Physics 259/209 Handout Gnuplot Basics

We'll use Extrema or Gnuplot to plot and fit data our data. They are both free, cross-platform (or soon will be), they do enough for our purposes, and they each are 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 was added later as 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, and 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
http://www.gnuplot.info

Gnuplot manual (long)
http://www.ucc.ie/gnuplot/gnuplot.html

Gnuplot FAQ
http://www.gnuplot.info/faq

Some nice Gnuplot tutorials

http://www.duke.edu/~hpgavin/gnuplot.html

http://www.cs.uni.edu/Help/gnuplot/

http://t16web.lanl.gov/Kawano/gnuplot/index-e.html

Getting Gnuplot

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

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

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

Free Mac download (System X, or System 9 with CarbonLib)
http://mac.iconet.com.br/adnload/205481_81894.html

For older Macs (PPC and even 68K!), there's a usable but flakey version
http://www.chemistry.ohio-state.edu/~grandinetti/teaching/Chem722/gnuplot1.0.5b.sit.hqx

Getting Extrema

Free Windows download

You can get v4.0.1 of extrema from
ftp://csftp.triumf.ca/pub/CompServ/physica/windows/
and click on extremaInstall-v4.0.1.exe

This is a currently only available in a windows version (it uses both command line input and also pop-up entry windows.

Joe Chuma

Your First Gnuplot

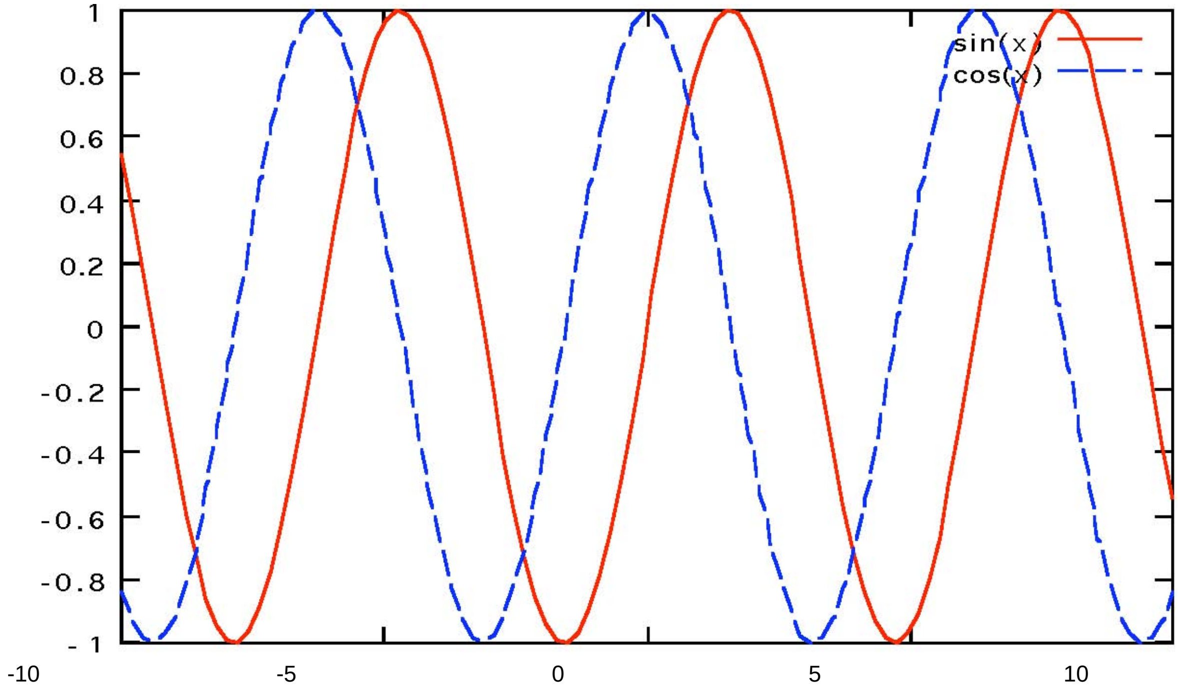
On physics.ubc.ca, type `gnuplot` in a terminal window (or if you are in the Hennings computer lab, click the gnuplot icon in the applications window) On a PC or Mac, double-click the icon for the program. On a Hebb 42 workstation, double-click the graph icon on the menu at the bottom of the screen, or type `gnuplot` 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 `help` for a list of commands, `help 'command'` (no quotes) for help with `command`, etc for options on commands.

