling Between Lines

fill x1,*d3* color *green* xmin *val* xmax *val*

Fills between the xaxis and a dataset, use the optional xmin, xmax, ymin, ymax qualifiers to clip the filling to a smaller region

fill *d4*,x2 color *blue* ymin *val* ymax *val*

This command fills from a dataset to the x2axis.

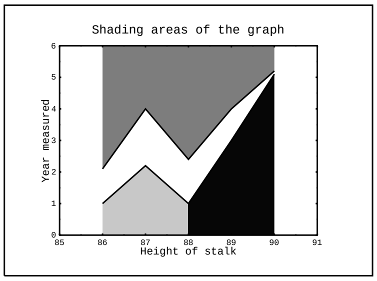
fill *d3*,*d4* color *green* xmin *val* xmax *val*

This command fills between two datasets.

fill *d4* color *green* xmin *val* xmax *val*

This command treats the dataset as a polygon and fills it. The dataset should be a closed polygon.

```
fill d2,x2 color grey40
fill x1,d1 color grey10 xmin 85 xmax 88
fill x1,d1 color grey90 xmin 88 xmax 91
```



3.6 Notes on Drawing Graphs

3.6.1 Importance of Order

Most of the graph commands can appear in any order, but in some cases order is significant.

As some let commands operate on data which has been read into datasets, the data commands should precede the let commands.

The wildcard dn command should appear before specific d1 commands which it will override.

By default xaxis commands also change the x2axis, and xlabels commands also change x2labels, so to specify different settings for the x and x2 axes, put the x2 settings after the x settings.

```
begin graph
   size 10 10
   data a.dat
   let d2 = d1*3
   dn marker square lstyle 3   ! sets d1 and d2
   d2 marker dot
   xaxis color green
   xticks color blue
   x2axis color black
end graph
```

3.6.2 Line Width

When scaling a graph up or down for publication the default line width may need changing. To do this simply specify a set lwidth command before beginning the graph.

```
size 10 10
set lwidth .1
begin graph
   ...
end graph
```

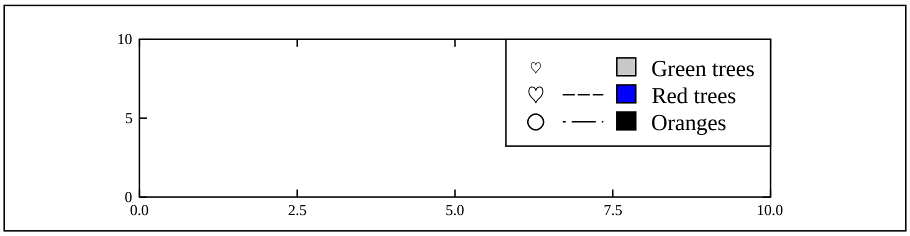
Chapter 4

The KEY module

This module is used for drawing keys for graphs. It is completely separate from the graph module.

Specify a position for the key, the size of the lettering and then for each dataset specify marker, color, lstyle and fill pattern:

```
begin graph
   ...
end graph
begin key
   hei .5
   position tr
   text "Green trees" marker heart msize .2 fill grey10
   text "Red trees" lstyle 3 marker heart fill blue
   text "Oranges" marker circle lstyle 6 fill black
end key
```



All commands to do with a particular line of the key module MUST appear on the same line.

4.1 Key commands

offset *x-exp y-exp*
: Specifies the offset in cm from the current point to the bottom left hand corner of the graph. This command should be on a line of its own.

position *justify-exp*
: This is an alternative to the OFFSET command. It allows you to specify a position on the graph, e.g., tl = top left. This command should be on a line of its own. See set just for a list of justify settings.

text *str-exp*
: The text which will be displayed on the end of the line.

lstyle *style-num*
: The line style which will be used for the short line drawn in the key.

marker *marker-name*
: The marker which will be used for that line of the key.

msize *exp*
: Specifies the size of the markers in cm.

mscale *exp*
: Specifies how much to scale the size of the marker. E.g., 0.5 would produce a marker half as big as normal.

color *color-name*
: The colour of the text, line and marker.

hei *cm-exp*
: This sets the height of the text used to draw the key. The key will change in size to fit around the text. If you omit this command the current font size is used.

fill *fill-pattern*
: The fill pattern used in that line of the key.

4.2 Key syntax

The syntax of the KEY module is rather confusing.

The commands which relate to global features of the key:

```
OFFSET, NOBOX, HEI, POS
```

Can appear anywhere except on the start of a line which defines a new dataset, e.g.:

```
begin key
   OFFSET 2 3 HEI 2
   text "abc" NOBOX
   NOBOX text "abc" (this line is NOT valid)
   ...
end key
```

The commands which relate to a single dataset (or line of the key):

```
TEXT, MARKER, MSIZE, MSCALE, COLOR, FILL, LSTYLE, LINE, LWIDTH
```

Must appear together on a line, but any one of them can start the line, .e.g.:

```
begin key
   marker circle text "abc" lstyle 2
   lstyle 2 marker square
end key
```

So you usually put the global commands first, and then one line for each line in the key, e.g.:

```
begin key
   nobox pos tl hei .5 (global commands)
   marker circle text "The circles"
   marker square lstyle 1 text "The squares"
end key
```

Chapter 5

Advanced features of GLE

This chapter covers the advanced features of GLE. Some of these features will not give exactly the same results on the PC screen as you would get when printing to a PostScript printer. E.g., clipping to an arbitrary shape is only implemented in the PostScript driver but most other features will give as close as possible representation given the limitations of the screen.

5.1 Colour

Internally GLE treats colour and fill identically, they are simply an intensity of Red, Green and Blue. Each of the predefined colour names (yellow,grey20,orange,red) simply define the ratio of red, green and blue.

There are two ways to use variables to show colour, one is for shades of grey:

```
for i = 0 to 10
   box 3 .2 fill (i/10)
   rmove 0 .2
next i
```

The other is for passing a colour **name** as a variable:

```
sub stick c$
   box .2 2 fill c$
end sub
@stick "green"
```

Remember a fill pattern completely obscures what is behind it, so the following command would produce a box with a shadow:

```
amove 4 4
box 3 2 fill grey10
rmove -.1 .1
box 3 2 fill white
rmove .4 .4
text hellow
```

5.2 Device Drivers

GLE supports the following devices.

Interactive: IBM/PC (BGI), VT100, REGIS (VT125, VT240), TEK4010, VWS, XWindows.

Output: PostScript, HPGL, EPSON, EPSON 24pin, HP Deskjet.

Keyboard Mappings:

VT100	VT200	PC	Meaning
GOLD 1	F11	F1	Help
GOLD 2	F12	F2	Save
GOLD 3	F13	F3	Load
GOLD 4	F14	F4	Save-as
GOLD 9	F9	F9	Graph-menu
GOLD 0	F10	F10	Draw-it
Control+Z	Control+Z	Control+Z	Exit/Escape
		Alt+X	Exit/Escape
Control+E	Control+E		Calls VAX EDT
Control+F	Control+F		Toggle fast/slow text

To find out what drivers are available type in:

```
ls /usr/local/gle/gle_*
```

5.2.1 PC Screen Drivers

Remember that what you see on the screen isn't always what you will get on the printer. For example filled regions will not be filled, and some characters may not look right.

After pressing F10 and drawing the graph it can be annotated by using the mouse (or arrow keys) to draw lines, text and boxes. To draw lines simply click on the points of the line, use the right hand mouse button to 'pick up' the pen.

