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Introduction to Gnuplot

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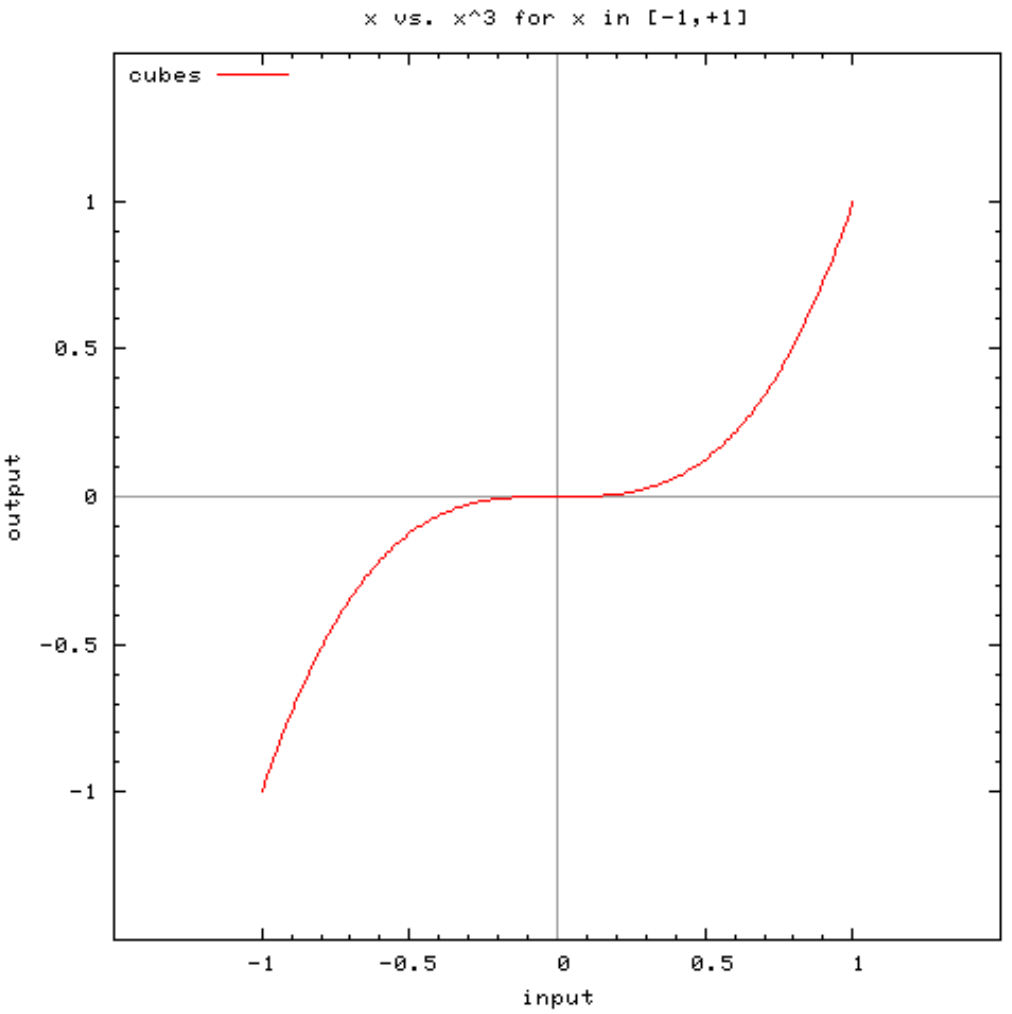
Course aims

- Simple graphs
- 2D
- Plotting data
- Scripted process
- No manual work



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What the course *won't* cover

Gnuplot can

- 3D plots
- Plotting functions
- Polar graphs
- Histograms

Gnuplot can't

- Manual artistry

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What the course *will* cover

1. Introduction
2. Part one
3. Break
4. Part two
5. Questions

- Course contents
- Command line
- Viewing tool
  - eog
  - “Eye of Gnome”

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What the course *will* cover

1. Introduction
2. Part one
3. Break
4. Part two
5. Questions

- Driving Gnuplot
- Basic settings
- Size
- Ranges of values
- Tick marks

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What the course *will* cover

1. Introduction
2. Part one
3. Break
4. Part two
5. Questions

- Multiple graphs
- Colours
- Labels
- Frills

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What the course *will* cover

1. Introduction
2. Part one
3. Break
4. Part two
5. Questions

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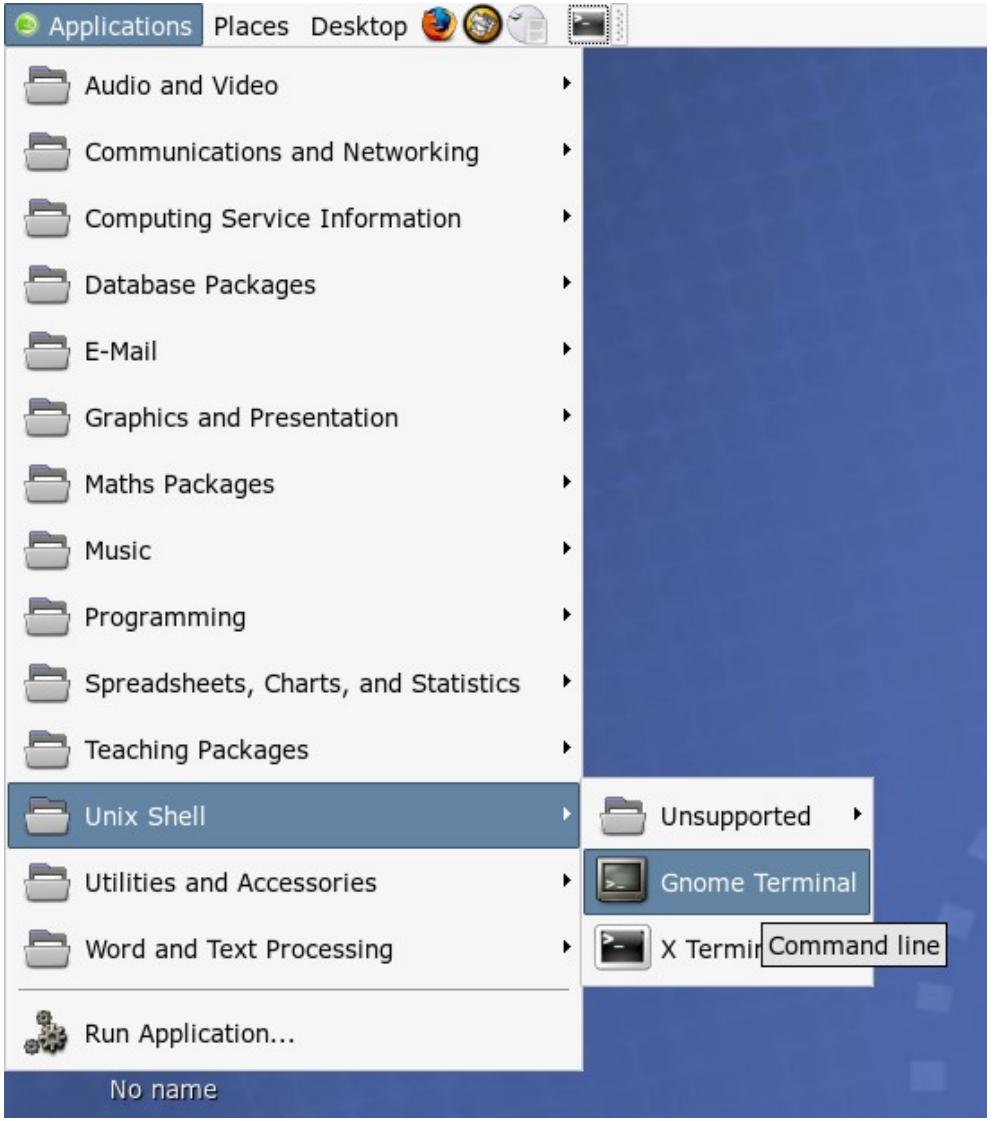
Terminal

- Command line
- Gnome terminal
- Applications menu



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Set up some files

- “Playground”
- Input files
- Gnuplot files
- Output files

> **/ux/Lessons/Gnuplot/setup**

Directory /home/*y500*/gnuplot created.