Gnuplot can plot functions

```
plot sin(x), cos(x)
```



Type `exit` or `quit` 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

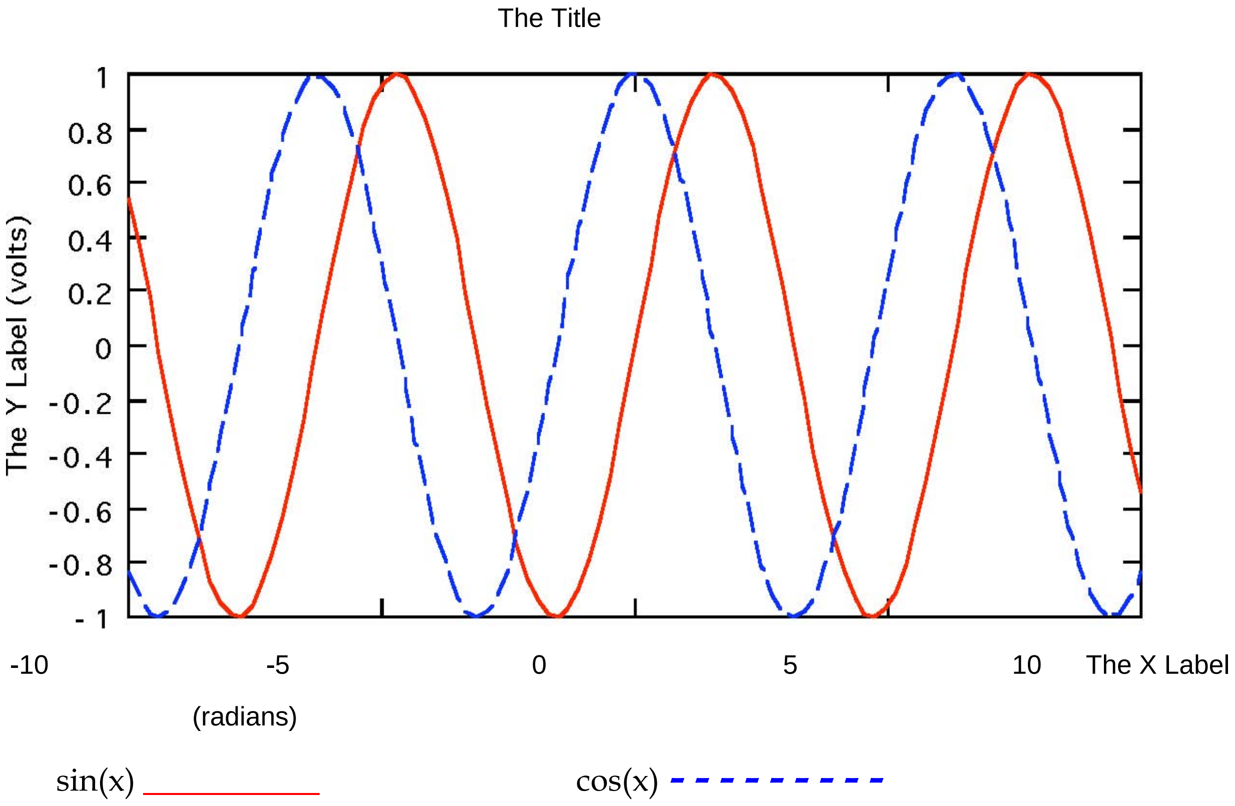
```
set key below
```

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

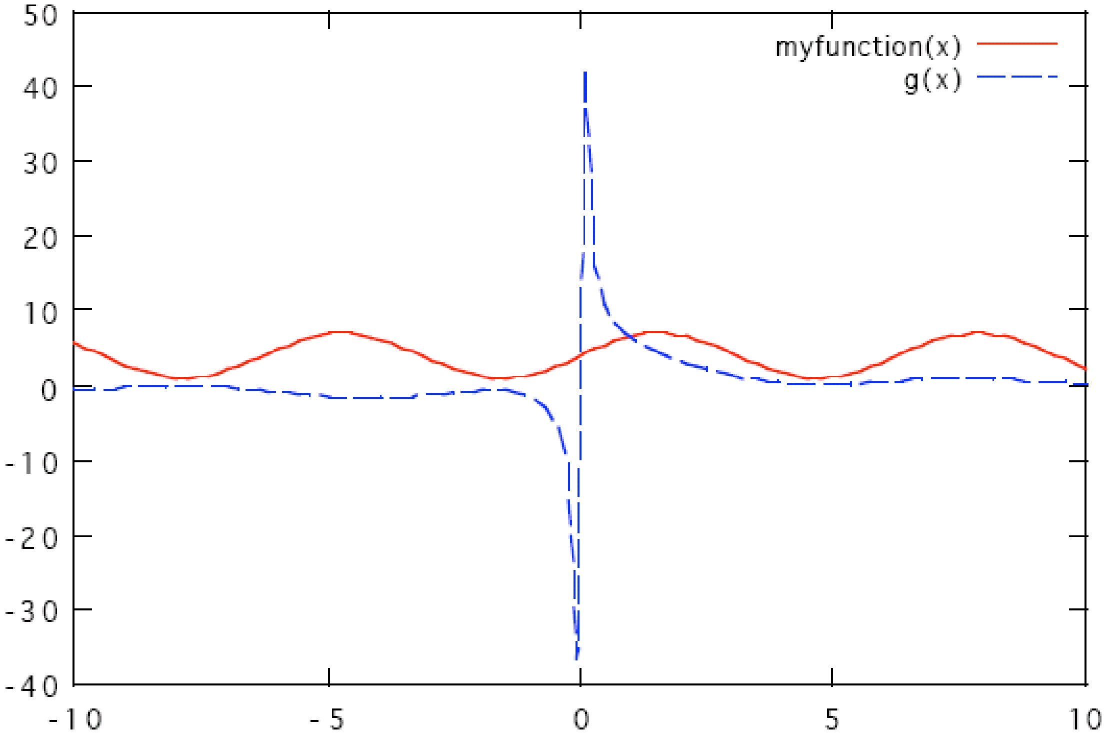
```
replot
```



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:

```
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: x^2 = x**2

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