To draw text press the letter 't' and then click on where you would like the text to be drawn.

All movements are rounded to the grid size settings which are 1.0cm, 0.1cm, 0.01cm etc.

The height and colour of the text/lines is determined by the current settings at the end of the GLE file.

If there is no mouse driver loaded then a cross-hair will appear and it can be moved around using the arrow keys. Press 'c' to click, instead of the mouse button.

SuperVGA

To use a SuperVGA card you first need to get a BGI driver that supports your card. From anonymous FTP you can get svgabgi3.zip: ftp wuarchive.wustl.edu

```
ftp> user anonymous
ftp> (mail ident)
ftp> cd /mirrors/msdos/borland
ftp> binary
ftp> get svgabgi3.zip
ftp> quit
```

Then unzip it, decide which driver will match your SVGA card and copy that driver into `\GLE\EXE`.

```
c:> pkunzip svgabgi3.zip
c:> pkunzip svgabgi3.zip
c:> type readme.
c:> copy svga16.bgi \gle\exe
```

Define an environment variable to tell gle about this driver and which mode to use. (put this line in your autoexec.bat)

```
c:> set gle_addbgi=4.svga16
```

5.2.2 GO32/GRX Screen Driver

GLE 32 is a 32-bit-Implementation of GLE for MS-DOS. Axel Rohde did this port of the GLE version 3.3b GLE32 was compiled with the free port of the GNU C-compiler DJGPP by D.J. Delorie. The compiler itself and the DJGPP-compiled executables are running with the 32-bit DOS-extender GO32.
GLE32 was compiled using Borland-C compatible libraries for text and graphics-modes and some filesystem calls. There exists for the DJGPP specific graphics-library GRX from Csaba Biegl a emulation-library called BCCGRX from Hartmut Schirmer to replace calls of the Borland-Graphics-Interface (BGI) with GRX-calls. Hartmut has implemented the mouse-functionality, too, with GRX-calls.
In the example on the following lines, the progams are installed in the directory `d:\gle32`, the fonts are in `d:\gle32\fonts`. GLE 32 searches for its vector-fonts in the directory `GLE_TOP`. Don't forget the trailing slash. In addition to this, `GL32FONT` points to the directory where the bitmap-fonts (you can see them in the status-line of the preview) can be found.
The directory with the DOS-Extender GO32 and, if there's no numeric-prozessor installed, the co-prozessor-emulator, must be in the path-environment.

```
set GLE_TOP=d:/gle32/
set gle32font=d:/gle32/grxfont
path=..your normal path..;d:\gle;
go32=driver d:/gle32/driver/vesa_s3.grn gw 1024 gh 768 tw 80 th 25 nc 256
```

The configuration of graphics-drivers is a little bit more complicated. Please study the documentation of the Libraries GRX und BCCGRX and the README of GO32 in their directories.

The environment GO32 sets den path-name and the mode of the driver an. This example installs the driver for an S3 graphics-board with a resolution of 1024 horizontal 768 vertical pixels and 256 colors.

There's a second way to install a graphics-mode. If the environment- variables GLE32WIDTH, GLE32HEIGHT and GLE32COLORS are set, the graphics- mode in the GO32 variable is overridden. You still have to specify a driver in the GO32 environment.

```
set GLE32WIDTH=800
set GLE32HEIGHT=600
set GLE32COLORS=16
```

There's a prepared batch-file `setgle32.bat` to set all the environment- variables in the directory gle32.

To figure out, which modes are supported, try to run the program modetest in the directory `gle32\driver\doc`.

! WARNING !

A wrong installed graphics-mode can DESTROY your MONITOR (and/or graphics board) if the refresh rate is too high!

USE THIS ON YOUR OWN RISK !

You should take a look into the manuals of your monitor and your graphics-adapter to figure out, which horizontal frequencies are supported. If the horizontal frequency of the monitor is 64 kHz or higher, you MAY feel save. (MY Monitor has a horizontal frequency of 64 kHz and supports a resolution of 1024x768 with a refresh rate up to 80Hz.)
If you want to go save, don't set the environment go32 at all! This will use the normal (flickering) VGA-mode on a VGA-compatible adapter.
For more detailed information and instructions how to install GO32 see `gle32.txt`!

5.2.3 PostScript Driver

To print a GLE file to the laser printer type:

```
$ cgle myfile /print
```

or on a PC:

```
C:\GLE> psgle myfile
C:\GLE> print myfile.ps
```

The postscript drivers for GLE will automatically flip a picture to best fit onto the page, e.g. a wide graph (as defined by the size command at the top) will be drawn in *landscape* mode and a tall thin graph will be drawn in *portrait* mode.

To produce an .eps file on a VAX for inclusion in LaTeX or WordPerfect you would type:

```
$ cgle myfile /dev=eps
```

On a PC you would type:

```
C:\GLE> psgle myfile  /eps
(this creates myfile.eps, not myfile.ps)
```

WordPerfect can also understand a special file format which contains both an EPS file for printing to PostScript printers and a bitmap TIFF image for displaying on the screen. GLE can create this sort of file with the command:

```
C:> wpgle myfile
```

This will create a file called MYFILE.EPF which you can include into WordPerfect.

To include Postscript in a LaTeX document use epsf.sty of the DVIPS-package. Inside your LaTeX document use
epsffile to put it at the right place in a picture-environment, e.g. :

```
\documentstyle[12pt,epsf]{article}
...
\begin{picture}(13.0, 5.5)
\put(0.0,0.0){
\epsfclipon
\epsfxsize=6cm
\epsffile[60 170 560 740]{myfile.ps} } % [ bounding-box ] { file_name }
\end{picture}
```

Advanced features of epsf.sty are described in `../TeX/src/dvips/dvips.tex`.

The laser printer driver will draw all zero width lines .02cm wide for any line width equal to zero, but if an lwidth is greater than zero and less than or equal to .0001 then it will use a line width of 1 pixel. Without this it would be impossible to specify a line width that didn't occasionally get rounded to 2 pixels.

There are also some commandline switches

```
/nod       (add ^D to ps file)
/addd      (Don't add ^D to ps file)
/nomaxpath (Don't choke on complex fill paths)
/fill      (For dvibit, makes bar's filled instead of shaded)
```

5.2.4 TEK4010 Driver

This driver allows initialization sequences to be defined with the symbols TEK_OPEN and TEK_CLOSE.

On a VAX this is normally done by CGLECMD.COM so that when you specify /DEV=V550 the assignments are done for you. (V550 = Visual 550)

5.2.5 HPGL Driver

This driver allows initialization sequences to be defined in the symbols HPGL_OPEN and HPGL_CLOSE. On the PC use environment variables and on the VAX use DCL symbols. Also HPGL_WIDTH and HPGL_HEIGHT can be defined for non A3 plotters.

The HPGL driver supports sizes greater than A3.

The symbols HPGL_ADDX, HPGL_ADDY add a margin to the plot. These default to .9cm and 1.5cm

On a VAX this is normally done by CGLECMD.COM so that when you specify /DEV=HPA4 the assignments are done for you.

The HPGL driver assigns the following colours to pen numbers:

1=black, 2=red, 3=green, 4=blue, 5=magenta, 6=white, 7=yellow.

To get Gle-Output in a WIN-WORD text, HPGL is a good and easy way to do it.

The use of the HPGL-Converter HP2XX of Heinz W. Werntges is another way to get various pix-map format output. HP2XX has been ported successfully for Unix, OS/2, DOS, Amiga, Atari, VMS and AXP.
HP2XX has many controling options. In the current version it is able to write the following formats: mf, cad, em, epic, eps, pcl, pcx, pic, img, pbm, pre, uis.