> **cd ~/gnuplot**

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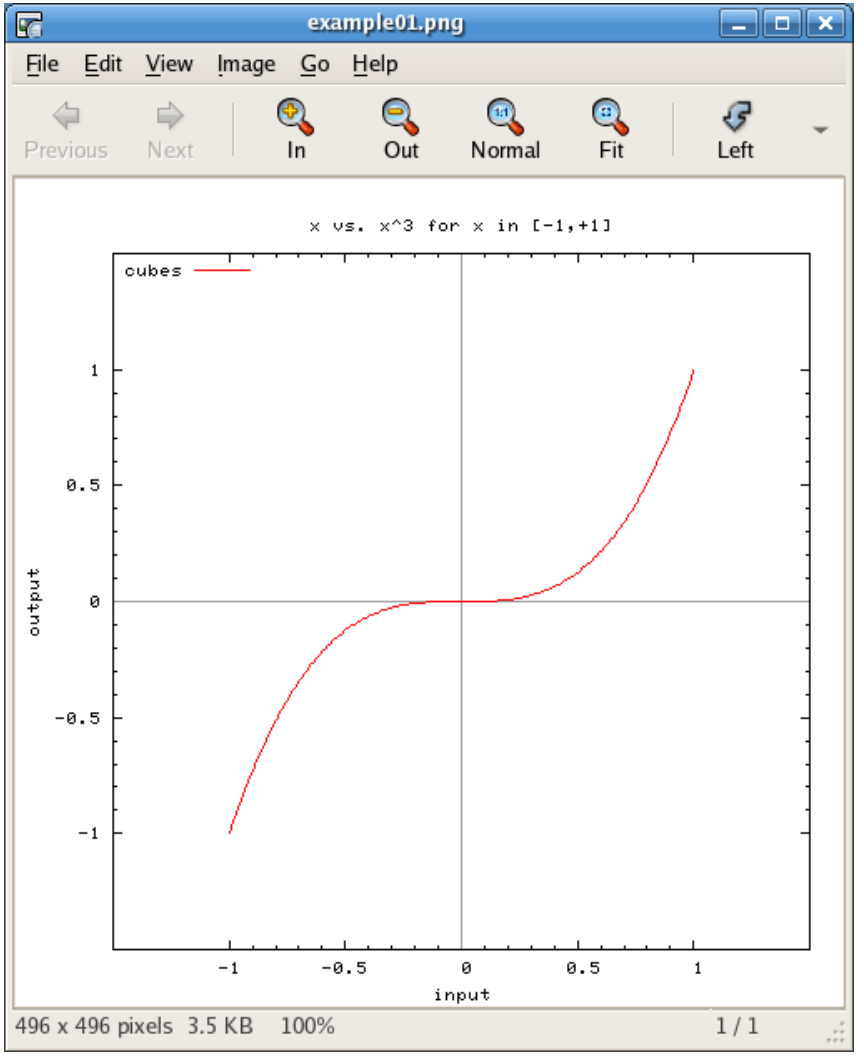
Test you can display graphics

> **eog example01.png**

Select image window

Close or Control-Q



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Interactive use of Gnuplot

- Run interactively
- Direct commands
- Built-in help
  - Not very helpful
- X11 graphics

```
> gnuplot

G N U P L O T
Version 4.0 …
Terminal type set to 'x11'
gnuplot> plot "cubic.dat"

…

gnuplot> quit

>
```

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Batch use of Gnuplot

- File of commands
- `cubic.gplt`
- Don't need a “quit”
- Just need end of file
- “Flash” of graph

> **more cubic.gplt**

```
plot "cubic.dat"
```

> **gnuplot cubic.dat**

>

Change output file format

- Want PNG
  - **P**ortable **N**etwork **G**raphics
- Gnuplot “terminal”:
  set terminal png
- Want a file:
  set output "cubic.png"
- File names in quotes
- *Before* the plot

```
> more cubic.gplt
set terminal png
set output "cubic.png"
plot "cubic.dat"
```

```
> gnuplot cubic.gplt
```

```
> eog cubic.png
```

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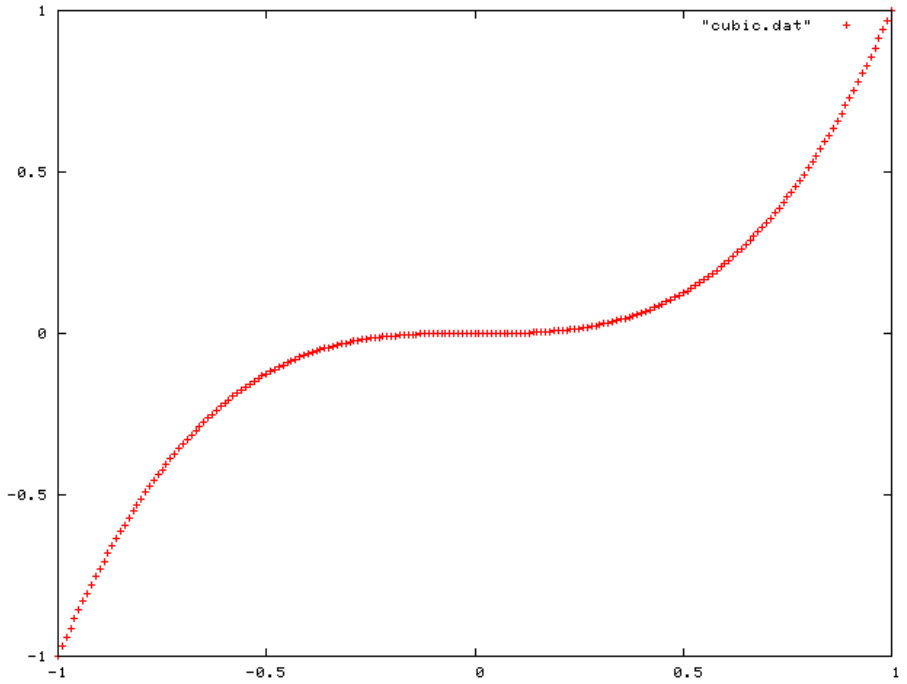
A look at the output



- 640×480 pixels
- Series of crosses
- Graph range = data range
- “Ticks” every 0.5
- No zero axes
- No labels
- Key uses file name
- Red

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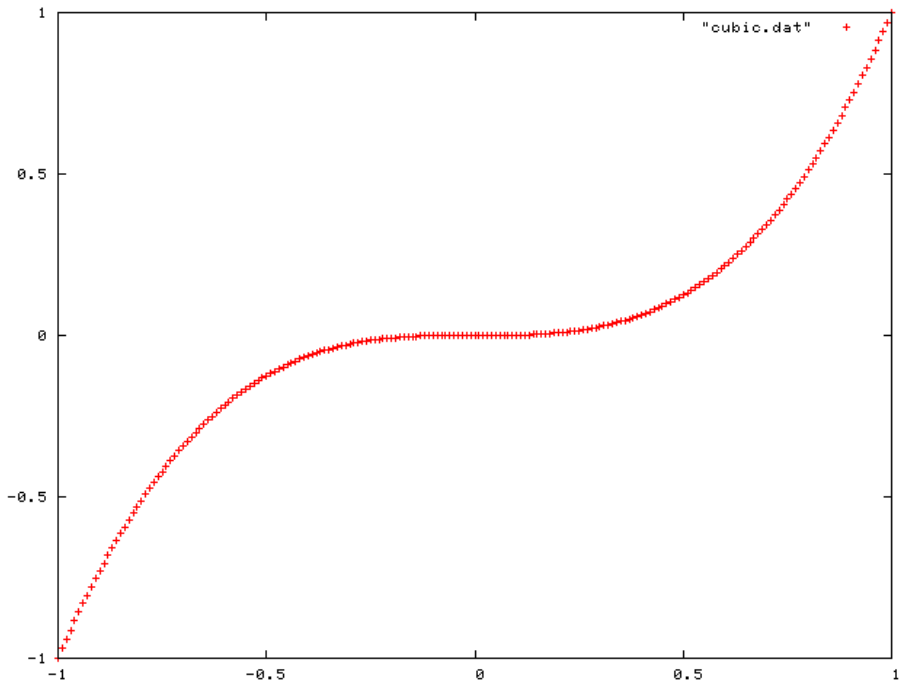
Problems with the shape



Problems:

- Image file 640×480
- Graph isn't square

Want to set:

- Image dimensions
- Graph aspect ratio

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Gnuplot commands

Image dimensions:

set terminal png picsize *X Y* Image size in pixels

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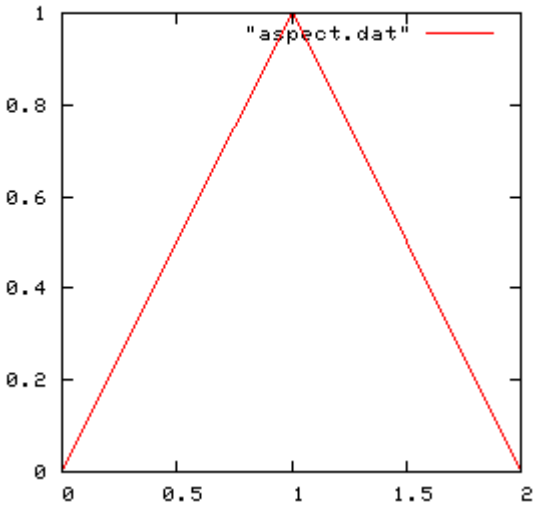
Gnuplot commands

Graph aspect ratio:

set size ratio *r*

Graph's aspect ratio

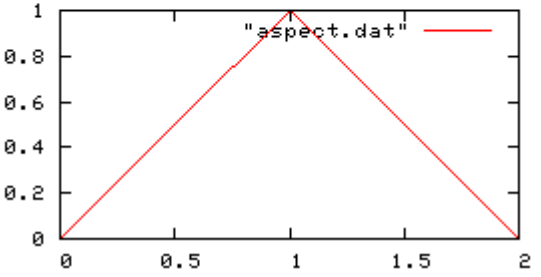
e.g. set size ratio +1:



set size ratio -*r*

Units' aspect ratio

e.g. set size ratio -1:



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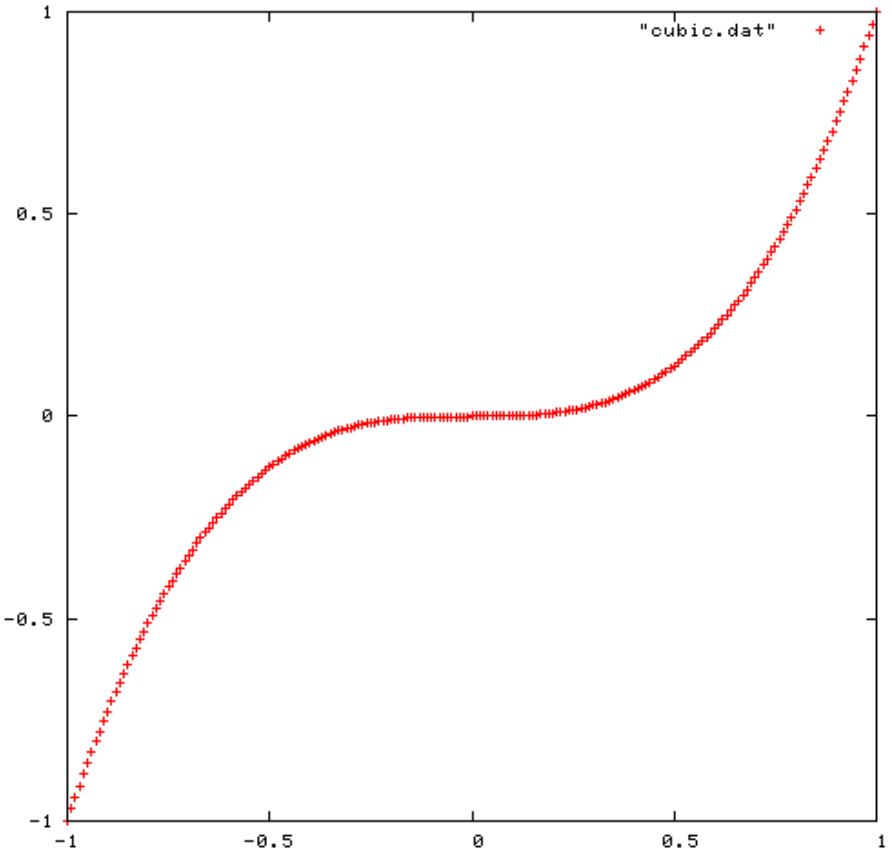
Next version of graph

set terminal png
picsize 512 512

set output "cubic.png"

set size ratio -1.0

plot "cubic.dat"



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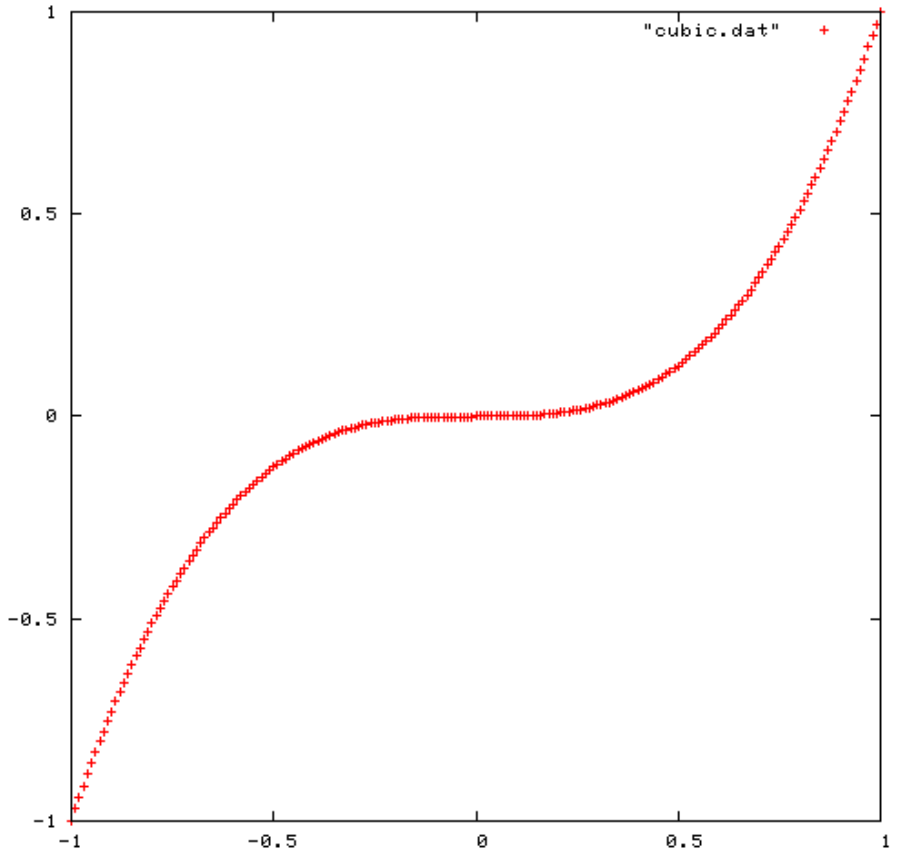
Problems with the curve



Problem:

- Set of crosses

Want to have:

- Set of line segments

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Gnuplot commands

Curve made of points:

set style data points

- “points” may be crosses or other marks

Curve made of line segments:

set style data lines

Curve made of true dots:

set style data dots

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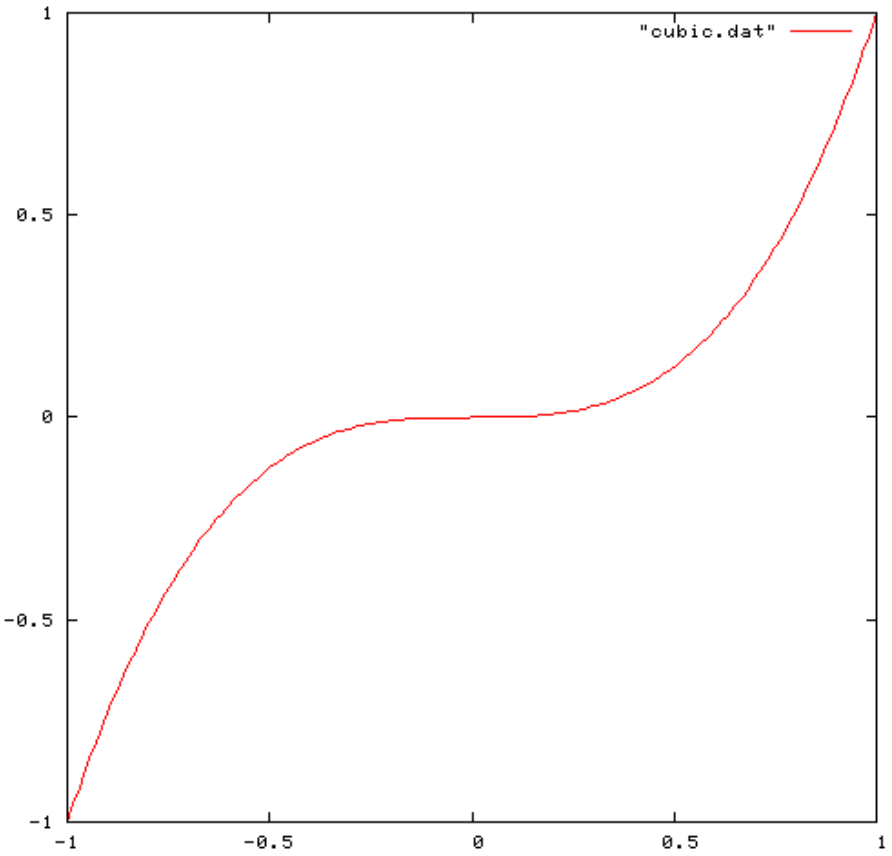
Next version of graph

```
set terminal png picsize
   512 512
set output "cubic.png"
set size ratio -1.0
set style data lines

plot "cubic.dat"
```