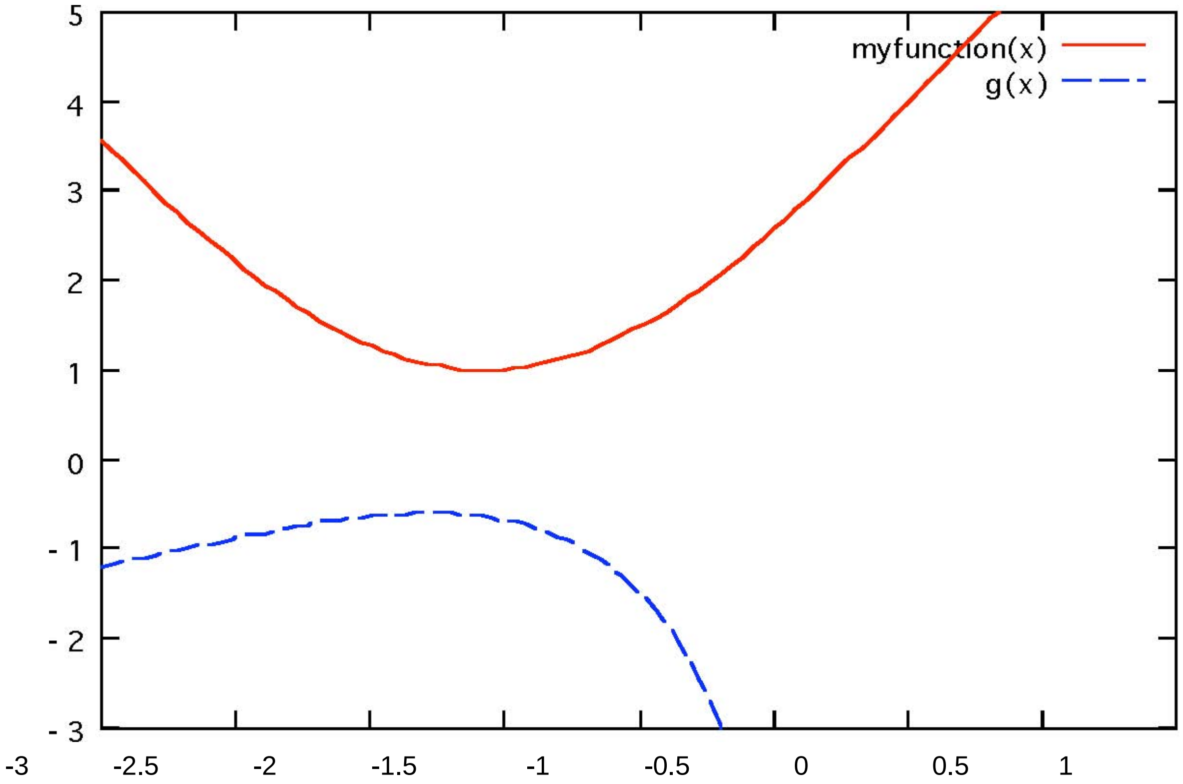
Controlling Plot Range in Gnuplot

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 gnuplot.eps, 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.

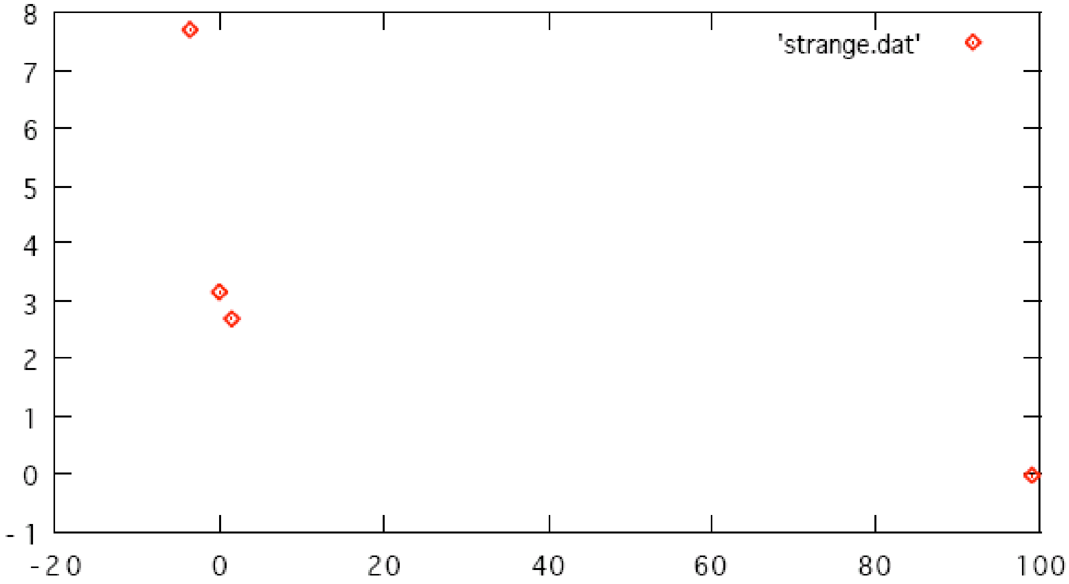
Plotting Data with Gnuplot

Gnuplot can plot text files of numbers in columns.

The columns can be separated by any number of spaces or tabs, and the number of digits can vary. Exponential notation (small or capital E) works.
