The different tools to graph your data

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Outline

SuperMongo,
MATPLOTLIB,
Gnuplot, IDL,
Mathematica,
Matlab,
Origin, Excel...

SuperMongo - SM

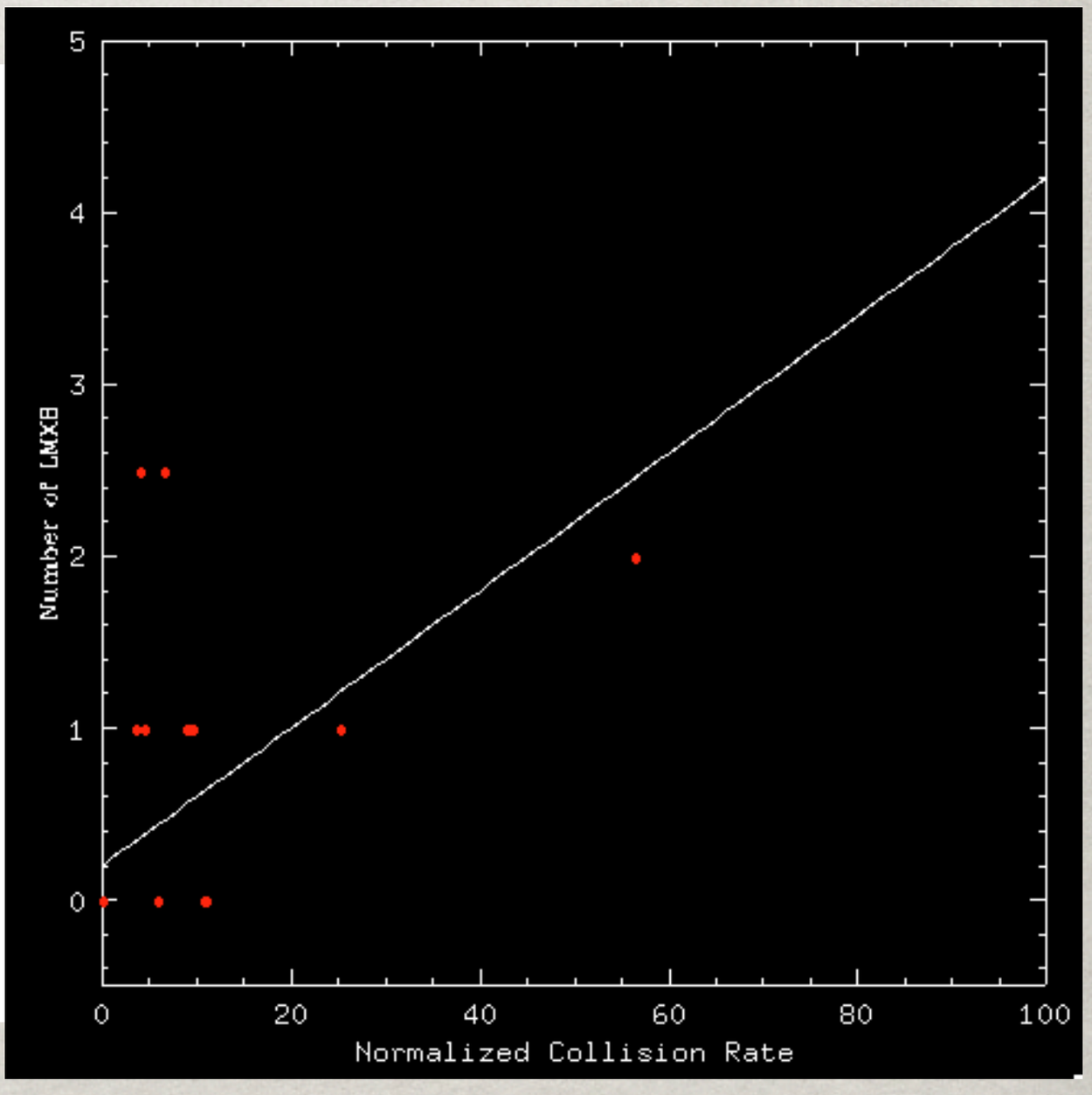
http://www.astro.princeton.edu/~rhl/sm/

+ Scripting and macros are possible
+ Read FITS files
+ "You can't beat SM" according to the website

– It can be obscure and unappealing to a novice
– Not free (I think)

SM - An example

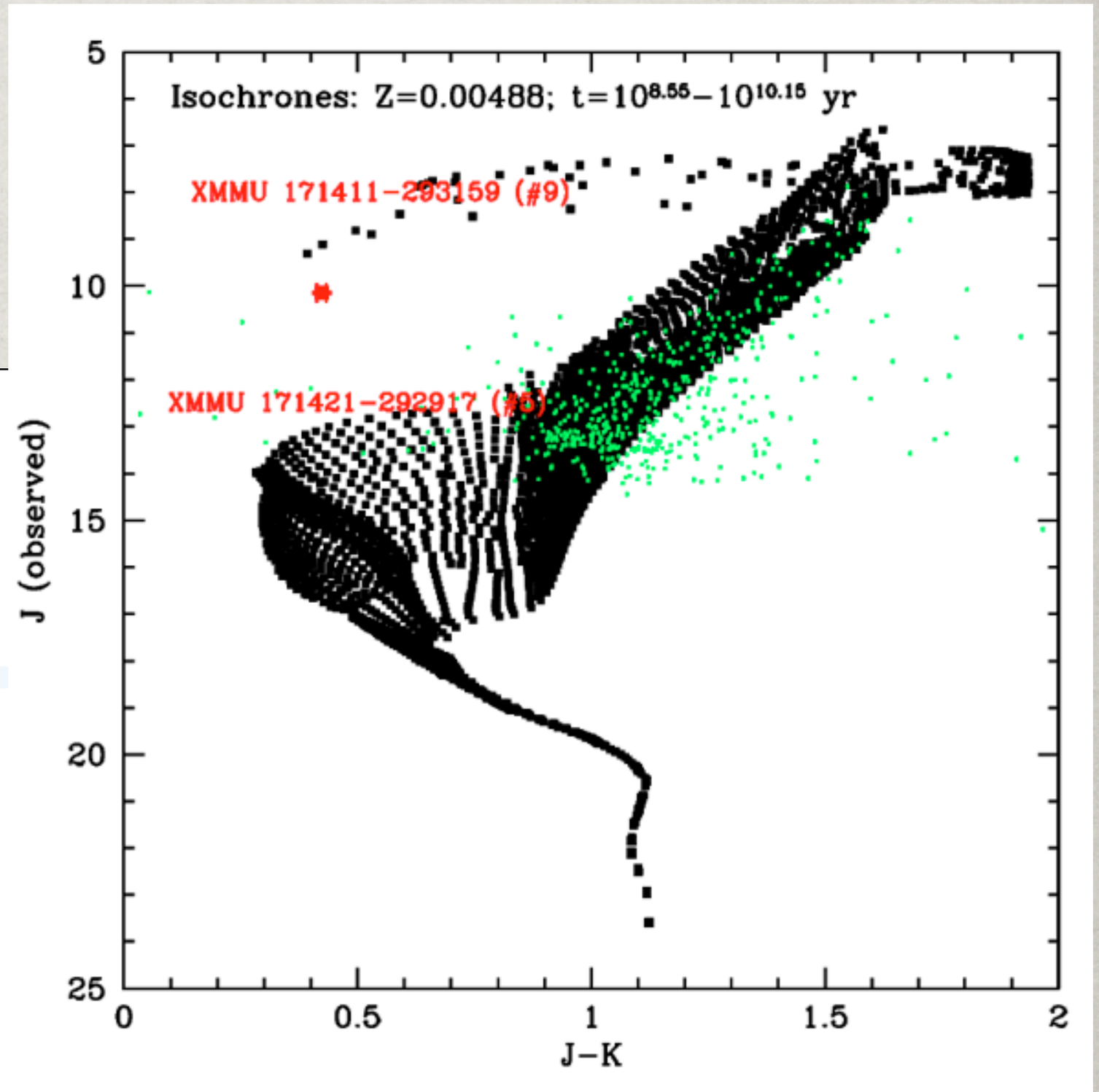
```
erase
ctype white
device x11

data encounter.dat
read {name 1.s rc 2 lrho 3 nqlmxb 4 distance 5}
set rc = rc*distance
set rho = 10**lrho

define NORM (100/((0.13*8.4)**2)/((10**5.28)**1.5))
set val = ($NORM)*(rc**2 * (rho**1.5))
set ggamma=0,120
set tval = 0.04*ggamma + 0.2

XLABEL Normalized Collision Rate
YLABEL Number of LMXB
limits 0 100 -0.5 5
box
connect ggamma tval

ctype red
ptype 6 3
points val nqlmxb

print gamma.dat '%s  %d %f  %f  %f\n' {name nqlmxb rc lrho val}
```