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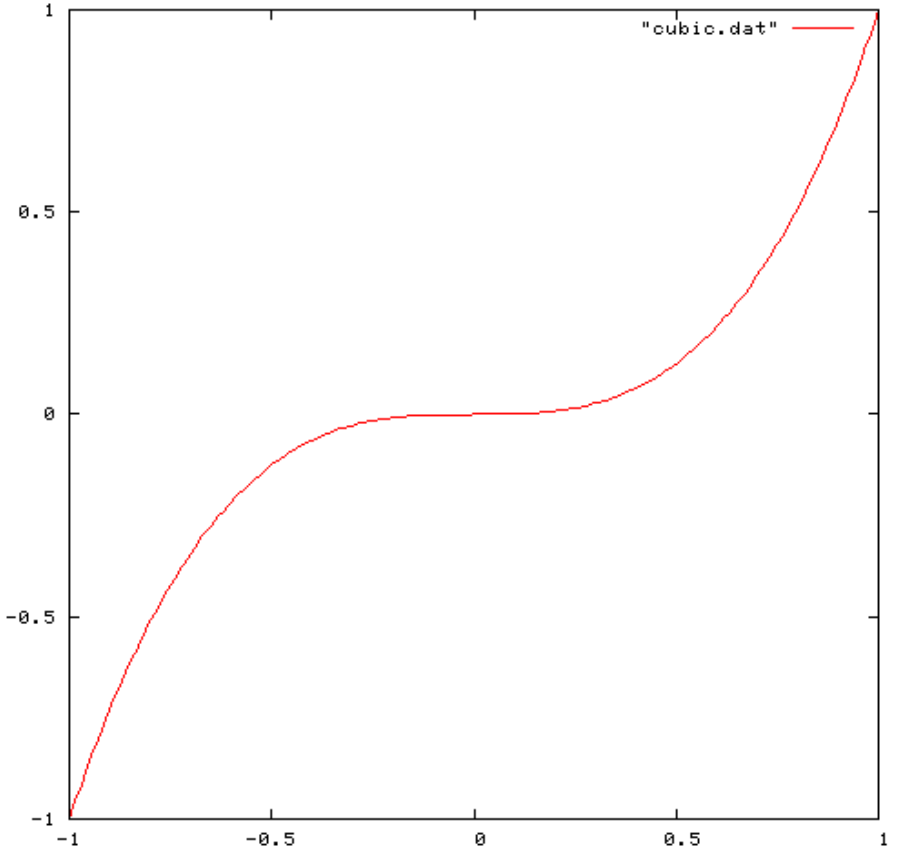
Problems with the range



Problem:

- Graph range = Data range
- [-1.0,+1.0]×[-1.0,+1.0]

Want to have:

- Manual setting
- [-1.5,+1.5]×[-1.5,+1.5]

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Gnuplot commands

Setting range explicitly:

```
set xrange [-1.5:1.5]
set yrange [-1.5:1.5]
```

Partial specification:

`set xrange [*:1.5]`	data minimum to 1.5
`set yrange [-1.5:*]`	-1.5 to data maximum

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Next version of graph

…

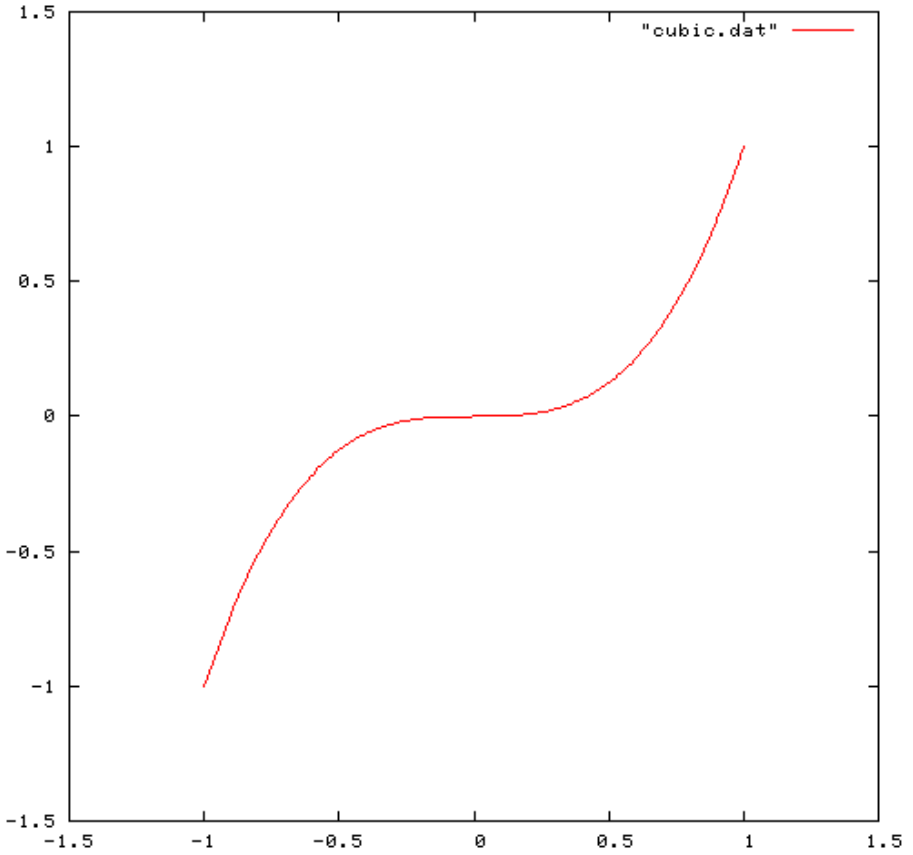
set size ratio -1.0

set style data lines

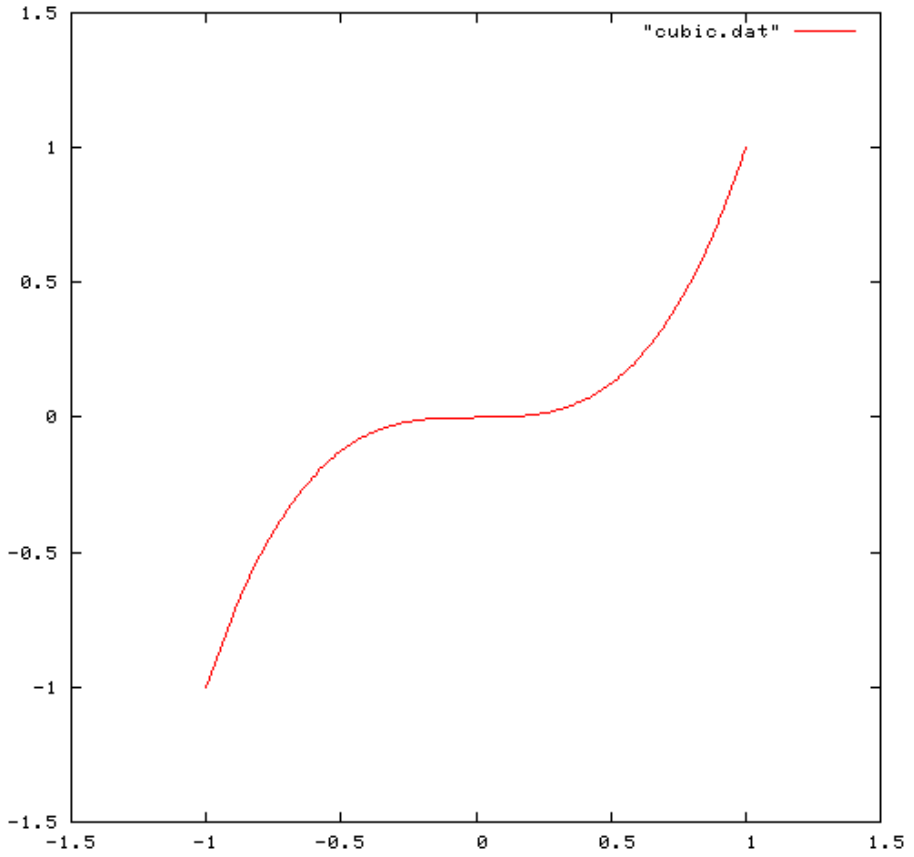
set xrange [-1.5:1.5]

set yrange [-1.5:1.5]

plot "cubic.dat"