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 `plot 'strange.dat'` you get



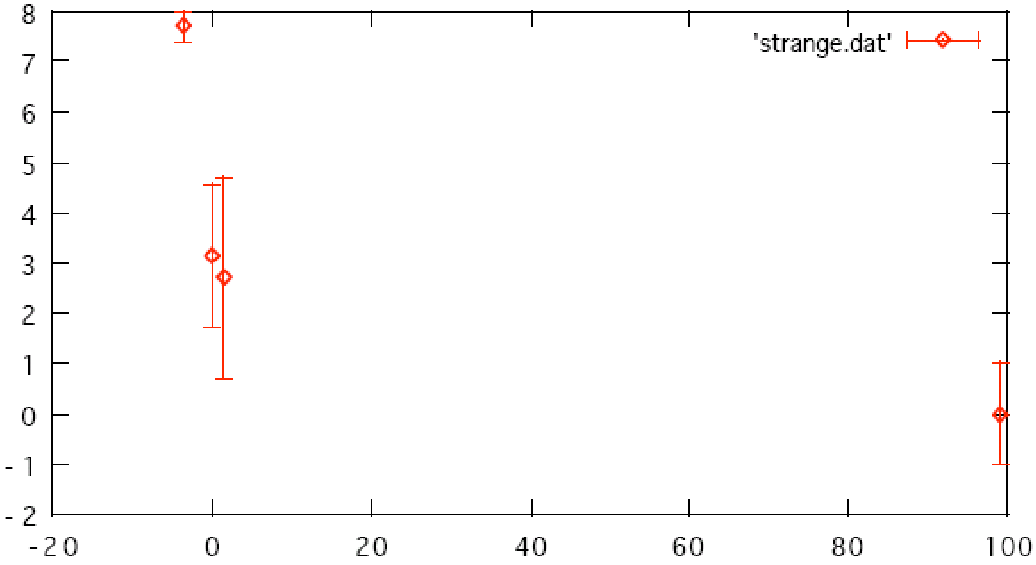
It ignores the funny spacing, and the third number in each line, and the order of the first column doesn't matter.

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

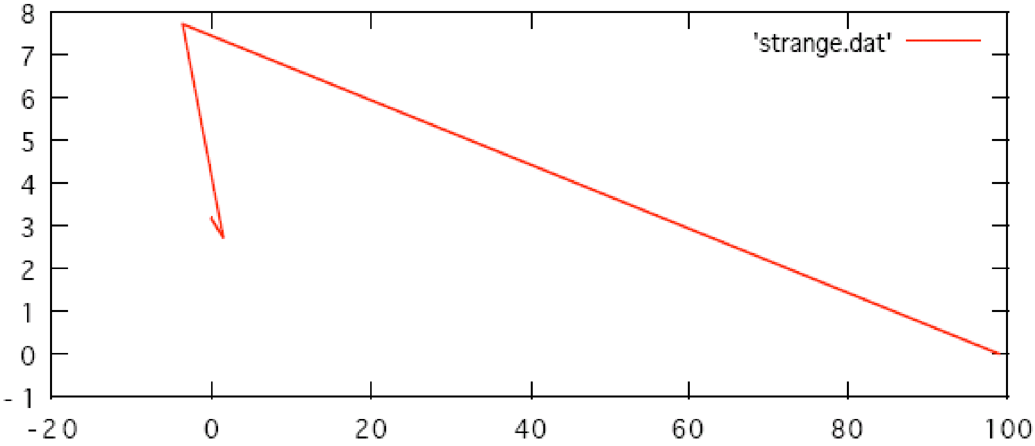
```
plot 'strange.dat' with errorbars
```

we get



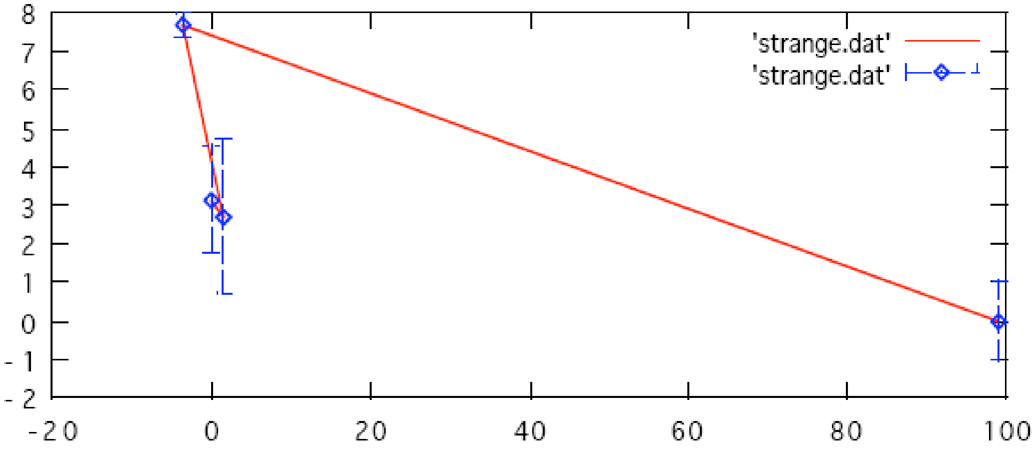
We can connect the points with lines (in file order):