HP2XX is available via anonymous FTP at ftp.rz.uni-duesseldorf.de. For further information ask Heinz (Internet: werntges@clio.rz.uni-duesseldorf.de).

5.2.6 PC Bitmap Drivers

GLE supports the EPSON 8 and 24 pin and HP deskjet/laserjet printers. To support bitmap devices which require a large amount of memory GLE first writes a device independent file OUT.DVI, then the appropriate bitmap driver for your printer will read the OUT.DVI file and create a bitmap which it then prints to LPT1:

```
C:> dvigle myfile       (produces OUT.DVI)
C:> dviepson            (creates bitmap and prints to LPT1:)
```

The output options are:

```
C:> dviepson            Standard EPSON printers
C:> dviep24             24 Pin EPSON printers (180dpi)
C:> dvilj               HP Laser jet, Desk jet (150 dpi)
C:> dvilj300            HP Laser jet, Desk jet (300 dpi)
C:> dviprint -dpj       HP PaintJet printers
C:> dviprint -dsx       Sixel graphics driver
```

The high resolution drivers (dviep24, dvilj300) are significantly slower than the low resolution drivers so would only be used for final output.

See the file AAREADME.GLE for the latest information on drivers.

5.2.7 DVIPRINT

All available bitmap drivers and options can be use with

```
gle myfile -ddevice [-hires] [...]
```

To find out what drivers are available type in:

```
gle_dviprint

Usage: dviprint [-depson | -dlj] [-old] [-hires] [-vhires] [-debug] [-output xx.prt]
        -depson   To produce output for epson printers
        -dwp      To add tiff image to wp .eps file
        -dec      Epson color ribbon printers
        -dlj      To produce output for HP LaserJet printers
        -dpj      To produce output for HP PaintJet printers
        -dsx      Sixel graphics, for DEC printers la100's ...
        -dvt      To print bitmap to screen (preview)
        -over     Overhead transparency mode for PaintJet
        -old      For old HP Laser Jet printers (no compression)
        -hires    Uses high resolution for that printer (slower)
        -vhires   Viritcal high resolution for sixel graphics
        -wide     If your printer has a wide carriage
        -noflip   Disable's auto flipping
        -flip     Forces flip
        -nosquash Tries to print it full size
        -compress Force internal bitmap compression (slow)
        -noff     No form feed
        -debug    Prints debug messages
        -out x.x  Prints output to file instead of printer port
```

5.2.8 Fonts (font mapping)

By default the generic fonts (rm, rmb, ss, tt etc) will all map to PLSR (plotter simplex roman) on BITMAP and HPGL drivers. To make this happen on other drivers put the command plotter fonts immediately after the size command at the top of the GLE file.

A typical result of this change in fonts is that something that lines up on the screen will not line up when printed to an EPSON printer. If this happens then use the plotter fonts command.

If a character is missing from a font, or isn't the particular variation you like, you can define a character to be from a different font in this way:

```
\chardef{%}{{\setfont{texcmr}\char{37}}}
\chardef{[}{{\setfont{texcmr}\char{91}}}
\chardef{]}{{\setfont{texcmr}\char{93}}}
```

On the PC some fonts may not be installed to save disk space. When one of the missing fonts is called for, a replacement font will be displayed, this may look terrible and some special characters may be completely wrong.

More importantly if you use a font which does not have its font metric file installed (e.g. C:/GLE/FONTS/PLSR.FMT) then the PostScript driver will space the characters incorrectly. This can be fixed by extracting that particular metric file from the distribution file CGLE_FVE.ZIP using PKUNZIP.

5.2.9 Printer Fonts

You can now tell gle about postscript fonts that you have downloaded into your own printer.

Lets pretend we are adding a font called Greek-Bold

```
                1) Download the font into you laser printer
                2) Add a line to FONT.DAT
psgb 86 psgb.fmt plsr.fve psgb.fmt
a    b  c         d
                a = GLE's name for the font
                b = The next unused number in font.dat
                c = The font metric file, this can be created using
                        makefmt from and adobe font metric file
                        (.afm) which you should have been supplied
                        with your font.
                d = The font vector file, this is just a font that
                        that gle can use to draw your font on non
                        postscript devices.
                3) Add a line to psfont.dat
psgb Greek-Bold
```

This tells the postscript driver that this is a font that the printer knows how to deal with.

5.3 Diagrams, Joining Named Objects

To draw lines between boxes which contain text, first name each box as it is drawn and then use the join command to draw the lines between the boxes.

```
box 2 3 fill blue  name square
amove 5 5
begin box add .1  name titlebox
     text Title
end box
join square.tr -> titlebox.bc
```

These commands draw a line from the "Top Right" of the square to the "Bottom Centre" of the titlebox, with an arrow at the titlebox end.

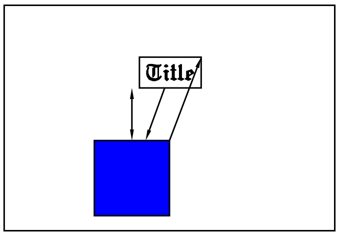
```
join square - titlebox
```

would draw a line from the centre of the square to the centre of the titlebox but clipped correctly at the edges of both boxes.

```
join square.tc <-> titlebox.v
```

would draw a vertical line from the top centre of the square to the titlebox with arrows at both ends.

```
set hei .3 font plge
amove 1.2 .2
box 1 1 fill blue  name square
amove 1.9 2
begin box add .1  name titlebox
        text Title
end box
join square.tr -> titlebox.tr
join square <- titlebox
join square.tc <-> titlebox.v
```



Named points on each box:

```
.bl Bottom left
.bc Bottom centre
.br Bottom right
.cr Centre right
.tr Top right
.tc Top centre
.tl Top left
.cl Centre left
.v  Vertical line
.h  Horizontal line
.cc Centre centre
.ci Circle clipping (for drawing lines to a circle)
```

To draw lines to a given point, simply move there and save that point as a named object.

```
rmove 2 3
save apoint
join apoint - square
```

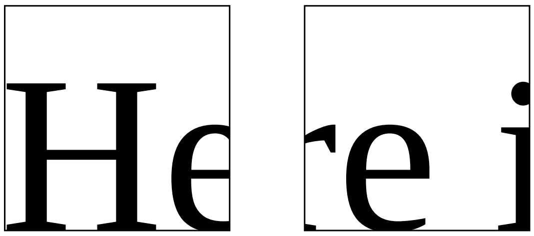
5.4 Filling, Stroking and Clipping Paths

It is possible to set up arbitrary clipping regions. To do this draw a shape and make it into a path by putting a `begin path clip` ... `end path`, around it. Then draw the things to be clipped by that region. To clear a clipping path surround the whole section of GLE commands with `begin clip` ... `end clip`

Characters can be used to make up clipping paths, but only the PostScript fonts will currently work for this purpose.