Problems with the graph



Problem:

- Ticks every 0.5
- Ticks from -1.5 to 1.5

Want to have:

- Ticks every 0.25
- Ticks from -1.0 to 1.0

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Gnuplot commands

Setting just the tick interval

```
set xtics 0.25
set ytics 0.25
```

Setting the interval and range

```
set xtics -1.0,0.25,1.0
set ytics -1.0,0.25,1.0
```

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Next version of graph

…

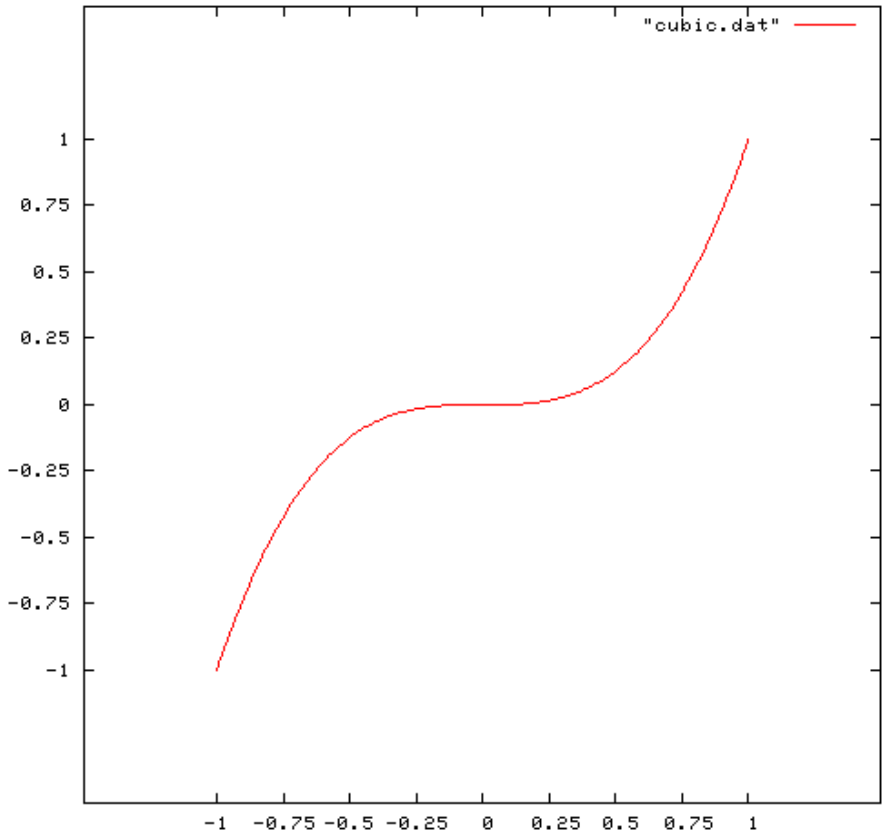
set xrange [-1.5:1.5]

set yrange [-1.5:1.5]

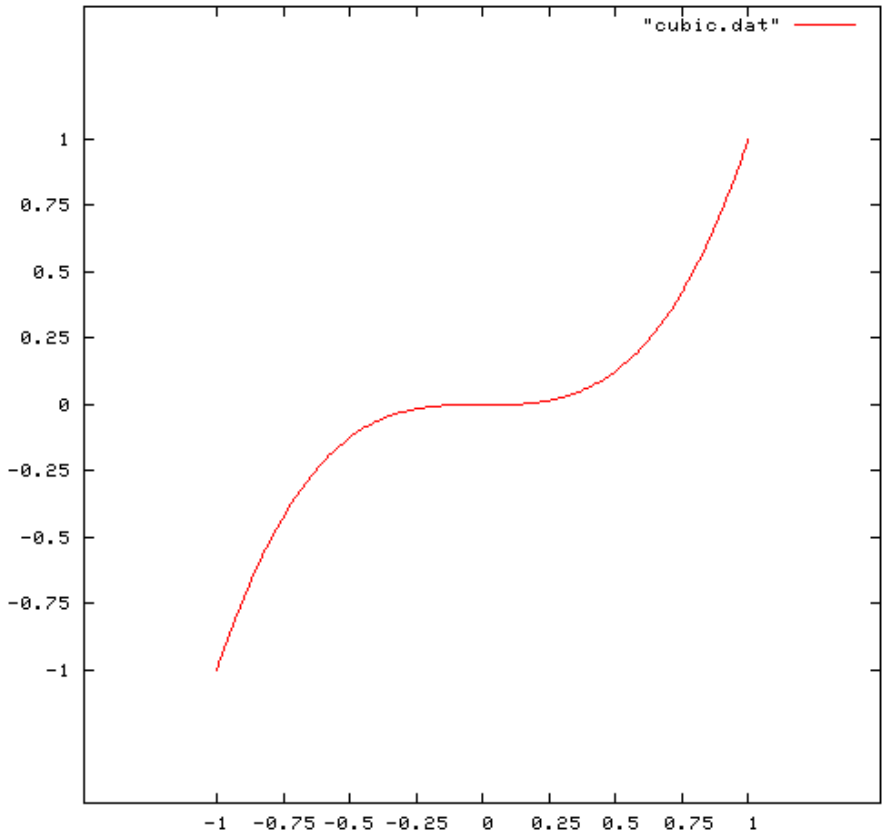
set xtics -1.0,0.25,1.0

set ytics -1.0,0.25,1.0

plot "cubic.dat"



Problems with the graph



Problem:

- No sub-ticks

Want to have:

- Sub-ticks every 0.05
- 5 sub-ticks to the tick

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Gnuplot commands

“Minor ticks”