```
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.

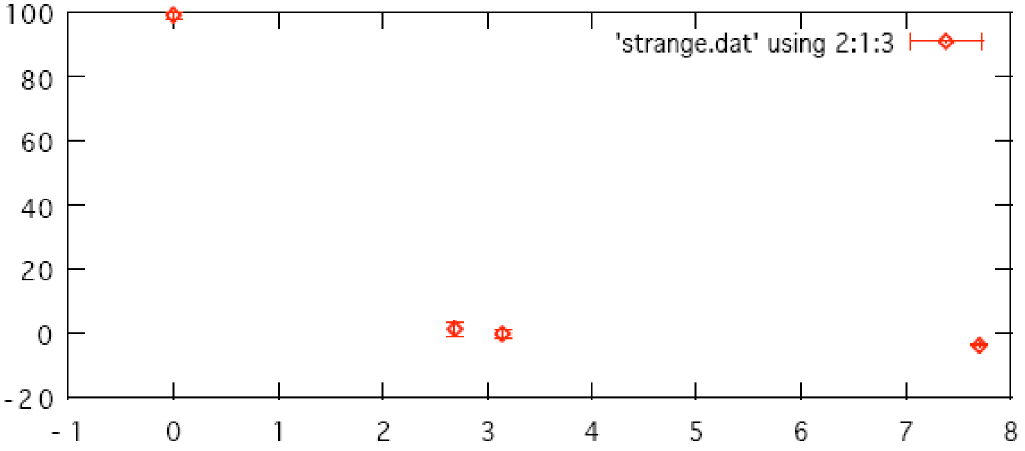
```
plot 'strange.dat' with lines, 'strange.dat' with errorbars
```



You can control how Gnuplot interprets the columns of the file with the `using` option of the `plot` 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
```


'strange.dat' using 2:1:3