Clipping doesn't work on the screen or p79 devices, but does on the laser printer. See example CLIP.GLE at end of manual.

```
size 10 5
begin clip       ! Save current clipping path
   begin path clip stroke  ! Define new clipping region
      amove 2 2
      box 3 3
      amove 6 2
      box 3 3
   end path
   amove 2 2
   set hei 3
   text Here is clipped text
end clip         ! Restore original clipping path
```



5.5 Using Variables

GLE has two types of variables, floating point and string. String variables always end with a dollar sign. A string variable contains text like "Hello this is text", a floating point variable can only contain numbers like 1234.234.

```
name$ = "Joe"
height = 6.5    ! Height of person
shoe = .05      ! shoe adds to height of person
amove 1 1
box .2 height+shoe
write name$
```

5.6 Programming Loops

The simple way to draw a 6×8 grid would be to use a whole mass of line commands:

```
amove 0 0
rline 0 8
amove 1 0
rline 1 8
...
amove 6 0
rline 6 8
```

this would be laborious to type in, and would become impossible to manage with several grids. By using a simple loop this can be avoided:

```
for x = 0 to 6
   amove x 0
   rline x 8
next x
for y = 0 to 8
   amove 0 y
   rline 6 y
next y
```

To draw lots of grids all of different dimensions a subroutine can be defined and then used again and again:

```
! define the subroutine
sub grid nx ny
gsave
begin origin
for x = 0 to nx
   amove x 0
   aline x ny
next x
for y = 0 to ny
   amove 0 y
   aline nx y
next y
end origin
end sub
! now draw the grids wherever
amove 2 4
@grid 6  8
amove 2 2
@grid 9 5
```

Now the main GLE file will be much easier to modify particularly if the subroutine definition is moved into a separate file:

```
size 10 10
include griddef.gle
amove 2 4
@grid 2 4
amove 2 2
@grid 9 5
```

5.7 Extended I/O Functions

Some standard I/O function and macros are available:

```
fopen, fclose, fread, freadln, fwrite, fwriteln
        e.g.:

        fopen "file.dat" inchan read
        fopen "file.out" outchan write
        until feof(inchan)
                fread inchan x y z
                aline x y
                rline x z
                fwriteln outchan x*2 "y =" y
        next
        fclose inchan
        fclose outchan
```

5.8 Device dependend Control

A built in function which returns a string describing the device is available.
e.g. `DEVICE$() = "HARDCOPY, PS,"`
on the postscript driver.

This can be used to use particular fonts etc on appropriate devices. E.g.:

```
if pos(device$(),"PS,",1)>0 then
        set font psncsb
end if
```

Chapter 6

GLE Utilities

6.1 Fitls

The FITLS utility allows an equation with n unknown constants to be fitted to experimental data.

For example to fit a simple least squares regression line to a set of points you would give FITLS the equation: `a*x+b`

FITLS would then solve the equation to find the *best* values for the constants a and b.

FITLS can work with non linear equations, it will ask for initial values for the parameters so that a solution around those initial guesses will be found.

FITLS writes out a GLE file containing commands to draw the data points and the equation it has fitted to them.

Here is a sample FITLS session:

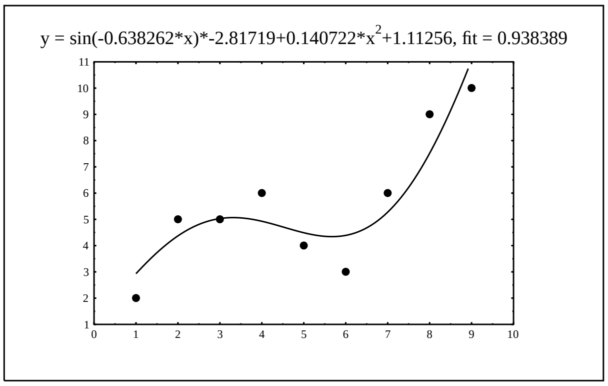
```
$ fitls
Input data file (x and y columns optional) [test.dat,1,2] ? fitls.dat
Loading data from file, fitls.dat,  xcolumn=1, ycolumn=2
Valid operators: +, -, *, /, ^ (power)
Valid functions:
        abs(), atn(), cos(), exp(), fix(), int()
        log(), log10(), not(), rnd(), sgn(), sin()
        sqr(), sqrt(), tan()

 Enter a function of 'x' using constants 'a'...'z'
 e.g.    a + b*x   (standard linear least squares fit)
         sin(x)*a+b
         a + b*x + c*x^2 + d*x^3
         log(a*x)+(b+x)*c+a

Equation ? sin(a*x)*b+c*x^2+d
\clearpage
Output file name to write gle file [fitls.gle] ?
```

```
Precision of fit required, [1e-4] ?
Initial value for constant a [1.0] ?
Initial value for constant b [1.0] ?
Initial value for constant c [1.0] ?
Initial value for constant d [1.0] ?
0 evaluations, 1 1 1 1 , fit = 1355.36
20 evaluations, 1.97005 1 1 1 , fit = 1281.95
40 evaluations, 1.97005 10.228 0.151285 1 , fit = 54.7694
60 evaluations, 2.01053 10.228 0.151285 1.06365 , fit = 54.1771
.
.
.
440 evaluations, -0.640525 -2.81525 0.13997 1.13871 , fit = 0.940192
460 evaluations, -0.638055 -2.82934 0.140971 1.10502 , fit = 0.93842
480 evaluations, -0.63808 -2.82357 0.140993 1.10452 , fit = 0.938389
a = -0.638262 b = -2.81719 c = 0.140722 d = 1.11256

10 Iterations, sum of squares devided by n = 0.938389
y = sin(-0.638262*x)*-2.81719+0.140722*x^2+1.11256
```



6.2 Manip

Manip is a data manipulation package. It reads in a text file of numbers and displays them like a spreadsheet. You can then do simple operations on the columns and write them out in any format you like.

6.2.1 Usage

```
MANIP infile.dat -recover -step -commands c.log -single -size x y
```

–recover
: Manip logs everything you type to a file called `MANIP_.J1` When you use the -RECOVER option on the manip command it then reads keys from that file as if they were typed at the keyboard.

  This will restore you to the point just before your pc crashed. The last three journal files are stored (.j1 .j2 .j3) simply copy the one you want to (.j1) to use it.

–step
: Used with recover, press a space for each key you want to read from the journal file, press any other key to stop reading the journal.

–commands *filename.man*
: This reads the commands in *filename.man* as if they were typed at the keyboard.

–single
: This makes MANIP use single precision arithmetic and doesn't store strings at all, this enables three times as much data in the same amount of memory

–size *x y*
: Sets the initial size of the spreadsheet. Use this with large datasets as it prevents the heap from becoming fragmented and thus lets you use much larger datasets.

Range

Most manip commands accept a range as one or more of there parameters. A range is a rectangular section of your spreadsheet. A range can ether start with a 'c' or an 'r' and this will affect how the command operates.

If your spreadsheet has 5 columns and 10 rows then.

```
c1 ==  c1c1r1r10  == 1,1  1,2  1,3  1,4  1,5  1,6 ...
r1 ==  r1r1c1c5   == 1,1  2,1  3,1  4,1  5,1
c1c2 ==c1c2r1r10  == 1,1  2,1  1,2  2,2  3,1  3,2 ...
r1r2c3=r1r2c3c5   == 3,1  3,2  4,1  4,2  5,1  5,2
```

Arrows

The arrow keys normally move the data cursor, however if you are half way thru typing a command then, the left and right arrow keys allow you to edit the command. Use the PAGE-UP and PAGE-DOWN keys to recall your last command.

SHIFT arrow keys will jump 7 cells at a time for fast movement.