- Number of minor ticks for each major tick

```
set mxtics 5
set mytics 5
```

Next version of graph

…

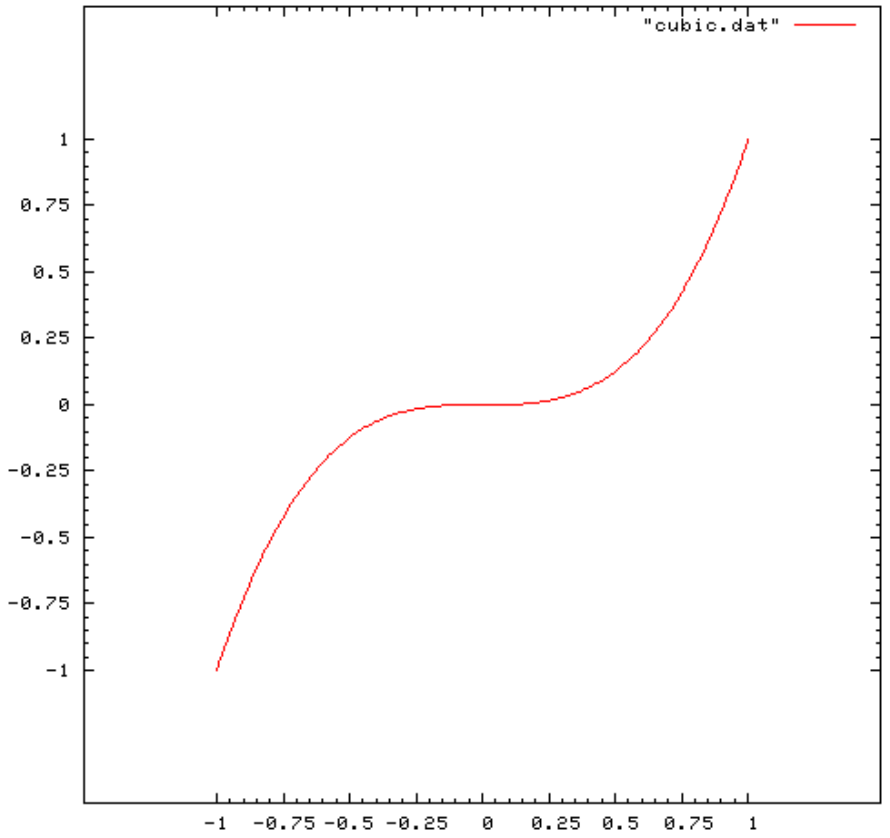
set xtics -1.0,0.25,1.0

set ytics -1.0,0.25,1.0

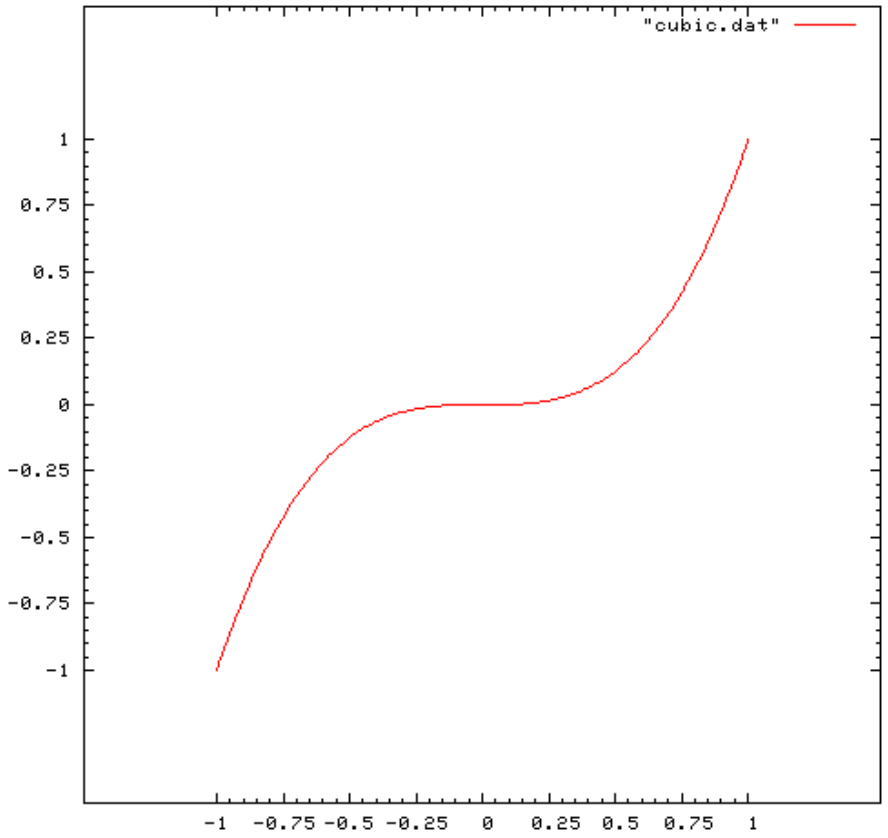
set mxtics 5

set mytics 5

plot "cubic.dat"



Problems with the graph



Problem:

- No axes

Want to have:

- Proper axes
- Running through (0,0)

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Gnuplot commands

Axes through the origin:

- A “zero axis”
- Defaults to being in grey
- Will consider colours later

set zeroaxis

or

set xzeroaxis

set yzeroaxis

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Next version of graph

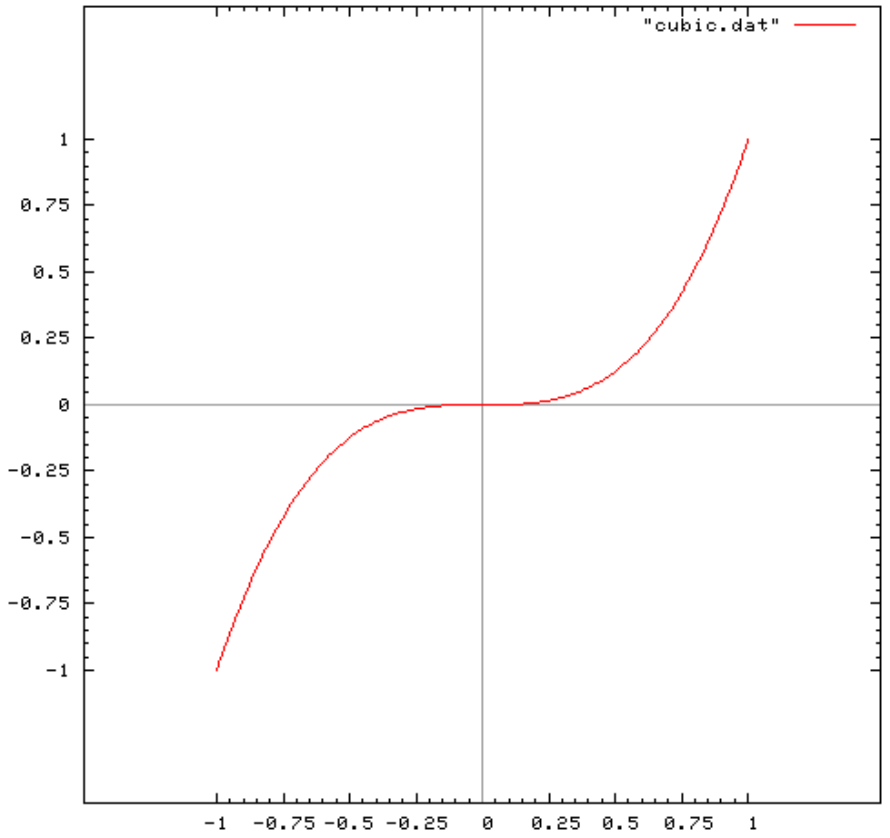
…

set mxtics 5

set mytics 5

set zeroaxis

plot "cubic.dat"



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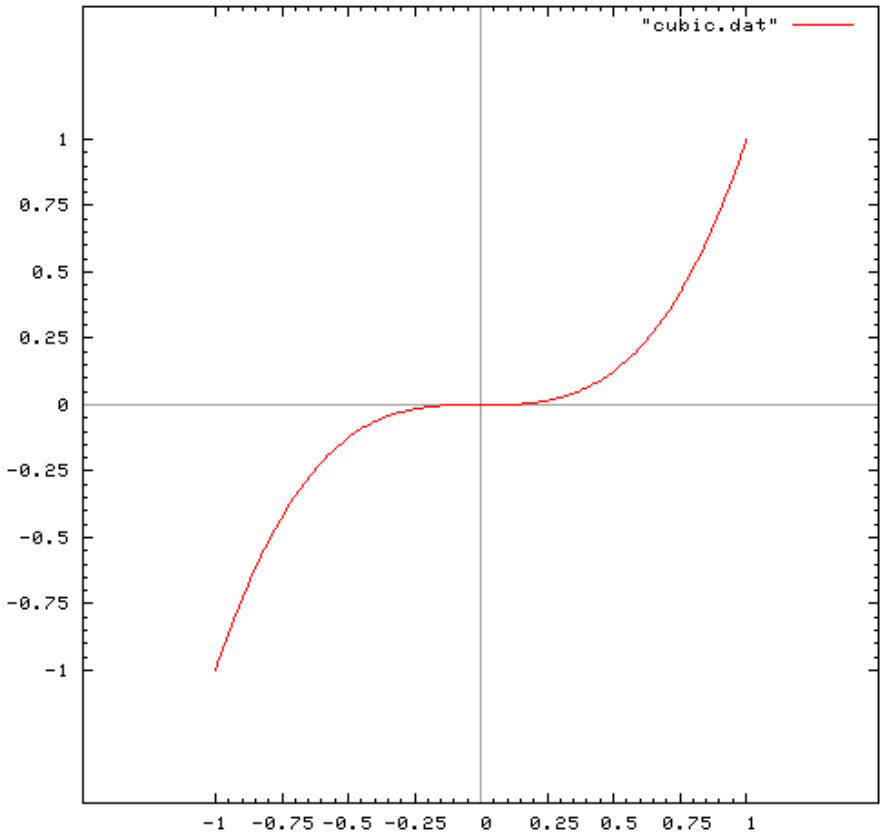
Problems with the graph



Problem:

- Key in top right
- Key uses file name

Want to have:

- Key in top left
- Manually specified key

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Gnuplot commands

Location of key:

- Only the corners are available

```
set key top left
set key bottom right
unset key
```

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Gnuplot commands

Text for key:

- Option on plot
- “Title” of the data
  not the whole graph

```
plot "cubic.dat" title "cubes"

plot "cubic.dat" notitle
```