SM - Another example

```
device x11
erase
ctype black
ptype 4 3
expand 1.3
lweight 4
define DM (13.44) # distance  modulus

data isochrones.dat
read {t 1 M 2 J 8 K 10}
set logic = (t>8.5 && t<20)
set JK = J-K if (logic)
set J = J + $DM if (logic)

limits  0 2 25 5
box
points JK J

ctype default
xlabel J-K
ylabel J (observed)

data 2MASS_2arcmin.tab
read {J2mass 3 K2mass 7}
set JK2mass = J2mass - K2mass
set JK2mass0 = JK2mass+0.
ctype green
lweight 6
ptype 1 1
points JK2mass0 J2mass
lweight 4

data jkbv.dat
read {jk 1 djk 2 j 3 dj 4}
ptype 4 3
ctype red
expand 2.3
points jk j
error_x jk j djk
error_y jk j dj
```

```
macro drawredline 3 {
reloc $1 $2
define EBV  ($3)
define dJ (0.86 * $EBV)
define dK  (0.36*$EBV)
define dB  (4.4 * $EBV)
define dV  (3.1*$EBV)
define _endX ($1 -( $dJ- $dK))
define _endY ($2 - ($dB - $dV))
draw $_endX $_endY
expand 1.3
putlabel 3 "E(B-V)=" $3
}

ctype red
relocate 0.55 8
expand 1.1
putlabel 5 "XMMU 171411-293159 (#9)"
relocate 0.5 12.5
putlabel 5 "XMMU 171421-292917 (#5)"


macro labit 1 {
relocate 0.05 $H
putlabel 6 $1
define H ($H-$DH)
}

define H (0.95)
define DH (0.05)
limits  0 1 0 1
expand 1.3
ctype black
labit "Isochrones: Z=0.00488; t=10^{8.55}-10^{10.15} yr"
```



MATPLOTLIB IN PYTHON

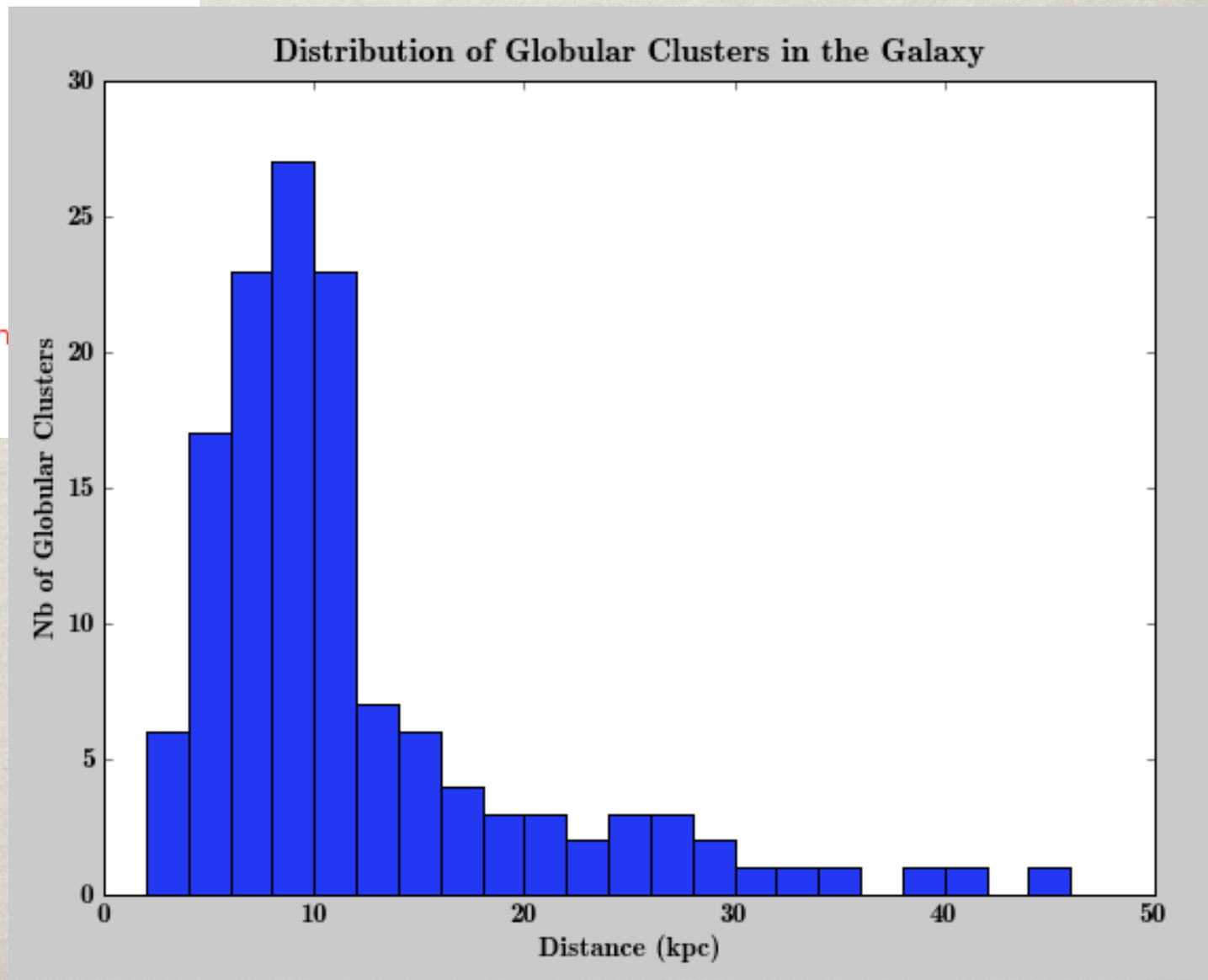
http://matplotlib.sourceforge.net/

+ Integrated to Python
+ Perfect to write code and display results
+ PyFITS module to read FITS files
+ Very complete documentation

– You need to know Python, which is easy, so it's not really a ' – '

Matplotlib - An example

```
#!/usr/bin/python
import sys, math, pylab

file1 = open('clustAll','r')
NB = 141
count=0
dist = []

line = file1.readline()
for i in range (0,NB):
.        line = file1.readline()
.        temp = line.split()
.        dist.append(float(temp[8]))
file1.close()

pylab.xlabel('Distance (kpc)')
pylab.ylabel('Nb of Globular Clusters')
pylab.title('Distribution of Globular Clusters in th
pylab.hist(dist,25,range=(0.,50))
pylab.show()
```



GNUPLOT

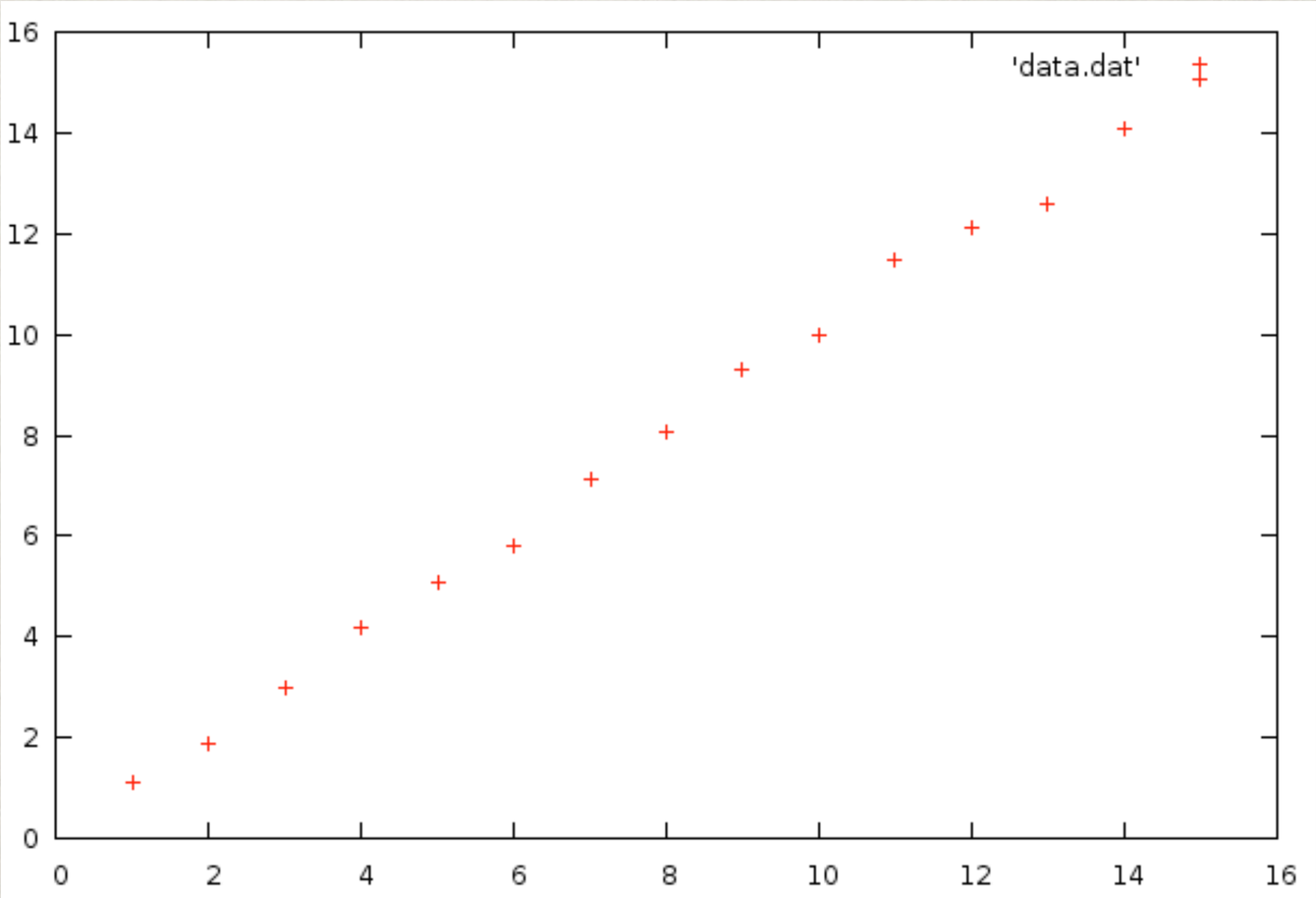
http://www.gnuplot.info/
http://t16web.lanl.gov/Kawano/gnuplot/index-e.html