Further help is available on the following toppics via the HELP command e.g. "HELP COPY"

6.2.2 Manip Primitives (a summary)

@*mycmds*
Arrows
BLANK
CLEAR
CLOSE
COPY [*range*] [*range*] IF [*exp*]
DATA [*range*]
DELETE [*range*] IF [*exp*]
EXIT *filename* [*range*] –TAB –SPACE –COMMA
FIT *c3*
Functions
GENERATE [*pattern*] [*destination*]
GOTO *x y*
INSERT [C*n*] or [R*n*]
LOAD *filename* [*range*] –0
LOAD *filename* [*range*]
LOGGING *mycmds.man*
MOVE [*range*] [*range*] IF [*exp*]
NEW
PARSUM [*range1*] [*range2*]
PROP [*range*] [*range*]
QUIT
Recover (recovering from power failure or crash)
SAVE *filename* [*range*] –TAB –SPACE –COMMA
SET SIZE *ncols nrows*
SET BETWEEN " "
SET COLTYPE
SET COLWIDTH
SET NCOL *n*
SET DPOINTS *n*
SET DIGITS *n*
SET WIDTH *n*
SHELL
SORT [*range*] on [*exp*]
SUM [*range*]
SWAP C*n*C*n* — R*n*R*n*

6.2.3 Manip Primitives (in detail)

COPY [*range1*] [*range2*] if [*exp*]

For copying a section to another section. They do not have to be the same shape. The pointers to both rangers are increased even if the number is not coppied e.g.

```
"% COPY r4r2 r1r2"
"% COPY c1c3r6r100  c6c8 if c1<c2"

"% COPY C1 C2 IF C1<4"
c1  c2
1       1
2       2
5       -
3       3
9       -
```

DELETE [*range*] IF [*exp*]

For deleteing entire rows or columns. e.g.

```
"% DELETE c1c3 IF r1>3.and.r2=0
"% DELETE r1"
```

Numbers are shuffled in from the right to take the place of the deleted range.

DATA [*range*]

Data entry mode is usefull for entering data. After typing in `"% DATA c1c3"` or `"% DATA C2"` you can then enter data and pressing ¡cr¿ will move you to the next valid data position. In this mode text or numbers can be entered. Press ESC to get back to command mode.

FIT *c3*

`"FIT C3"` will fit a least squares regression line to the data in columns c3 and c4 (x values taken from c3) and print out the results.

EXIT

EXIT saves the data in your input file spec and exits to DOS. You can optionally specify an output file as well. eg. `"% EXIT myfile.dat"`

The command `"EXIT myfile.dat c3c5r1r3"` will write out that range of numbers to the file.

By default manip will write columns seperated by spaces.

The command `"EXIT myfile.dat -TAB"` will put a single tab between each column of numbers and `"EXIT myfile.dat -COMMA"` will put a comma and a space between each number. (these two options are usefull if your data file is very big and you don't want to waste diskspace with the space characters.) Note: The settings stay in effect for future saves and exits.

You can make it line up the columns on the decimal point by typing in the command. `"SET DPOINTS 3"`

You change the width of each column or completely remove the spaces between columns with the command. `"SET WIDTH 10"` (or set width 0)

You can change the number of significant digits displayed with the command `"SET DIGITS 4"`

SAVE *myfile.dat*

Saves all or part of your data. The command `"SAVE myfile.dat c3c5r1r3"` will write out that range of numbers to the file.

By default manip will write columns seperated by spaces.

The command "`SAVE myfile.dat -TAB`" will put a single tab between each column of numbers and "`SAVE myfile.dat -COMMA`" will put a comma and a space between each number. (these two options are usefull if your data file is very big and you don't want to waste diskspace with the space characters).

Further options are the same like EXIT

GOTO
: For moving the cursor directly to a point in your array. e.g. "`% GOTO x y`"

CLEAR
: "`% CLEAR C2C3`" Clears the given range of all values

BLANK
: "`% BLANK C2C3`" Clears the given range of all values

NEW
: Clears the spread sheet of all data and frees memory.

INSERT
: Inserts a new column or row and shifts all others over. e.g."`% INSERT c5" or "% INSERT r2`".

LOAD
: Load data into columns. eg. "`% LOAD filename`" loads all data into corresponding columns. "`% LOAD filename c3`" load first column of data into c3 etc.

  "`LOAD myfile.dat c3 -LIST`" This commmand will load the the data into a single column or range (even if it is several columns wide in the data file)

MOVE [*range1*] [*range2*] if [*exp*]
: For copying a section to another section. They do not have to be the same shape. The pointer to the destination is only increased if the line or column is coppied e.g.

```
"% MOVE c1 c2c3"
"% MOVE r4r2 r1r2"
"% MOVE c1c3r6r100  c6c8 if c1<c2"

"% MOVE C1 C2 IF C1<4"
c1  c2
1       1
2       2
5       3
3       -
9       -

(See COPY command)
```

SORT [*range*] ON [*exp*]
: Sort entire rows of the data based on the data in a particular column. e.g.

```
"% SORT c8 on c9"
"% SORT c1c8 on -c8"
"% SORT c1c3 on c2  "  !for sorting strings
```

This command works out how to sort the column (or exp) specified in the ON part of the command. It then does that operation to the range specified. e.g. "SORT C1 ON C1" will sort column one.

Use the additional qualifier -STRINGS if you want to sort a column with strings in it. e.g. "sort c1 on c2 -strings"

SWAP

Swap over two columns or rows. e.g.

```
  "% SWAP c1c2"
"% SWAP r3r1"
```

SET SIZE *ncols nrows*

"SIZE 3 4" Truncates the spreadsheet to 3 columns and 4 rows. This also sets the values to use for default ranges.

SET BETWEEN " "

"SET BETWEEN "##" Defines the string to be printed between each column of numbers when written to a file. This is normally set to a single space.

SET COLWIDTH

Set the width of each column when displayed. e.g. "% SET COLWIDTH 12"

SET COLTYPE [*n*] DECIMAL — EXP — BOTH — DPOINTS *n*

This commands allows all or individual columns to be set to different output types. If colnumber is missing then that setting is applied to all columns.

SET COLTYPE Ccolnumber TYPE Where TYPE is one of:

```
DECIMAL    produces  123.456
EXP    produces 1.23456e02
BOTH       produces whichever is more suitable
DPOINTS n  produces a fixed number of decimal places.
 e.g.
SET COLTYPE c2 DECIMAL
SET COLTYPE c1 EXP
SET COLTYPE c3 DPOINTS 4
```

Would print out: 1.2e02   1.2   1.2000

```
SET COLTYPE EXP   (column number missed out)
```

Would print out: 1.2e02   1.2e02 1.2e02

SET NCOL *n*

Set the number of columns to display. e.g."% SET NCOL 3"

SET DPOINTS *n*

Sets the number of decimal places to print. This is used for producing columns which line up on the decimal point. e.g. with DPOINTS 3.

```
2.2   ->   2.200
234   -> 234.000
```

(See also SET COLTYPE)

SET DIGITS n

Sets the number of significat digits to be displayed, e.g. with `DIGITS 3`.

```
123456    becomes   123000
0.12345   becomes   0.123
```

SET WIDTH n

Sets the width of padding to use for the columns when they are written to a file. The columns usually one space wider than this setting as the BETWEEN string is usually set to one space by default.

LOGGING

For creating command files. e.g.

```
"% LOG sin.man"
"% c2=sin(c1)
"% c3=c2+2
"% close"
```

Then type in `"@sin"` to execute these commands.

