Physics 309 Handout 2 Gnuplot Basics

We'll use Gnuplot to plot and fit data. It's free, cross-platform, does enough for our purposes, and is fairly simple to use.

Mathematica was written for symbolic math, which is a hard problem that it does well. The data-file handling and numerics is an afterthought, and it shows.

Maple has roughly the same strengths and weaknesses and Mathematica.

For big data sets and numerics, engineers use Matlab, and experimental physicists use specialized program packages for their field, written in Fortran or C/C++.

Mathematical, Maple, and Matlab are all available on the physics.ubc.ca machine; you can run them through X-Windows on the Hebb 42 lab computers vis SSH and X-tunneling if you want.

It's OK to use Mathematica or some other program instead of Gnuplot if you know it and love it, and if it has enough features. But we can't promise that we will be able to give you much support of there is a problem.

Gnuplot References

The built-in text-mode help is pretty good. Just type "help" in the Gnuplot window to get a list of commands, then "help plot" or "help set" or whatever command you need. But it's more of a memory aid than a tutorial.

Gnuplot home page <u>http://www.gnuplot.info</u>

Gnuplot manual (long) http://www.gnuplot.info/docs/gnuplot.html

Gnuplot FAQ http://www.gnuplot.info/faq Some nice Gnuplot tutorials <u>http://www.duke.edu/~hpgavin/gnuplot.html</u> <u>http://t16web.lanl.gov/Kawano/gnuplot/index-e.html</u>

Getting Gnuplot

Gnuplot is already on the Hebb 42 computers, and on the Physics Sun machine.

Most Linux distributions come with Gnuplot installed. If not, it's probably an option on the install CD.

Gnuplot downloads: http://www.gnuplot.info/download.html

Free Windows download <u>ftp://ftp.gnuplot.info/pub/gnuplot/gp373w32.zip</u>

Free Mac download (System X, or System 9 with CarbonLib) <u>http://lee-phillips.org/info/Macintosh/gnuplot.html</u> <u>http://mac.softpedia.com/get/Math-Scientific/gnuplot.shtml</u>

Your First Gnuplot

On physics.ubc.ca, type <u>gnuplot</u> in a terminal window (or if you are in the Hennings computer lab, click the gnuplot icon in the applications window) On a PC or Mac, double-click the icon for the program. On a Hebb 42 workstation, double-click the graph icon on the menu at the bottom of the screen, or type <u>gnuplot</u> in a terminal window.

Commands are typed into a text window. Graphic output goes to a separate window (physics output can go to your workstation).

Type <u>help</u> for a list of commands, <u>help 'command'</u> (no quotes) for help with <u>command</u>, etc for options on commands.

Gnuplot can plot functions



Type <u>exit</u> or <u>quit</u> to get out.

Decorating the Plot

If we want to label the axes and state the units:

```
set xlabel "The X Label (radians)"
set ylabel "The Y Label (volts)"
```

Having the function labels in the key in the corner is nice for a working plot, but not so nice for a writeup, so we move the key to the bottom

set key below

It's nice to have a global title at the top

set title 'The Title'

Now we can re-generate the plot with the added stuff

<u>replot</u>



Fancy Functions in Gnuplot

You can define non-trivial functions in Gnuplot, and define constants, use the constants in the functions, and define other functions using your functions:

 $\frac{a=4}{b=3}$ myfunction(x)=a+b*sin(x) g(y)=myfunction(y)/y plot myfunction(x), g(x)



Exponentiation is indicated by ** like in FORTRAN: $\chi^2 = \underline{x^{**2}}$

DON'T use "^2" to square a number! Confusingly, "^" is a legal operator, but it means "binary bitwise AND", not exponentiation!

Controlling Plot Range in Gnuplot

You can control the scales, and repeat the same plot set xrange [-3:1] set yrange [-2:5] replot



Go back to autoscale by

set xrange [*:*] set yrange [*:*],

or more simply by

set autoscale

Command Files and Printing in Gnuplot

Gnuplot has no print command built in. But it can generate postscript output in ASCII form, it can execute Unix commands, and it can execute commands from a text file. So we can make a text file containing some commands that will cause a plot to be printed.

Here's an example I call "printit" (# means comment)

gnuplot load file to make and print postscript file

generate postscript graphics instead of screen graphics
"encapsulated" postscript that can be inserted in other files
set terminal postscript eps monochrome "Times-Roman" 24

send it to a file rather than the input window set output "gnuplot.eps"

eps makes half-size landscape by default
make it a bit bigger
set size 1.4, 1.4

re-generate the most recent plot replot

next line is sent back to operating system
to print the postscript file
! lpr gnuplot.eps

restore size to default
set size 1, 1

restore output to default, and flush buffer set output

restore graphics to screen
set terminal x11

After you have made a plot, and decorated it with labels, etc, even if it takes you many steps, you can make a paper hard-copy by just typing

load 'printit'

which will produce a postscript file called <u>gnuplot.eps</u>, and also print the file.

Note that if "printit" is in a different directory than you are currently in, you will need to tell the system that, e.g., "load /home/student/bin/printit" or something like that.

Plotting Data with Gnuplot

Gnuplot can plot text files of numbers in columns. These can be separated by any number of spaces or tabs; the number of digits can vary. Exponential notation (small or capital E) is OK.

If the file strange.dat contains the following

0.0		3.14159	1.4	
1.59			2.7	2
-3.5	7.7		0.3	
99		-0.3e-2	1	

and you type <u>plot 'strange.dat'</u> you get



It ignores the funny spacing, and the third number in each line, and the order of the first column doesn't matter.

The default is the first column is the horizontal (x) variable and the second column is the vertical (y) variable. If the third column is the error on the second column, and we type



plot 'strange.dat' with errorbars

We can connect the points with lines (in file order): plot 'strange.dat' with lines



We can plot more than one data file in a graph by separating the quoted file names and styles by commas. <u>plot 'strange.dat' with lines, 'strange.dat' with errorbars</u>



You can control how Gnuplot interprets the columns of the file with the <u>using</u> option of the <u>plot</u> command.

If the first column is the y data, the second is x, and the third is the error on the y data, we type

plot 'strange.dat' using 2:1:3 with errorbars