+ Very quick and easy for a quick-look at your data
+ Scripting is possible
+ Function fitting included

– But does not necessarily make article-quality graphs
– Modification of default parameters can be difficult
– Not always well documented

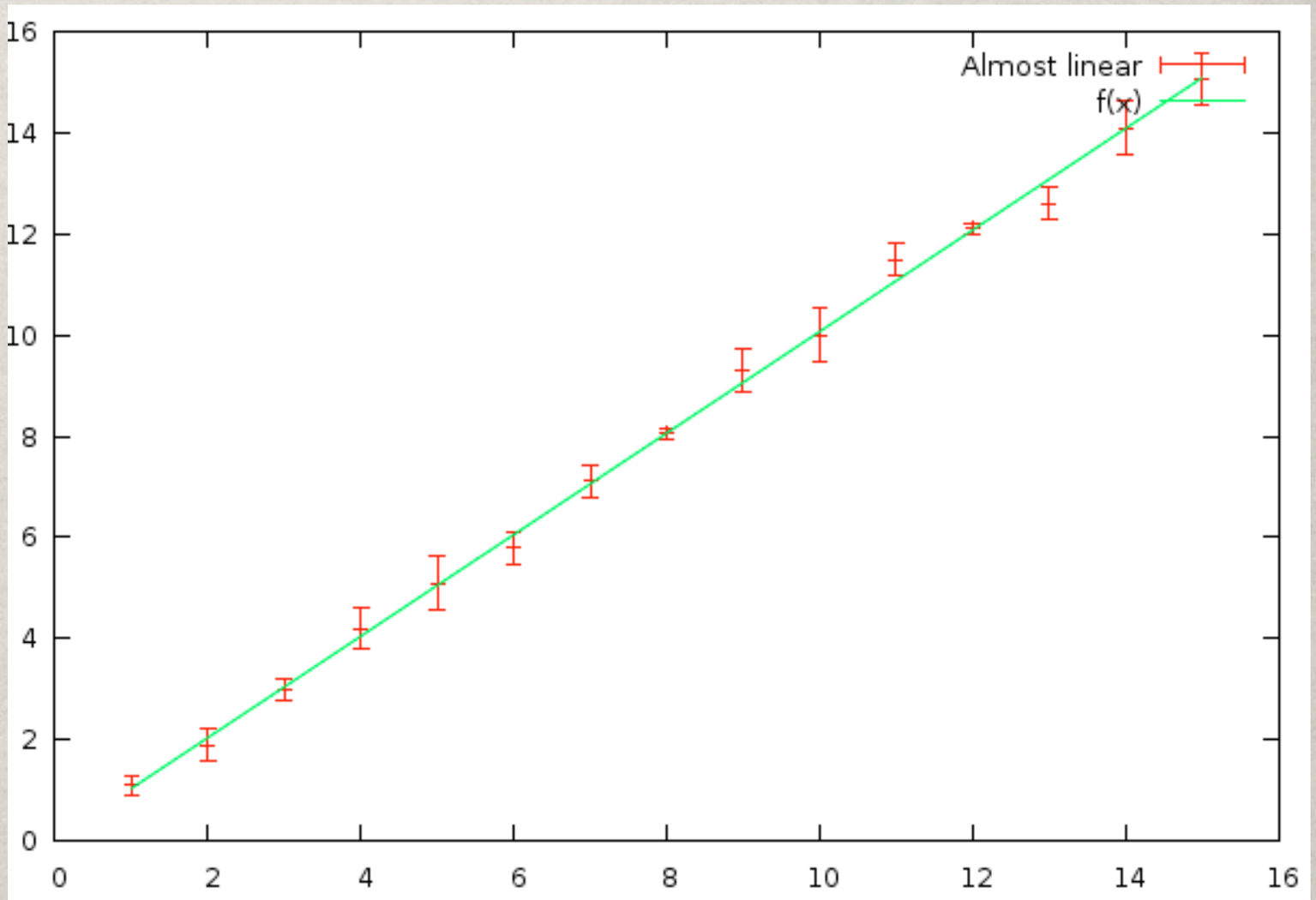
Gnuplot - An example

```
plot 'data.dat'
```



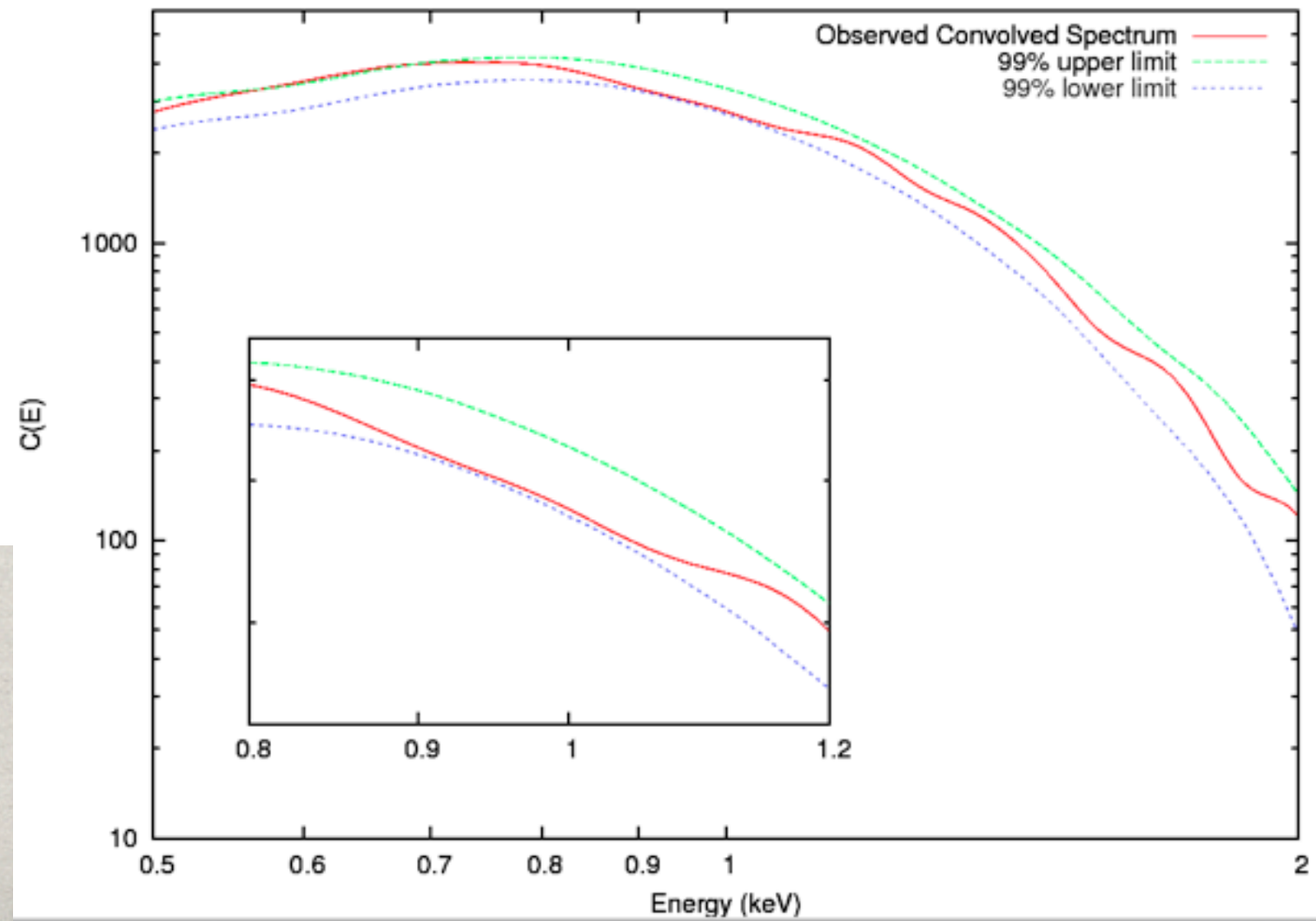
Gnuplot - Another example

```
plot 'data.dat' using 1:2:3 with yerrorbars title "Almost linear"
f(x) = a*x+b
fit f(x) 'data.dat' using 1:2:3 via a,b
replot f(x)
```