PROPAGATE [*source*] [*destination*]

This command has the same format as move. The difference is that the source is coppied as many times as possible to fill up the destination. e.g. `"% PROP c1r1r7 c2"`

SUM [*range*]

Adds up all the numbers in a range and displays the total and average. e.g. `"% SUM C1C3"`

PARSUM [*range1*] [*range2*]

Adds up one coloumn, putting the partial sum's into another coloumn. e.g. `1,2,3,4` becomes `1,3,6,10`.

GENERATE [*pattern*] [*destination*]

For generating a patter of data e.g. `1 1 2 2 5 5 1 1 2 2 5 5` etc.

```
"% GEN 2(1,2,5)30 c4" !1 1 2 2 5 5  repeated 30 times
"% GEN (1:100:5)5 c1" !1 to 100 step 5,  5 times
"% GEN (1,2,*,3:5)5 c1" !missing values included
```

Functions

Calculations can be performed on rows or columns. eg `"% C1=C2*3+R"` where "R" stands for row-number and C1 and C2 are columns. They can also be performed on ROWS. eg

```
r1=sin(r2)+log10(c)
c1 = cell(c+1,r)+cell(c+2,r)
cell(1,3) = 33.3
3+4*COS(PI/180)^(3+1/30)+C1+R
```

Valid operators and functions:

,	+	−	^	*	/	<=
>=	<>	<	>	=	)AND(	)OR(
ABS(	ATN(	COS(	EXP(	FIX(	INT(	LOG(
LOG10(	SGN(	SIN(	SQR(	TAN(	NOT(	RND(
SQRT(	.NE.	.EQ.	.LT.	.GT.	.LE.	.GE.
.NOT.	.AND.	.OR.				

QUIT
Abandon file.

SHELL
Gives access to DOS.

Chapter 7

SURFACE

7.1 Surface primitives

SURFace plots 3 dimensional data using a wire frame with hidden line removal. The simplist SURFACE file would look like this.

```
BEGIN SURFACE
DATA myfile.z 5 5
END SURFACE
```

More help is available on the following topics:
SIZE x y
CUBE [OFF] [XLEN v] [YLEN v] [ZLEN v] [NOFRONT] [LSTYLE l] [COLOR c]
DATA *myfile.z* [XSAMPLE *n1*] [YSAMPLE *n2*] [SAMPLE *n3*] [NX *n1*] [NY *n2*]
HARRAY n
XLINES — YLINES [OFF]
XAXIS — YAXIS — ZAXIS [MIN v] [MAX v] [STEP v] [COLOR c] [LSTYLE l] [HEI v] [OFF]
XTITLE — YTITLE — ZTITLE "title" [DIST v] [COLOR c] [HEI v]
TITLE "*Main title*" [DIST v] [COLOR c] [HEI v]
ROTATE θ ϕ x
VIEW x y p
TOP — UNDERNEATH [OFF] [LSTYLE n] [COLOR c]
BACK [ZSTEP v] [YSTEP v] [LSTYLE l] [COLOR c] [NOHIDDEN]
BASE [XSTEP v] [YSTEP v] [LSTYLE l] [COLOR c] [NOHIDDEN]
RIGHT [ZSTEP v] [XSTEP v] [LSTYLE l] [COLOR c] [NOHIDDEN]
SKIRT ON
POINTS *myfile.dat*
MARKER *circle* [HEI v] [COLOR c]
DROPLINES — RISELINES [COLOR c] [LSTYLE n]
ZCLIP [MIN *v1*] [MAX *v2*]

7.1.1 Surface Commands

size *x* *y*

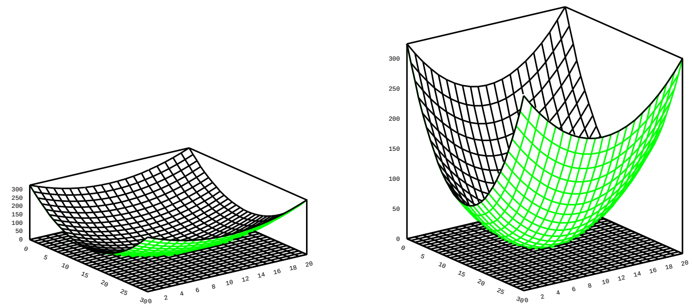
Specifies the size in cm to draw the surface. The 3d cube will fit inside this box. The default is 18cm x 18cm e.g. `SIZE 10 10`

cube [OFF] [XLEN *v*] [YLEN *v*] [ZLEN *v*] [NOFRONT] [LSTYLE *l*] [COLOR *c*]

Surface is drawing a 3d cube.

OFF	Stops GLE from drawing the cube.
XLEN	The length of the cubes x dimension in cm.
NOFRONT	Removes the front three lines of the cube.
LSTYLE	Sets the line style to use drawing the cube.
COLOR	Sets the color of lines to use drawing the cube.

```
begin surface
size 10 10
data jack.z
cube zlen 5
end surface
```



DATA it myfile.z [XSAMPLE *n1*] [YSAMPLE *n2*] [SAMPLE *n3*] [NX *n1*] [NY *n2*]

Loads a file of Z values in. The NX and NY dimensions are optional, normally the dimensions of the data will be defined on the first line of the data file. e.g.

```
! NX 10  NY 20    XMIN 1 XMAX 10 YMIN 1 YMAX 20
1 2 42 4 5 2 31 4 3 2 4
1 2 42 4 5 2 31 4 3 2 4 etc...

y1,x1, y1,x2 ... y1,xn
y2,x1, y2,x2 ... y2,xn
              .
.
.
yn,x1, yn,x2 ... yn,xn
```

Data files can be created using LETZ or FITZ. LETZ will create a data file from an x,y function. FITZ will create a data file from a list of x,y,z data points.

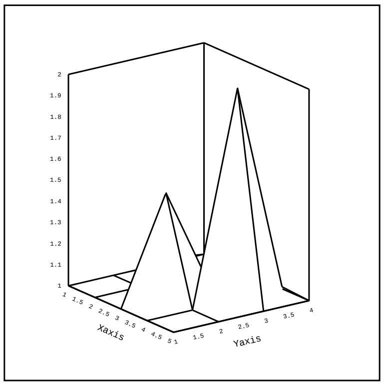
XSAMPLE Tells surface to only read every n'th data point from the data file. This speeds things up while you are messing around.

YSAMPLE Tells surface to only read every n'th line from the data file.

(see also POINTS)

SAMPLE Sets both XSAMPLE and YSAMPLE

```
begin surface
        size 5 5
        xtitle "Xaxis"
        ytitle "Yaxis"
        data surf1.z
end surface
```



harray *n*

The hidden line removal is accomplished with the help of an array of heights which record the current horizon, the quality of the output is proportional to the width of this array. (also the speed of output)

To get good quality you may want to increase this from the default of about 900 to 2 or 3 thousand. e.g. `HARRAY 2000`

xlines off

Stops SURF from drawing lines of constant X.

YLINES OFF

Stops SURF from drawing lines of constant Y.