Next version of graph

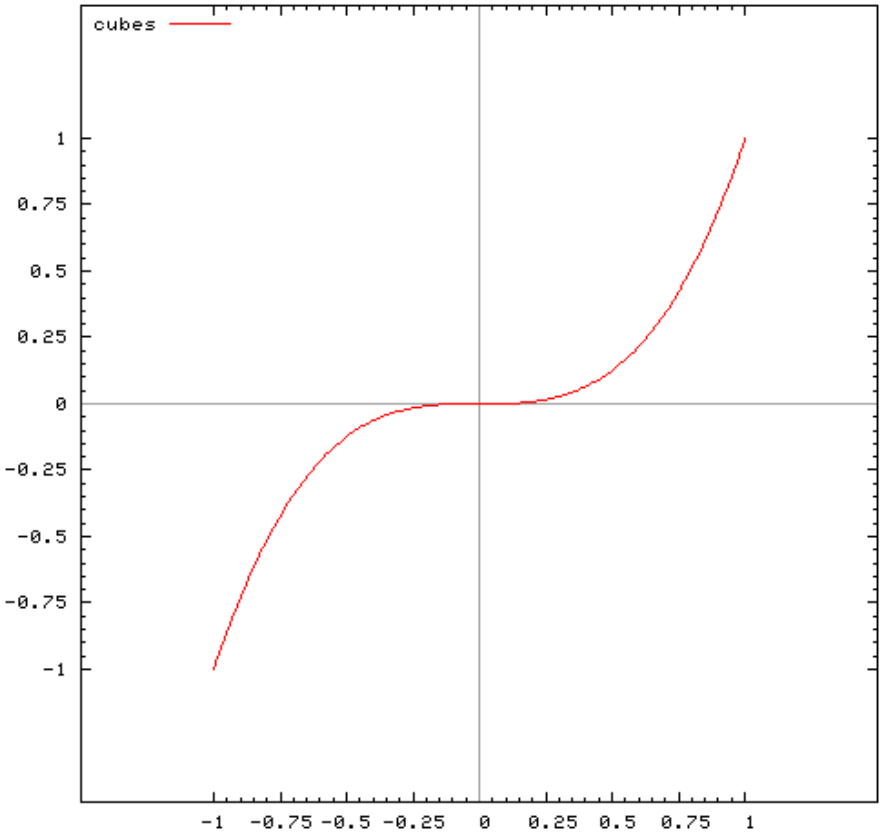
…

set xzeroaxis

set yzeroaxis

set key top left

plot "cubic.dat" **title "cubes"**



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Half time exercise

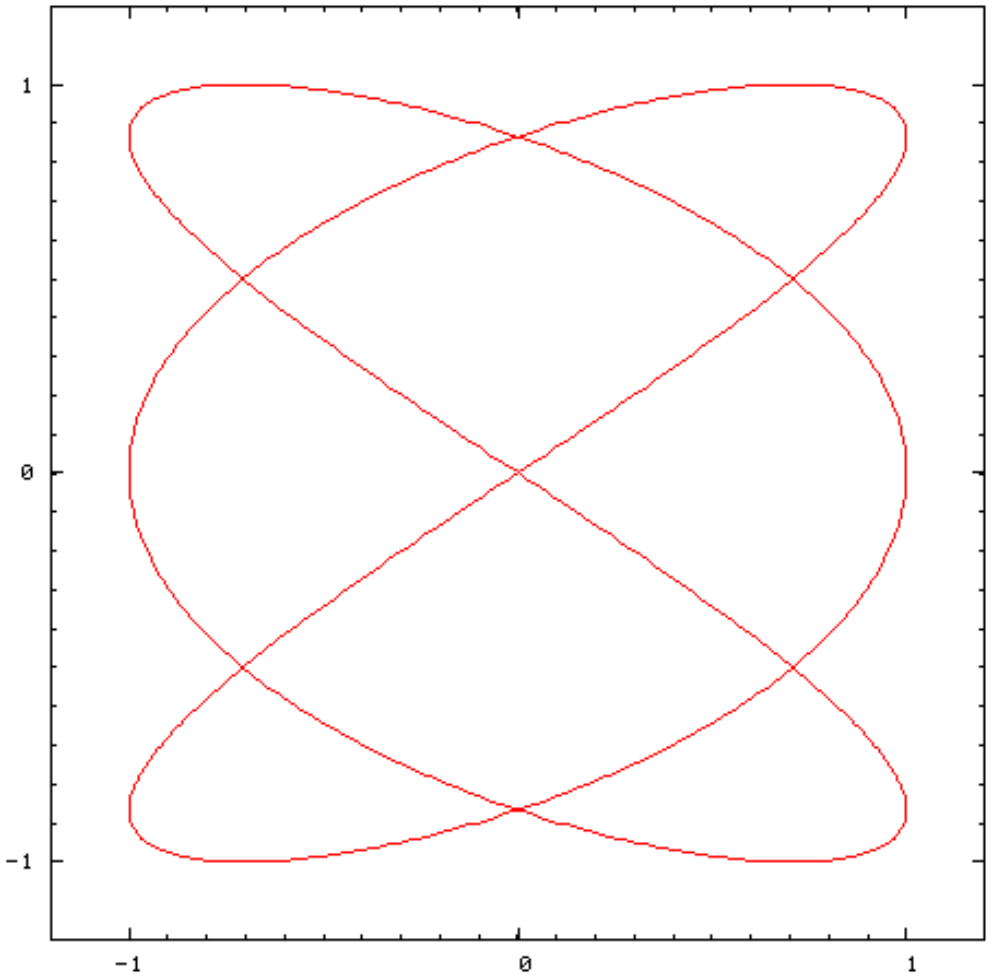
- Fifteen minutes
- Create the graph
- Then have a break

lissajou1.dat +

lissajou1.gplt

↓

lissajou1.png



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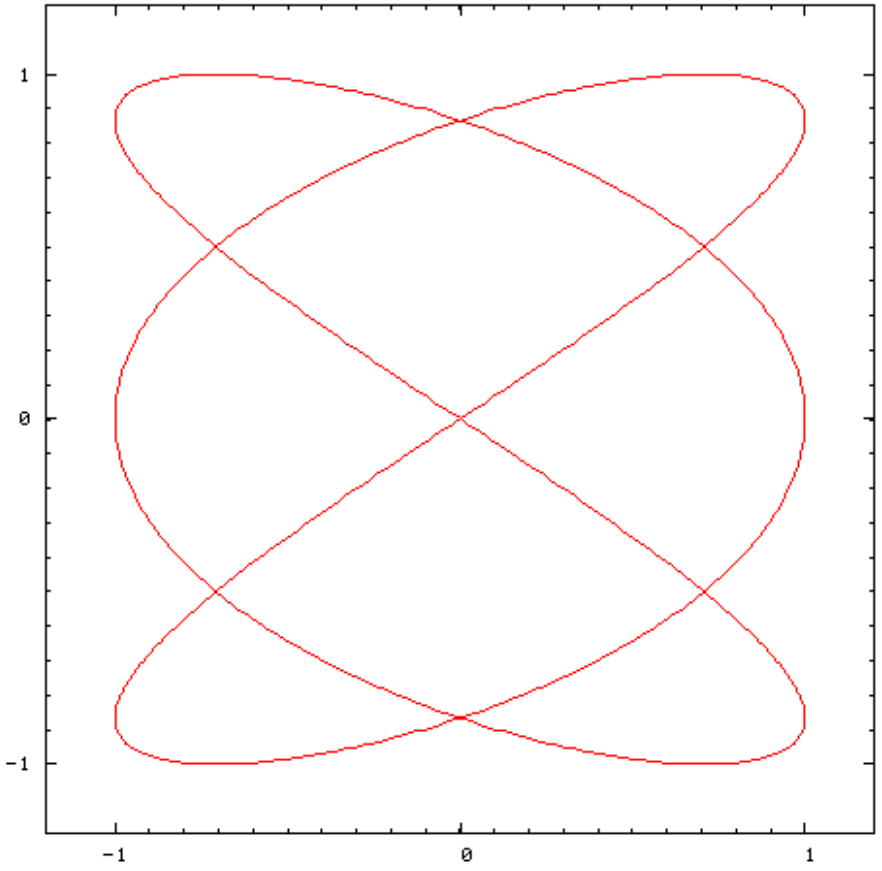
Welcome back



- lissajou1.gplt
- Any questions?