Gnuplot - A more complex example

```
reset

set multiplot
set logscale x
set logscale y
set xlabel 'Energy (keV)'
set ylabel 'C(E)'
set xrange [0.5:2.0]
set yrange [10:6000]
set origin 0.0,0.0
set size 1,1
set xtics (0.5,0.6,0.7,0.8,0.9,1.0,2.0)

plot 'SpectrumConvolved.dat' with lines title 'Observed Convolved Spectrum'
replot 'Limits.dat' using 1:990 with lines title '99% upper limit'
replot 'Limits.dat' using 1:10 with lines title '99% lower limit'

set xrange [0.8:1.2]
set yrange [1500:4500]
set origin 0.15,0.15
set size 0.5,0.5
set xtics (0.8,0.9,1.0,1.2)
set xlabel ''
set ylabel ''
unset key

plot 'SpectrumConvolved.dat' with lines
replot 'Limits.dat' using 1:990 with lines
replot 'Limits.dat' using 1:20 with lines
replot 'Limits.dat' using 1:10 with lines

unset multiplot
```



Interactive Data Language - IDL

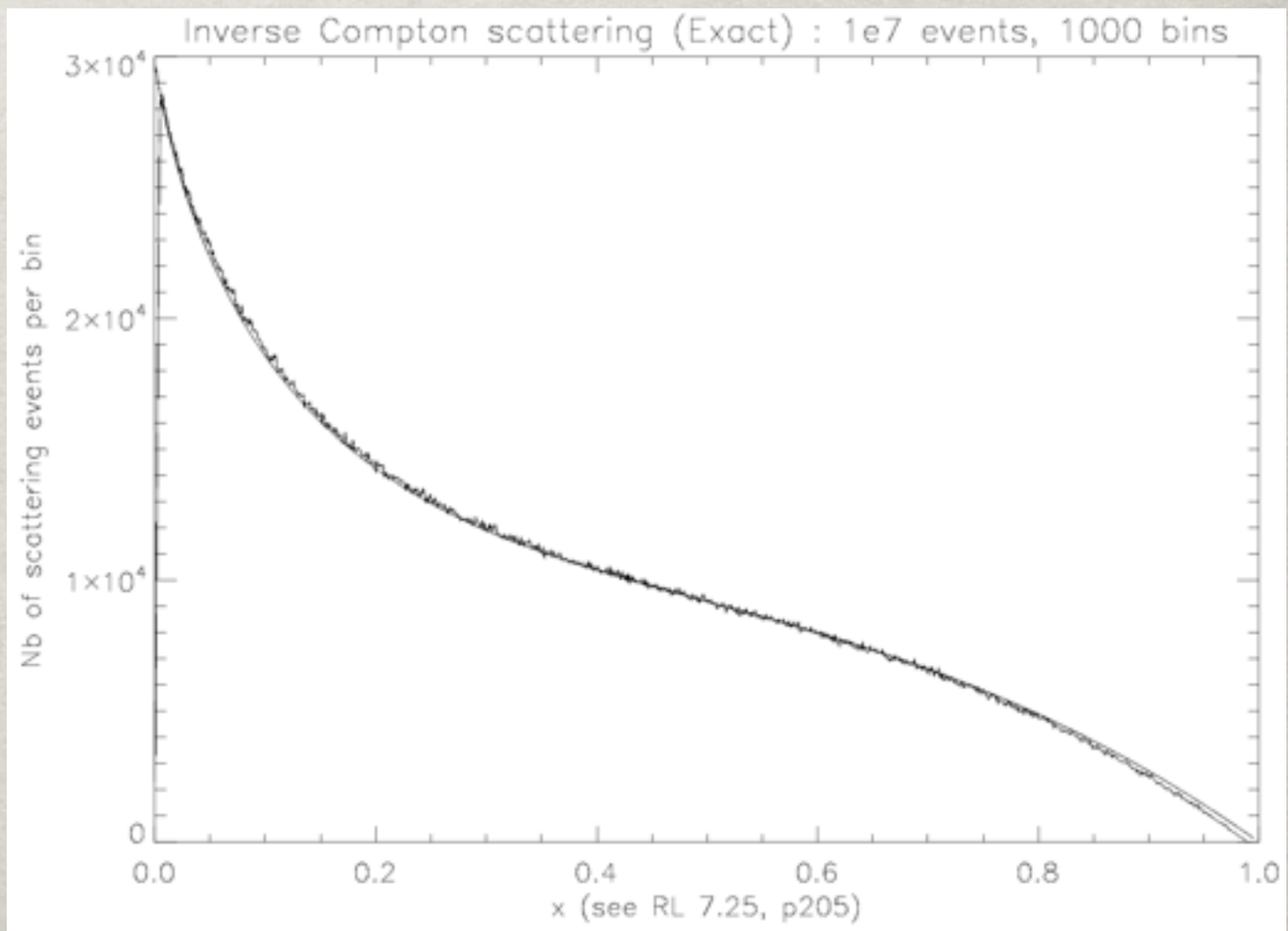
...The coyote website...

+ Read FITS files
+ Programming language
+ Used extensively in astronomy/astrophysics

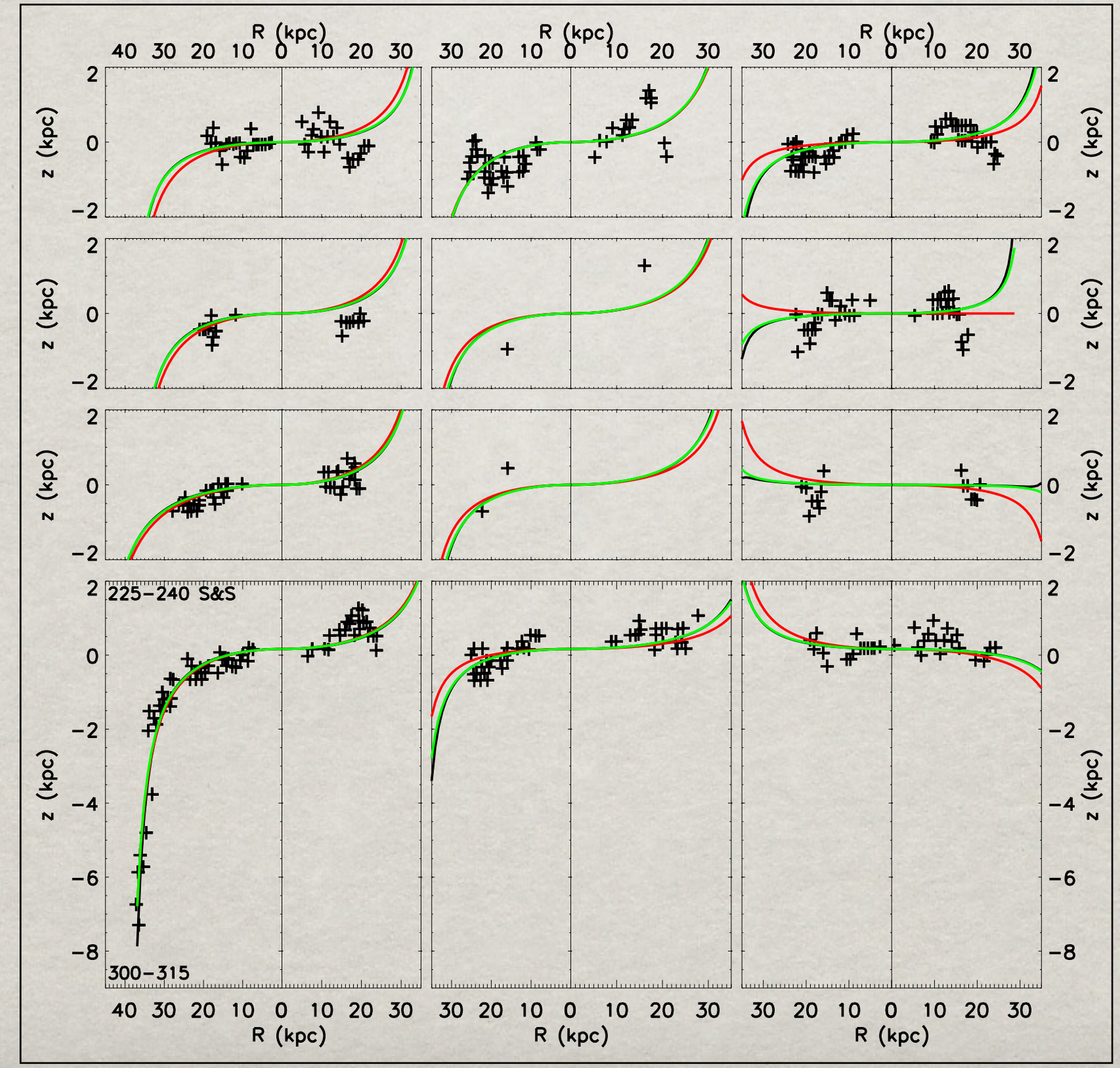
– Multi-plots and Graphs-in-graphs can be difficult
– Not free, but available in all astro departments