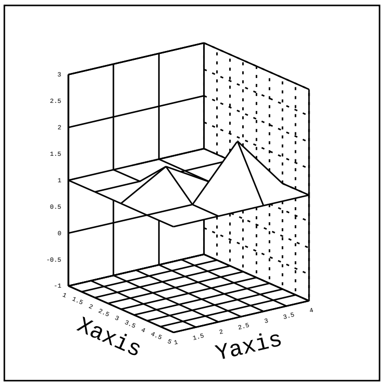
XAXIS [MIN v] [MAX v] [STEP v] [COLOR c] [LSTYLE l] [HEI v] [OFF]

ZAXIS [MIN v] [MAX v] [STEP v] [COLOR c] [LSTYLE l] [HEI v] [OFF]

YAXIS [MIN v] [MAX v] [STEP v] [COLOR c] [LSTYLE l] [HEI v] [OFF]

MIN,MAX	Set the range used for labelling the axis.
STEP	The distance between labels on the axis.
COLOR	The color of the axis ticks and labels.
LSTYLE	The line style used for drawing the ticks.
TICKLEN	The length of the ticks.
HEI	The height of text used for labelling.
OFF	Stops GLE from drawing the axis.

```
begin surface
   size 5 5
   data surf1.z
   zaxis min -1 max 3
   base xstep .5 ystep .5
   back ystep 1 zstep 1
   right xstep .5 zstep .5 lstyle 2
   xtitle "Xaxis" hei .3
   ytitle "Yaxis" hei .3
end surface
```



XTITLE "X title" [DIST v] [COLOR c] [HEI v]

YTITLE "Y title" [DIST v] [COLOR c] [HEI v]

ZTITLE "Z title" [DIST v] [COLOR c] [HEI v]

DIST	Moves the title further away from the axis.
COLOR	Sets the color of the title.
HEI	Sets the hei in cm of the text used for the title.

TITLE "*Main title*" [DIST v] [COLOR c] [HEI v]

DIST	Moves the title further away from the axis.
COLOR	Sets the color of the title.
HEI	Sets the hei in cm of the text used for the title.

ROTATE θ ϕ x

`ROTATE 10 20 30`

Imagine the unit cube is sitting on the front of your terminal screen, x along the bottom, y up the left hand side, and z coming towards you.

The first number (10) rotates the cube along the xaxis, ie hold the right hand side of the cube and rotate your hand clockwise 10 degrees.

The second number (20) rotates the cube along the yaxis, ie hold the top of the cube and rotate it 20 degrees clockwise.

The third number is currently ignored.

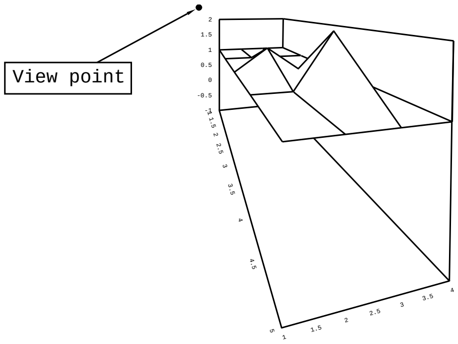
The default setting is 60 50 0.

VIEW x y p

Sets the perspective, this is where the cube gets smaller as the lines dissappear towards infinity.

x and y are the position of infinity on your screen. p is the degree of perspective, 0 = no perspective and with 1 the back edge of the box will be touching infinitiy. Good values are between 0 and 0.6

```
begin surface
   size 5 5
   data surf1.z
   zaxis min -1
   rotate 85 85 0
   view 0 5 .7
end surface
```



TOP [OFF] [LSTYLE n] [COLOR c]

Sets the features of the top of the surface. By default the top is on.

(see also UNDERNEATH, XLINES, YLINES)

UNDERNEATH [OFF] [LSTYLE n] [COLOR c]

Sets the features of the under side of the surface. By default the underneath is off.

(see also TOP, XLINES, YLINES)

BACK [ZSTEP v] [YSTEP v] [LSTYLE l] [COLOR c] [NOHIDDEN]

Draws a grid on the back face of the cube.

By default hidden lines are removed but NOHIDDEN will stop this from happenning.

BASE [XSTEP v] [YSTEP v] [LSTYLE l] [COLOR c] [NOHIDDEN]

Draws a grid on the base of the cube.

By default hidden lines are removed but NOHIDDEN will stop this from happenning.

RIGHT [ZSTEP v] [XSTEP v] [LSTYLE l] [COLOR c] [NOHIDDEN]

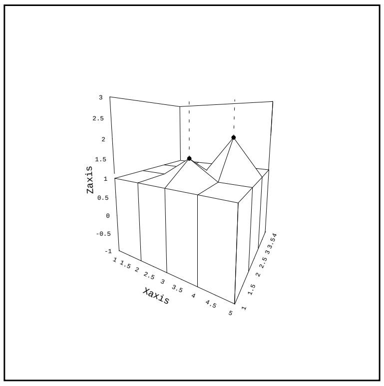
Draws a grid on the right face of the cube.

By default hidden lines are removed but NOHIDDEN will stop this from happenning.

SKIRT ON

Draws a skirt from the edge of the surface to ZMIN.

```
begin surface
   size 5 5
   data surf1.z
   zaxis min -1 max 3
   xtitle "Xaxis"
   ztitle "Zaxis"
   points surf3.dat
   riselines lstyle 2
   marker fcircle
   skirt on
   rotate 80 30 0
   view 2.5 3 .6
end surface
```



POINTS *myfile.dat*
: Reads in a data file which must have 3 columns (x,y,z)

  This is then used for plotting markers and rise and drop lines.

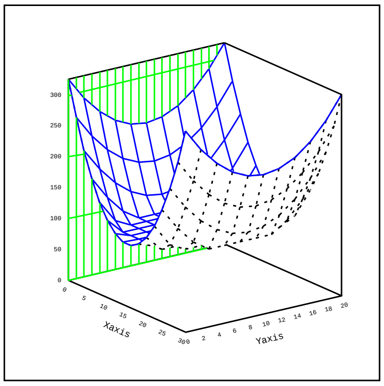
MARKER *circle* [HEI *v*] [COLOR *c*]
: Draws markers at the co-ordinates read from the POINTS file.

DROPLINES [COLOR *c*] [LSTYLE*n*]
: Draws lines from the co-ordinates read from the POINTS file down to zmin.

RISELINES [COLOR *c*] [LSTYLE *n*]
: Draws lines from the co-ordinates read from the POINTS file up to zmax.

ZCLIP [MIN *v1*] [MAX *v2*]
: ZCLIP goes through the Z array and sets any Z value smaller than MIN to *v1* and sets any value greater than MAX to *v2*.

```
begin surface
        size 5 5
        data jack.z sample 2
        back ystep 1 zstep 100
                color green
        xtitle "Xaxis"
        ytitle "Yaxis"
        top color blue
        zclip min 100
        zaxis min 0
        underneath on lstyle 2
end surface
```



7.2 LETZ

LETZ generates a data file of z values given an expression in terms of x and y.

e.g. the following example does something like this:

```
For y = 0 to 20 step 1
For x = 0 to 30 step 1
z[x,y] = x+sin(y^2)/pi+10.22
next x
next y
```

```
----------- Log of a typical LETZ session ------------------------------
$ letz
File to store data in ? jack
Storing data in {jack.z} and commands in {jack.let}
Enter xmin,xmax,xstep (on one line) [0,30,1] ?
Enter ymin,ymax,ystep [0,30,1] ? 0,20,1
For y = 0 to 20 step 1
For x = 0 to 30 step 1
Valid funtions:  (trig functions use radians)
abs(), atn(), cos(), exp(), fix(),
int(), log(), log10(), rnd(), sgn(), sin(),
sqr(), sqrt(), tan(), PI, (x^3 = x*x*x)
e.g. 3*x^2+sin(y*180/pi)
Enter equation:
 ? x+sin(y^2)/pi+10.22
z = x+sin(y^2)/pi+10.22

Y = 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Use   LETZ <jack.let   to remake the same data file
$
$ ----------- End of Log ------------------------------
```

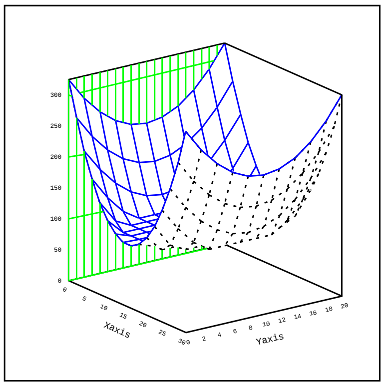
The file JACK.Z now contains the required data.