IDL - An example

```
openr, 1,'dataB.dat'
NbLines = 10000000
En1 = fltarr(1,NbLines)
readf,1,En1
close, 1

Epsilon0 = 1e-8
beta = 0.99
gamma = (1-beta^2)^(-0.5)
X = 1 / (4 * gamma^2 * Epsilon0)

mymin = 0
mymax = 2e-6
Nbbin = 1000
mybin = (mymax-mymin)/Nbbin

MyHisto1 = HISTOGRAM(En1[*],MIN=mymin,MAX=mymax,BINSIZE=mybin)
HistoX = (findgen(Nbbin)*mybin + mymin)*X
Fx = (2*HistoX*ALOG(HistoX)+HistoX+1-2*(HistoX)^2)*30000

plot, HistoX,MyHisto1,xrange=[0,1],xtitle="x (see RL 7.25, p205)",
ytitle="Nb of scattering events per bin",title="Inverse Compton sc
attering (Exact) : 1e7 events, 1000 bins"
oplot, HistoX,Fx

device, /close
end
```



IDL - Another example



```
set_plot, 'ps'
device,/inches,ysize=7.0,scale_factor=1.0
device,/inches,xsize=7.0,scale_factor=1.0
;Make your own color table
red=[0,1,1,0,0,1]
green=[0,1,0,1,0,1]
blue=[0,1,0,0,1,0]
tvlct, 255*red, 255*green, 255*blue
device, color=1
!P.CHARSIZE = 1.5
!P.CHARTHICK = 4.0
!P.THICK = 4.0
!X.TICKINTERVAL = 10
!Y.TICKINTERVAL = 2

erase

device, filename='paper_plot.ps'

;declare ranges of R and B
;Declare the Constants for the fit of the mu
A=2.2
B=0.0363
C=1.18
D=0.0366
warpMaj=-55 ; in degrees
warpMin=132
;Declare constants for FLOATING fit of the o
warp_f=-63
Aconst_f=1.135
Bconst_f=0.0352
;Declare constants for NON-FLOATING/ SAWA fi
warp=-50
Aconst=1.185
Bconst=0.035


;positive are from 0-15 in Sawa =7; in ours
onezero = fltarr(2,20)
OpenR, 17, '10.txt'
ReadF, 17, onezero
Close, 17
theta10=173
;positive are from 15-30 in Sawa =23; in our
twozero = fltarr(2,8)
OpenR, 17, '20.txt'
ReadF, 17, twozero
Close, 17
theta20=157
;positive are from 30-45 in Sawa =37; in our
threefive = fltarr(2,17)
OpenR, 17, '37.txt'
ReadF, 17, threefive
Close, 17
theta35=143
6;positive values are from 45-60=50 in Sawa
fivezero = fltarr(2,23)
OpenR, 17, '50.txt'
ReadF, 17, fivezero
Close, 17
theta50=130
```

```
;for 10 degrees
plot, abs(onezero[0,*]), onezero[1,*], psym=1,xrange=[0,35],yrange=[-2,2],
  xstyle=4,ystyle=4, /noerase,charsize=0.9, position=[0.23,0.79,0.36,0.93]
Axis, YAxis=1, yRange=[-2,2],charsize=0.0001,ystyle=1
Axis, XAxis=1, XRange=[0,35],charsize=0.9,xstyle=1
Axis, XAxis=0, XRange=[0,35],charsize=0.0001,xstyle=1
XYOUTS, 4200, 14100, '180-165', /DEVICE, CHARSIZE = 0.8
XYOUTS, 4200, 14400, '0-15 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta10,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta10,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta10,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3

;for 20 degrees
plot, abs(twozero[0,*]), twozero[1,*], psym=1,xrange=[0,35],yrange=[-2,2],
  xstyle=4,ystyle=4, /noerase,charsize=0.9, position=[0.23,0.63,0.36,0.77]
Axis, YAxis=1, yRange=[-2,2],charsize=0.0001,ystyle=1
Axis, XAxis=1, XRange=[0,35],charsize=0.0001,xstyle=1
Axis, XAxis=0, XRange=[0,35],charsize=0.0001,xstyle=1
XYOUTS, 4200, 11300, '165-150', /DEVICE, CHARSIZE = 0.8
XYOUTS, 4200, 11600, '15-30 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta20,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta20,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta20,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3

;for 35 degrees
plot, abs(threefive[0,*]), threefive[1,*], psym=1,xrange=[0,35],yrange=[-2,
  xstyle=4,ystyle=4, /noerase,charsize=0.9, position=[0.23,0.47,0.36,0.61]
Axis, YAxis=1, yRange=[-2,2],charsize=0.0001,ystyle=1
Axis, XAxis=1, XRange=[0,35],charsize=0.0001,xstyle=1
Axis, XAxis=0, XRange=[0,35],charsize=0.0001,xstyle=1
XYOUTS, 4200, 8400, '150-135', /DEVICE, CHARSIZE = 0.8
XYOUTS, 4200, 8700, '30-45 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta35,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta35,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta35,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3

;for 50 degrees
plot, abs(fivezero[0,*]), fivezero[1,*], psym=1,xrange=[0,35],yrange=[-9,2]
  xstyle=1,ystyle=4, position=[0.23,0.07,0.36,0.45],/noerase,charsize=0.9
Axis, YAxis=1, yRange=[-9,2],charsize=0.0001,ystyle=1
XYOUTS, 4200, 1400, '135-120', /DEVICE, CHARSIZE = 0.8
XYOUTS, 4200, 1700, '45-60 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta50,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta50,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta50,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3
```

```
plot, abs(threeonezero[0,*]), threeonezero[1,*], psym=1, xrange=[
  yrange=[-2,2],xstyle=4,ystyle=4, /noerase, position=[0.66,0.79,
Axis, XAxis=0, XRange=[35,0],charsize=0.0001,xstyle=1
Axis, XAxis=1, XRange=[35,0],charsize=0.9,xstyle=1, xtitle=''
Axis, YAxis=0, yRange=[-2,2],charsize=0.0001,xstyle=1
Axis, YAxis=1, yRange=[-2,2],charsize=0.0001,ystyle=1
XYOUTS, 11800, 16250, '240-225', /DEVICE, CHARSIZE = 0.8
XYOUTS, 11800, 15950, '300-315 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta310,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta310,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta310,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3
;start with threetwofive
plot, abs(threetwofive[0,*]), threetwofive[1,*], psym=1, xrange=[
  yrange=[-2,2],xstyle=4,ystyle=4,position=[0.66,0.63,0.8,0.77],/
Axis, XAxis=0, XRange=[35,0],charsize=0.0001,xstyle=1
Axis, XAxis=1, XRange=[35,0],charsize=0.0001,xstyle=1
Axis, YAxis=0, YRange=[-2,2],charsize=0.0001,ystyle=1
Axis, YAxis=1, YRange=[-2,2],charsize=0.0001,ystyle=1
XYOUTS, 11800, 13400, '225-210', /DEVICE, CHARSIZE = 0.8
XYOUTS, 11800, 13100, '315-330 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta325,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta325,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta325,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3

;start with threethreefive
plot, abs(threethreefive[0,*]), threethreefive[1,*], psym=1,xrang
  yrange=[-2,2],xstyle=4,ystyle=4,position=[0.66,0.47,0.8,0.61],/
Axis, XAxis=0, XRange=[35,0],charsize=0.0001,xstyle=1
Axis, XAxis=1, XRange=[35,0],charsize=0.0001,xstyle=1
Axis, YAxis=0, yRange=[-2,2],ystyle=1,charsize=0.0001
Axis, YAxis=1, yRange=[-2,2],ystyle=1,charsize=0.0001
XYOUTS, 11800, 8750, '210-195', /DEVICE, CHARSIZE = 0.8
XYOUTS, 11800, 8450, '330-345 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta335,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta335,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta335,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3
;start with threefivefive

plot, abs(threefivefive[0,*]), threefivefive[1,*], psym=1,xrange=
  yrange=[-9,2],xstyle=4,ystyle=4,position=[0.66,0.07,0.8,0.45],/
Axis, XAxis=0, XRange=[35,0],charsize=0.9,xstyle=1,xtitle=''
Axis, XAxis=1, XRange=[35,0],charsize=0.0001,xstyle=1
Axis, YAxis=0, yRange=[-9,2],ystyle=1,charsize=0.0001
Axis, YAxis=1, yRange=[-9,2],ystyle=1,charsize=0.0001
XYOUTS, 11800, 1650, '195-180', /DEVICE, CHARSIZE = 0.8
XYOUTS, 11800, 1350, '345-0 S&S', /DEVICE, CHARSIZE = 0.8
xvals=findgen(42)
yvals=heightfxn_fourier(xvals,theta355,A,B,C,D,warpMaj,warpMin)
oplot, xvals, yvals
y2vals=heightfxn2(xvals,theta355,Aconst,Bconst,warp)
oplot, xvals, y2vals, color=2
y3vals=heightfxn2(xvals,theta355,Aconst_f,Bconst_f,warp_f)
oplot, xvals, y3vals, color=3
```

MATHEMATICA

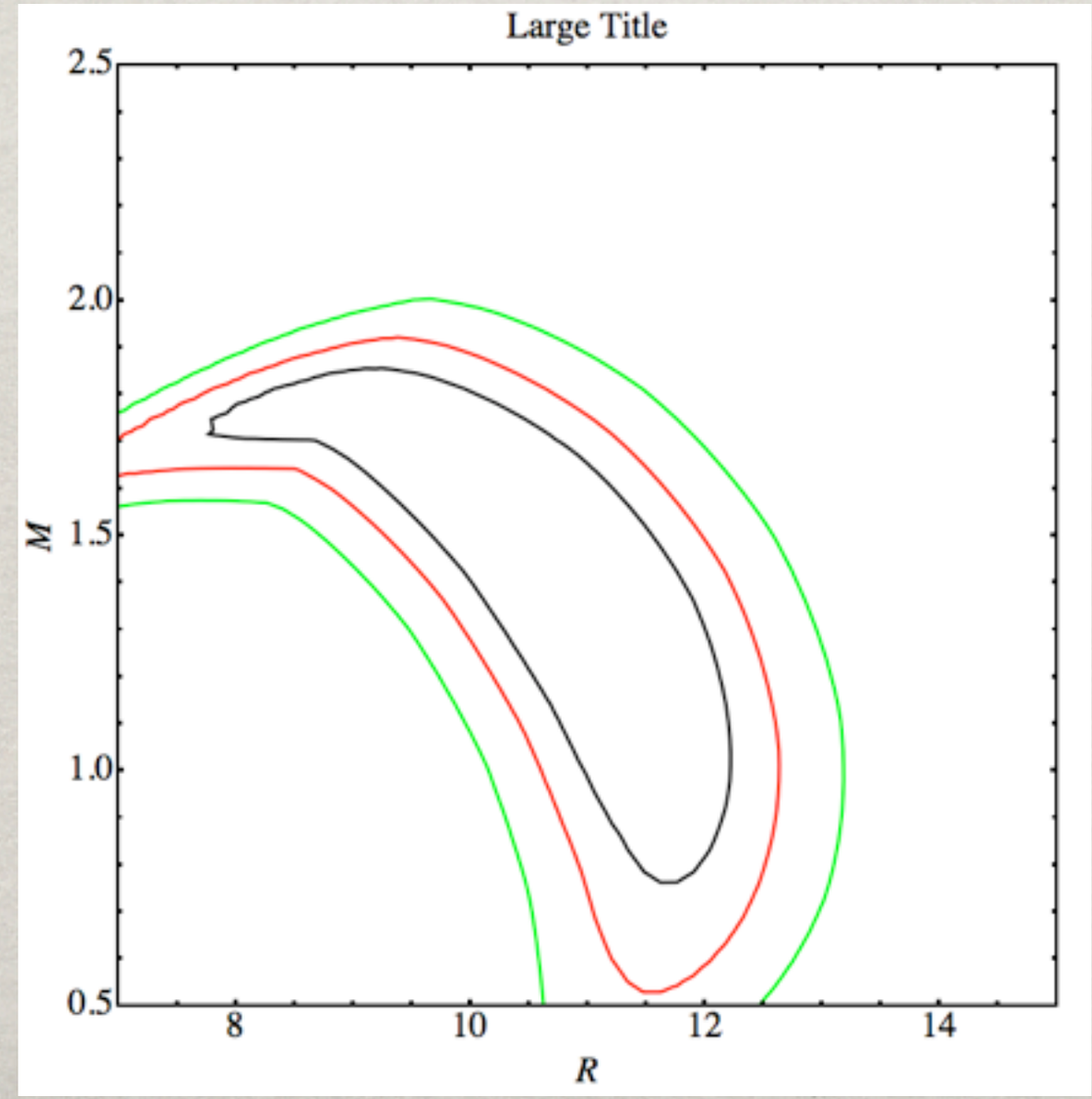
http://www.wolfram.com/mathematica/

+ Well documented with many examples
+ Programming language
+ Read FITS files
+ Make pretty graphs and other cool stuff
+ Some cool functions make things easy.

– Not free, but sometimes available for students in universities
– Arrays/Table can be tricky to use...(I still haven't quite figured it out)

Mathematica - An example

```
MyData = Import["/Users/Sebastien/Desktop/Contours/U24_Alone.dat", "Table"];
ListContourPlot[MyData, Contours → {2.3, 4.61, 9.21},
 ContourStyle → {{Thick, Black}, {Thick, Red}, {Thick, Green}},
 ContourShading → None, PlotRange → {{7, 15}, {0.5, 2.5}}, FrameLabel → {R, M},
 FrameStyle → Thick, LabelStyle → Large, PlotLabel → Style["Large Title", Large]]
```

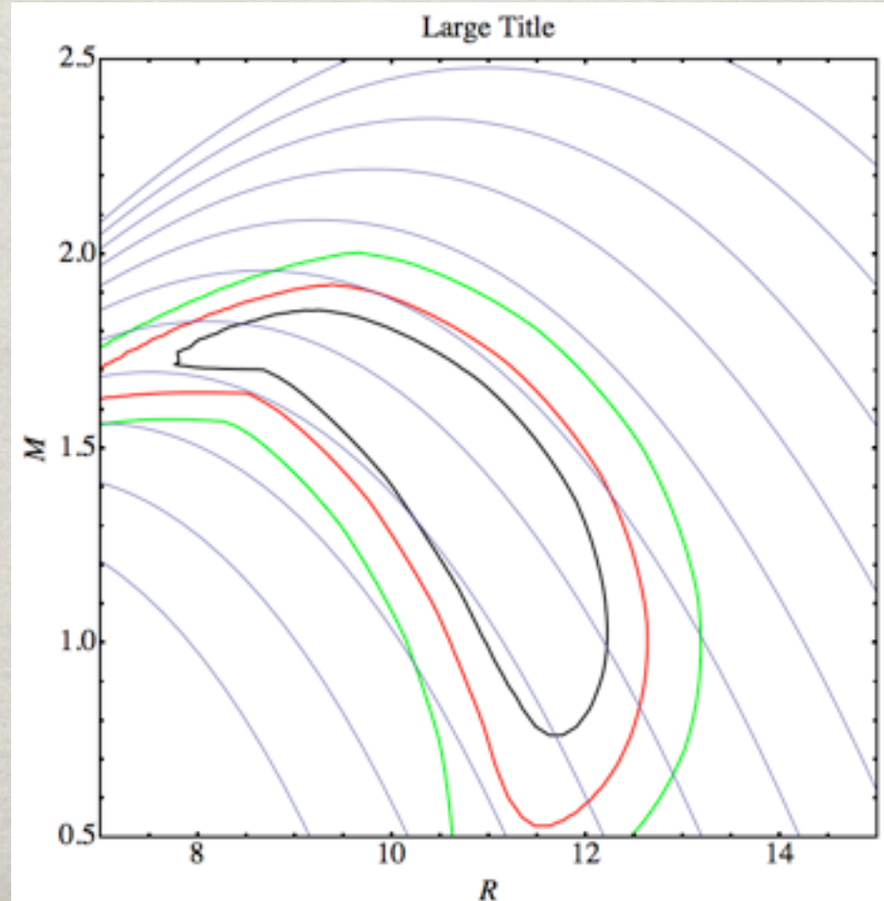


Mathematica - An example

```
MyData = Import["/Users/Sebastien/Desktop/Contours/U24_Alone.dat", "Table"];
Plot1 := ListContourPlot[MyData, Contours → {2.3, 4.61, 9.21},
  ContourStyle → {{Thick, Black}, {Thick, Red}, {Thick, Green}}, ContourShading → None,
  PlotRange → {{7, 15}, {0.5, 2.5}}, FrameLabel → {R, M}, FrameStyle → Thick,
  LabelStyle → Large, PlotLabel → Style["Large Title", Large]]
```

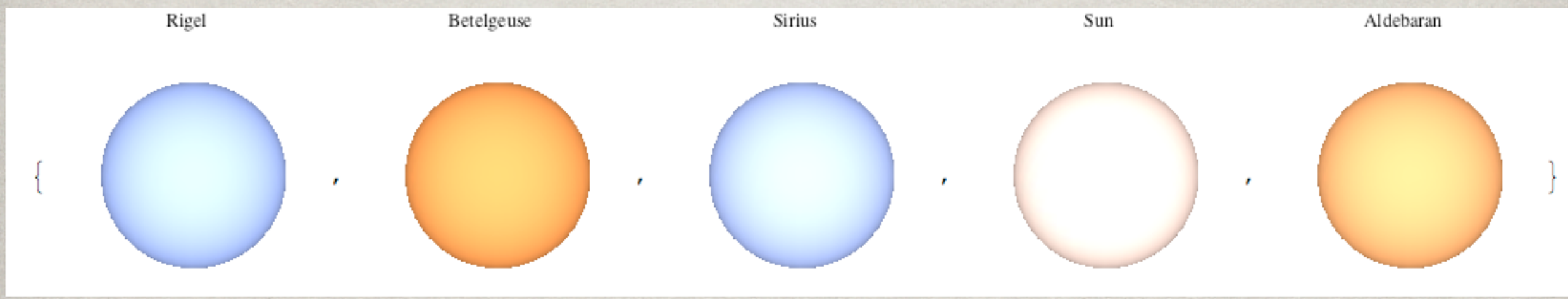
$$M[R\_, Ri\_] = -\frac{0.339\left(-Ri^2 R + R^3\right)}{Ri^2};$$

```
Plot2 := Table[Plot[M[R, Ri], {R, 5, 15}], {Ri, 10, 20, 1}]
Show[Plot1, Plot2]
```