The file JACK.LET contains

```
--------------JACK.LET-----------
jack.z
0, 30, 1
0, 20, 1
x+sin(y^2)/pi+10.22
-------------------end of file----
```

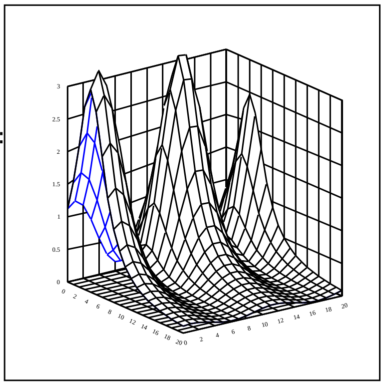
This can be edited and then used to regenerate the data using a different range or a different equation.

```
begin surface
        size 5 5
        data jack.z sample 2
        back ystep 1 zstep 100
                color green
        xtitle "Xaxis"
        ytitle "Yaxis"
        top color blue
        zclip min 100
        zaxis min 0
        underneath on lstyle 2
end surface
```




```
           LETZ
   File to store data in ?
                   saddle.z
   Enter xmin,xmax,xstep (on one line):
                   0, 20, 1
   Enter ymin,ymax,ystep:
                   0, 20, 1
   Enter equation:
```

$3/2*(\cos(3/5*(y-1))+5/4)/(1+(((x-4)/3)^2))$



7.3 FITZ

FITZ fits smooth curves to a surface of data points. e.g. Given some data points, e.g.

```
x y z
---- data file testf.dat -----
1  1  1
1  2  1
2  2 1
2  1 1
1.5  1.5  2
------------------------------
```

These points defile the for corners of a surface which has one high point in the center. As you can see the order of points is not relevant.

It is important that each line of the data file has three points on it. (x, y, z)

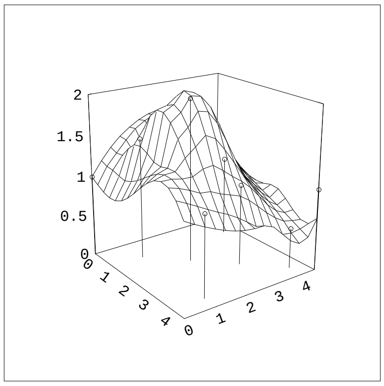
FIT then asks you for a range of x and y values generate z values for. The range is given as minimum,maximum,stepsize.
e.g. 1,3,.5 would produce 1, 1.5, 2, 2.5, 3

Use SURF to draw the surface on the screen and see the finished product.

```
$ FITZ
Data file conaining x y z data ? TESTF.DAT
Read 5 points from file {testf.dat}
Will write data to {testf.z}
Number of points to use for contouring each point ? [3]
Range of output x values [1,2,6.666667e-02] ? 1,2,.05
Range of output y values [1,2,6.666667e-02] ? 1,2,.05
nx 21, ny 21, Work space iwk=2384 bytes wk=160 bytes
Y = 1 1.05 1.1 1.15 1.2 1.25 1.3 1.35 1.4 1.45 1.5 1.55 1.6 1.65
1.7 1.75 1.8 1.85 1.9 1.95 2
```

Now use TESTF.Z as your data file for SURFACE.

```
begin surface
   size 5 5
   data fitz1.z
   xaxis step 1 hei .2
   yaxis step 1 hei .2
   zaxis step .5 hei .2
   zaxis min 0 max 2
   points fitz1.dat
   droplines lstyle 1
   marker circle
   view 2.5 3 .3
end surface
```



7.4 CONTOUR

This utility produces a graph with contour lines.

For input you give it grid of z values in a file the x and y values are assumed. e.g. a 4x3 grid of points would look like this:

```
! nx 4 ny 3 xmin 0 xmax 0 xmax 6 ymax 0 ymax 10
1 1 1 1
1 2 2 1
1 1 1 1
```

This defines the points

0,0,1	2,0,1	4,0,1	6,0,1
0,5,1	2,5,2	4,5,2	6,5,1
0,10,1	2,10,1	4,10,1	6,10,1

You would normally generate this file using the utility LETZ or FITZ.

LETZ takes an x,y function and produces a grid of z values

FITZ takes a file of x,y,z data points and fits a grid of z values.

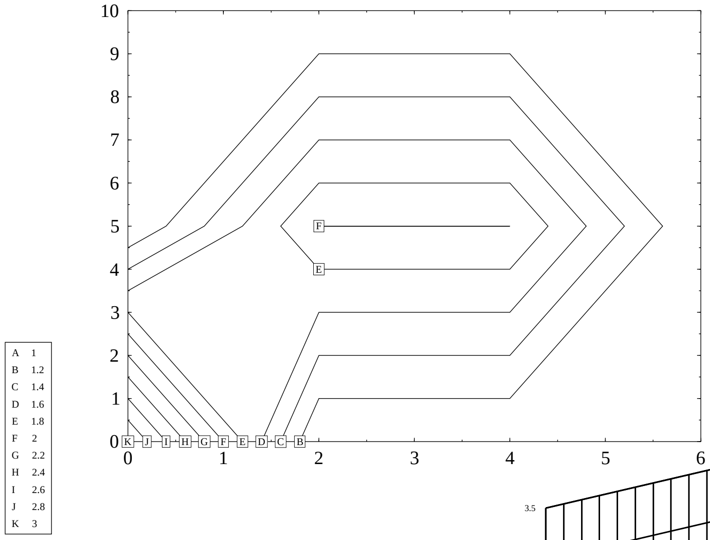
Having created a data file of the correct sort CONTOUR will ask for a list of values to contour at, you can enter a list of values, e.g. `"1 2 3 4.5 5"` or you can enter a range and step size e.g. `"1:3:.5"` which would generate `"1 1.5 2 2.5 3"`

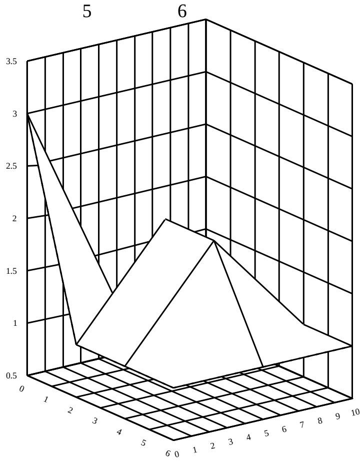
You are then asked if you want the lines labeled with the letters A ... Z or by the actual numbers.

Then you are asked for a file name to write output to. If you give the name *XYZ* then CONTOUR will create:

xyz.gle	The gle file to draw the contour plot
xyz.dat	The data file containing the contour lines
xyz.lab	A gle include file which labels the graph
xyz.key	A gle include file which draws a key

Then wait while the contours are calculated, this takes some time (even on a fast PC) e.g. 10 seconds on 33Mhz 386. The exact time will depend on the number of points and number of contour lines you are using.


A 1
B 1.2
C 1.4
D 1.6
E 1.8
F 2
G 2.2
H 2.4
I 2.6
J 2.8
K 3



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