Mathematica - A neat example

```
starColorPlot[star_] :=
 Graphics3D[{ColorData["BlackBodySpectrum"][AstronomicalData[star, "EffectiveTemperature"]], Sphere[]},
  Boxed → False, Lighting → {{"Ambient", Gray}, {"Directional", White, ImageScaled[{0, 0, 1}]}},
  PlotLabel → star]
starColorPlot /@ {"Rigel", "Betelgeuse", "Sirius", "Sun", "Aldebaran"}
```



MATLAB

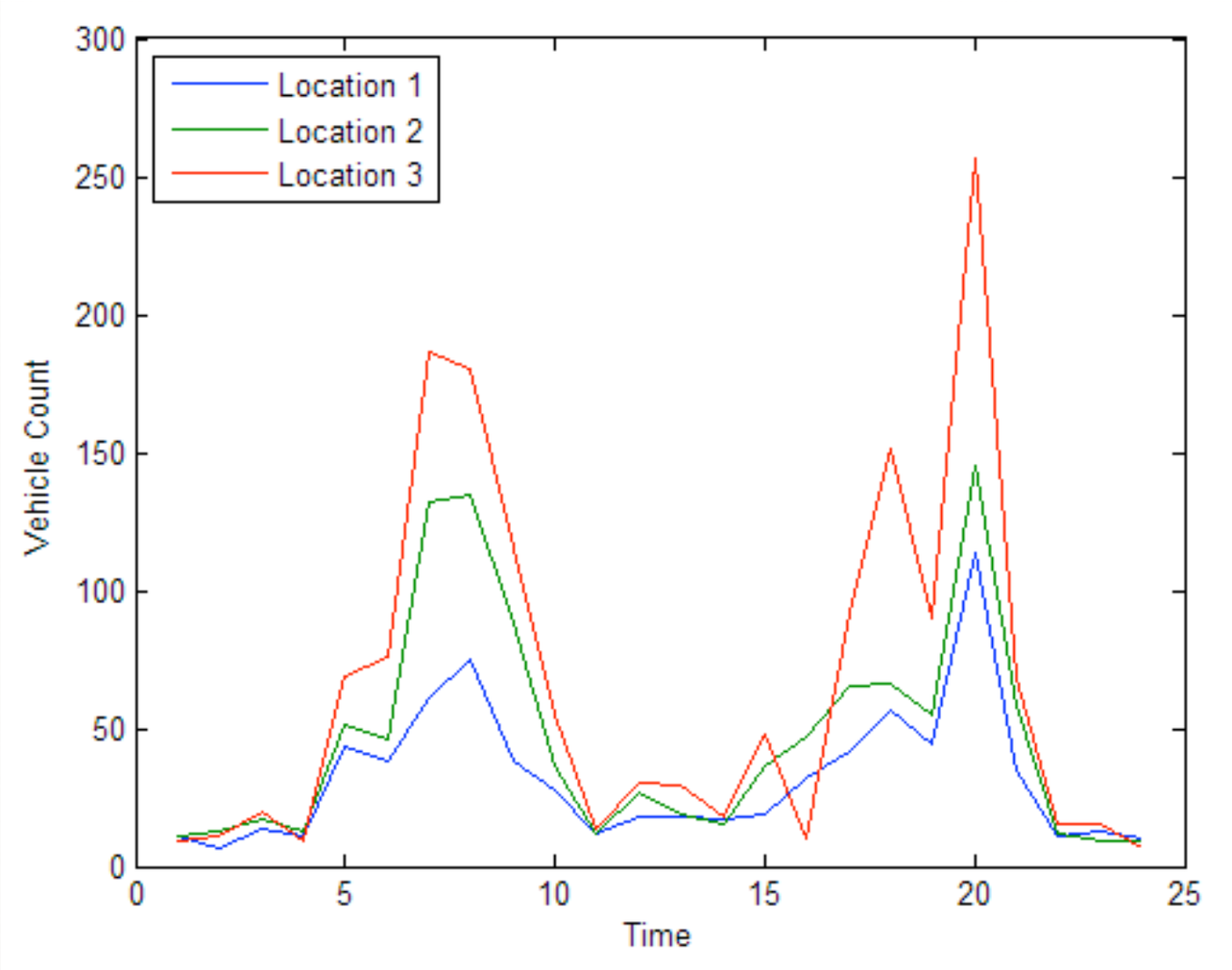
http://www.mathworks.com/products/matlab/

+ Programming language
+ Read FITS files
+ Interactive modification of an image, and transcription into code

– Not free, but sometimes available for students in universities

Matlab - An example

```
load count.dat        // load the data in the n*p matrix called "count"

[n,p] = size(count) // Get the size of the n*p matric

t = 1:n;              // Create a time vector t, with integers from 1 to n:

plot(t,count),
legend('Location 1','Location 2','Location 3',2)
xlabel('Time'), ylabel('Vehicle Count')
```



ORIGIN

http://www.originlab.com/

+ Makes pretty graphs
+ Programming language
+ Works on Mac and Windows only

– Not free, but sometimes available for students in some labs
– Works on Mac and Windows only

Origin - An example

Outlier - Outlier.dat

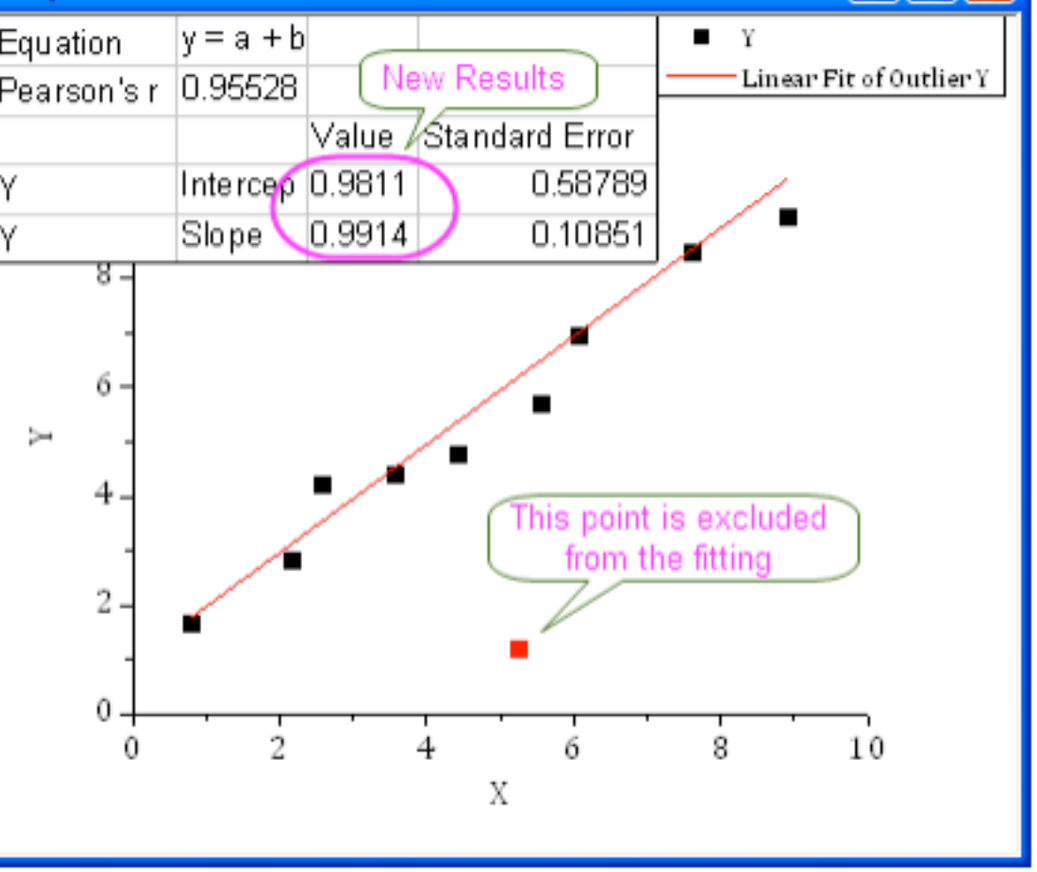
	A(X1)	B(Y1)	C1(X2)	C2(Y2)	C3(Y2)
Long Name	Independe	Linear Fit of	Independ	Regular R	Standardize
Parameters	Fitted Curves Plot				
1	0.79	1.43673	0.79	0.23327	0.13281
2	0.87202	1.51561	2.16	0.08563	0.04875
3	0.95404	1.5945	2.56	1.08092	0.61539
4	1.03606	1.67339	3.57	0.28951	0.16483
5	1.11808	1.75227	4.43	-0.14762	-0.08404
6	1.2001	1.83116	5.23	-4.47705	-2.54889
7	1.28212	1.91004	5.55	-0.31482	-0.17923
8	1.36414	1.98893	6.06	0.44467	0.25316
9	1.44616	2.06781	6.67	2.41798	1.37662
10	1.52818	2.1467	7.61	0.48391	0.2755
11	1.6102	2.22558	8.91	-0.09641	-0.05489

Outlier | FitLinear1 | FitLinearCurve1

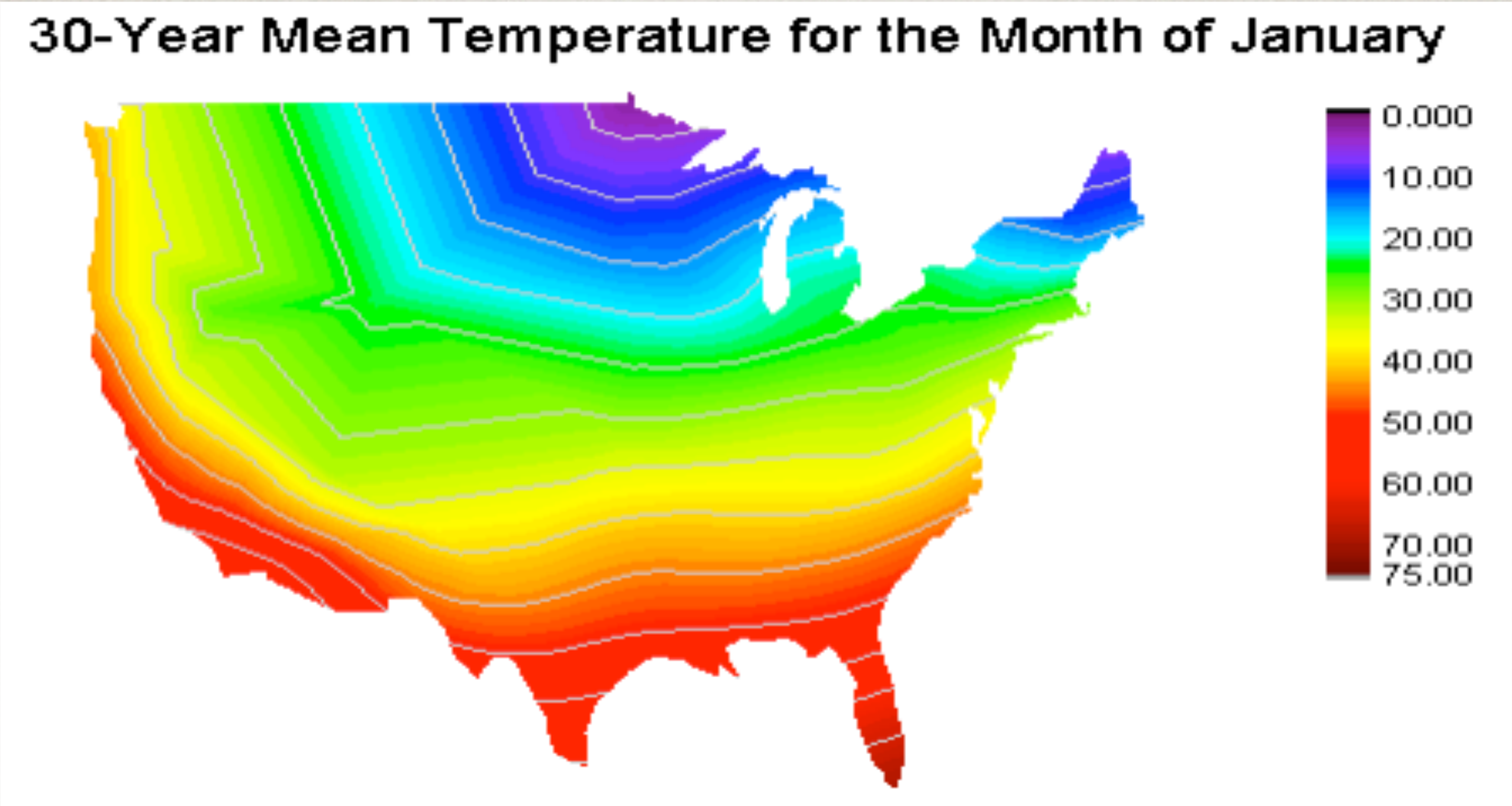
Graph1

1	Equation	y = a + b	
	Pearson's r	0.95528	
		Value	Standard Error
Y	Intercep	0.9811	0.58789
Y	Slope	0.9914	0.10851

New Results



Origin - Another example

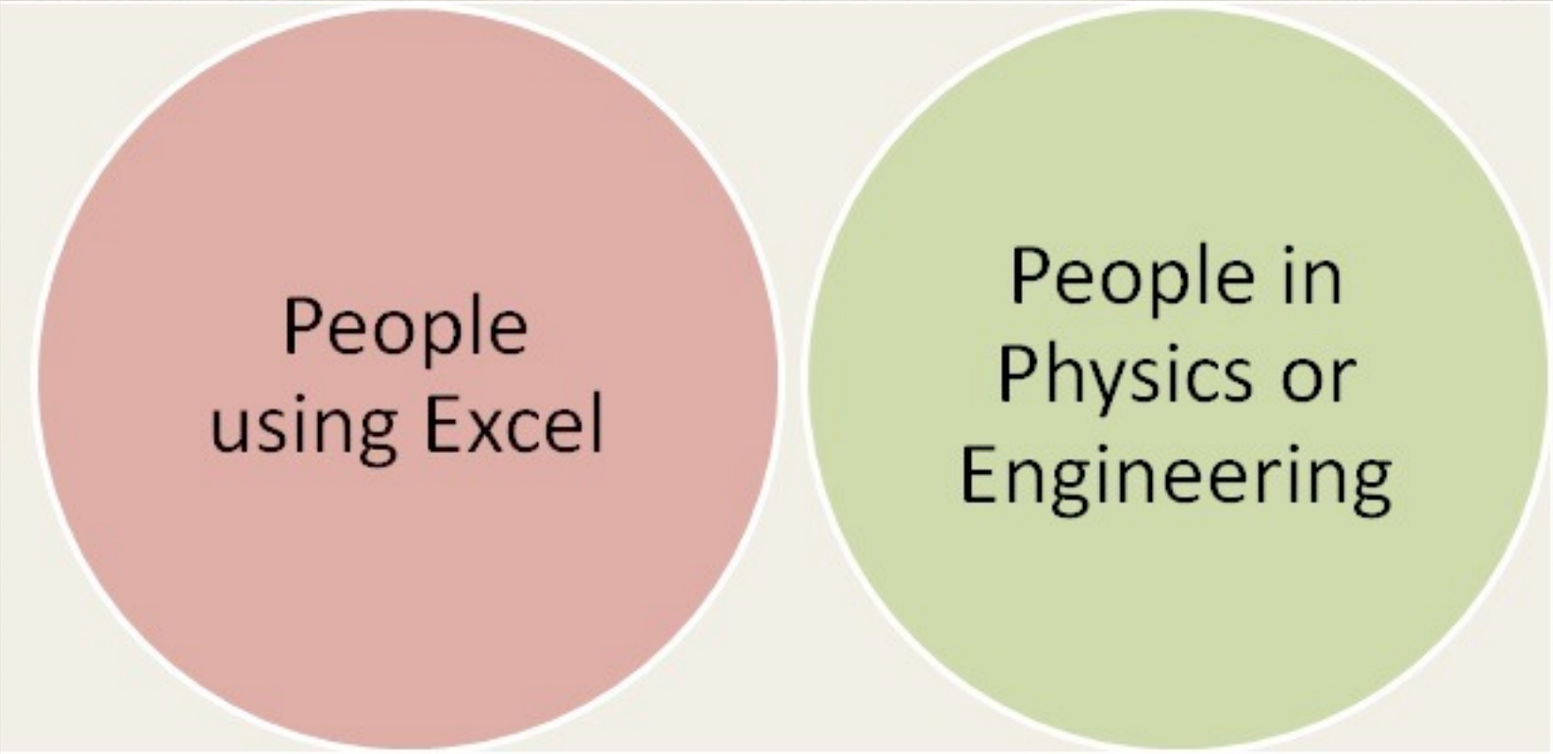


Excel, and Other Spreadsheet softwares

+ Still looking for advantages...
+ I think I found one...
+ You can easily...
+ No, it's not that easy. Forget it, false alarm.

- Not free, but discounts for students in some universities
- MACROS are a pain to write
- It never does what you want to do...because it tries to be smarter than you !
- Do you really want to publish an Excel graph ?

Excel - An example



Thanks