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Second half

- Introduction
- Part one
- Break
- Part two
- Questions

- Multiple graphs
- Colours
- Labels
- Titles

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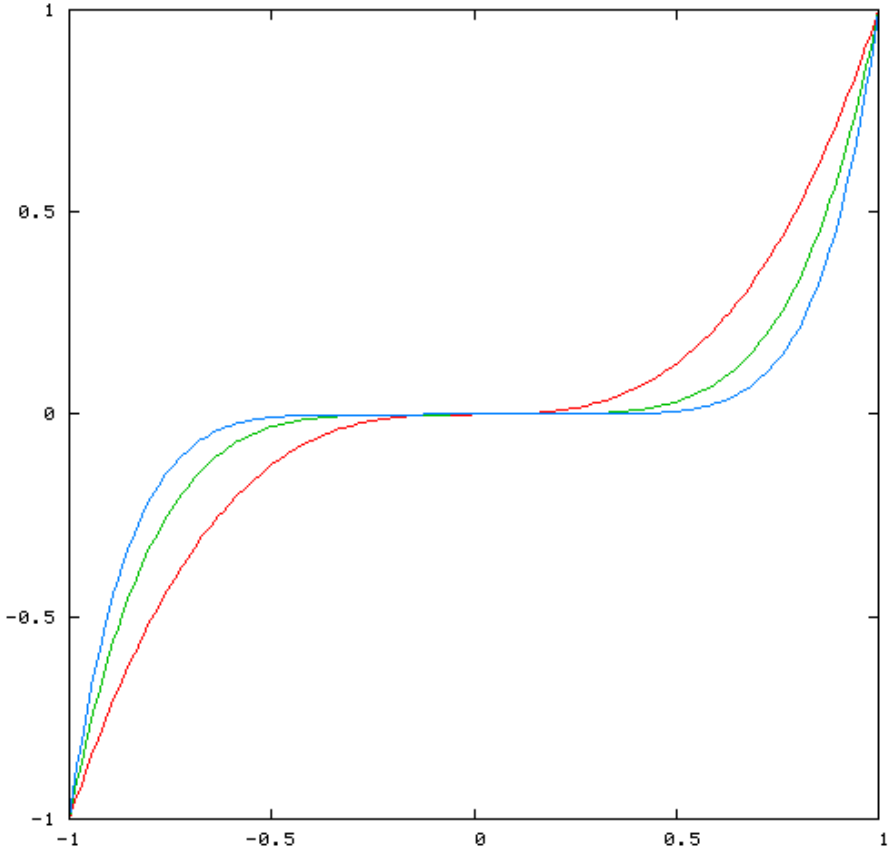
Compound graph



- Single graph
- Several lines

- Single input file
  - Several columns
- Multiple input files
  - Two columns each

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Data file

```
# x, x^3, x^5, x^7
-1.000000   -1.000000   -1.000000   -1.000000
-0.990000   -0.970299   -0.950990   -0.932065
...
0.990000    0.970299    0.950990    0.932065
1.000000    1.000000    1.000000    1.000000
```

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Properties of the data file

```
# x, x^3, x^5, x^7
-1.000000   -1.000000   -1.000000   -1.000000
-0.990000   -0.970299   -0.950990   -0.932065
...
```

- "#" introduces a comment line
- Ignored by Gnuplot
- Columns separated by whitespace

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Gnuplot commands

- Extend the plot command
- Specify the columns to use
- Specify the data files to use
- Comma between curve definitions
- Continue lines with a backslash

```
plot  "powers.dat" using 1:2, \
      "powers.dat" using 1:3, \
      "powers.dat" using 1:4
```

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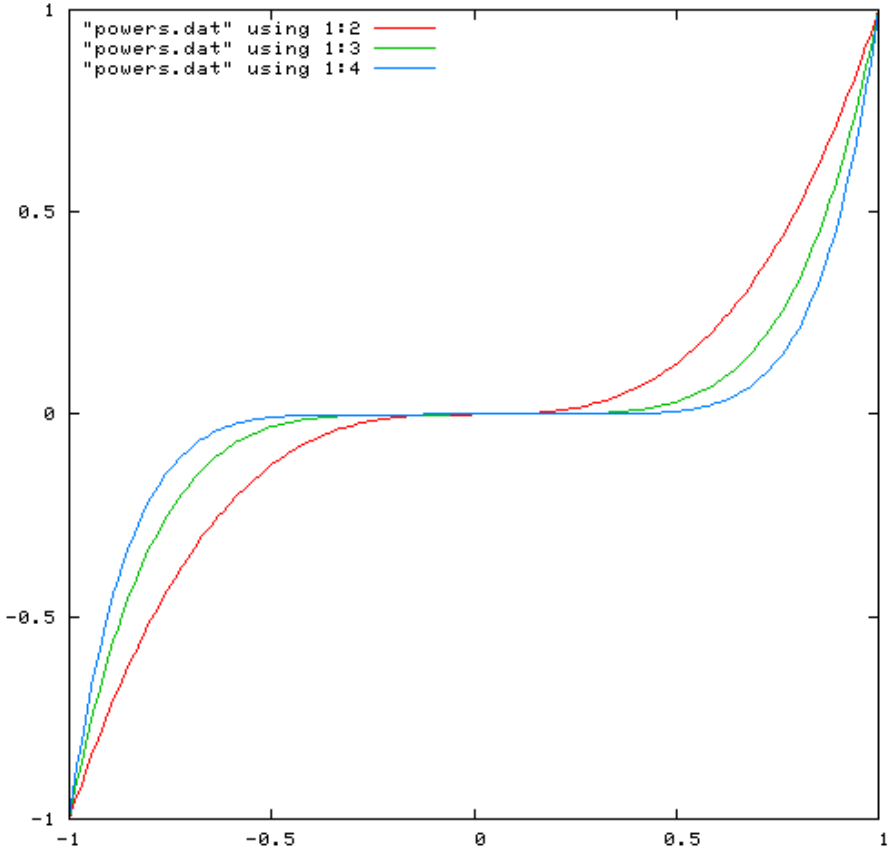
Problems with the graph



Problem:

- Key is very ugly

Want to have:

- Our line names

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Gnuplot commands

- Same extension of the plot command
- Once per curve in the graph

```
plot  "powers.dat" using 1:2 title "x^3", \
      "powers.dat" using 1:3 title "x^5", \
      "powers.dat" using 1:4 title "x^7"
```

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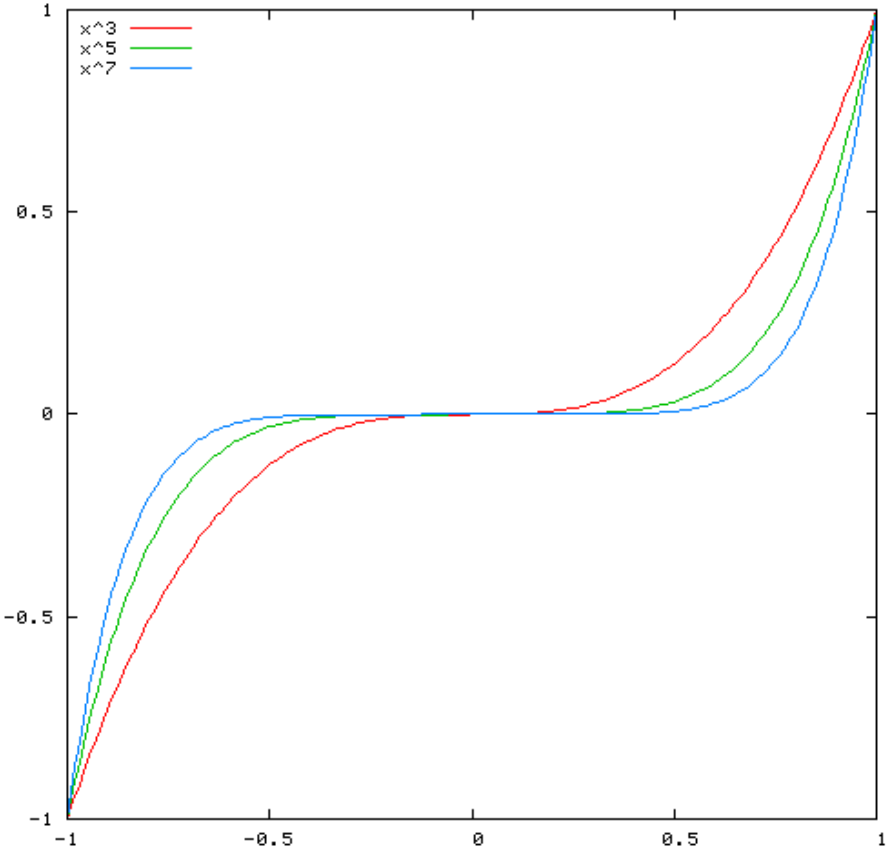
Next version of graph

```
plot  \
"powers.dat" using 1:2 \
title "x^3", \
"powers.dat" using 1:3 \
title "x^5", \
"powers.dat" using 1:4 \
title "x^7"
```



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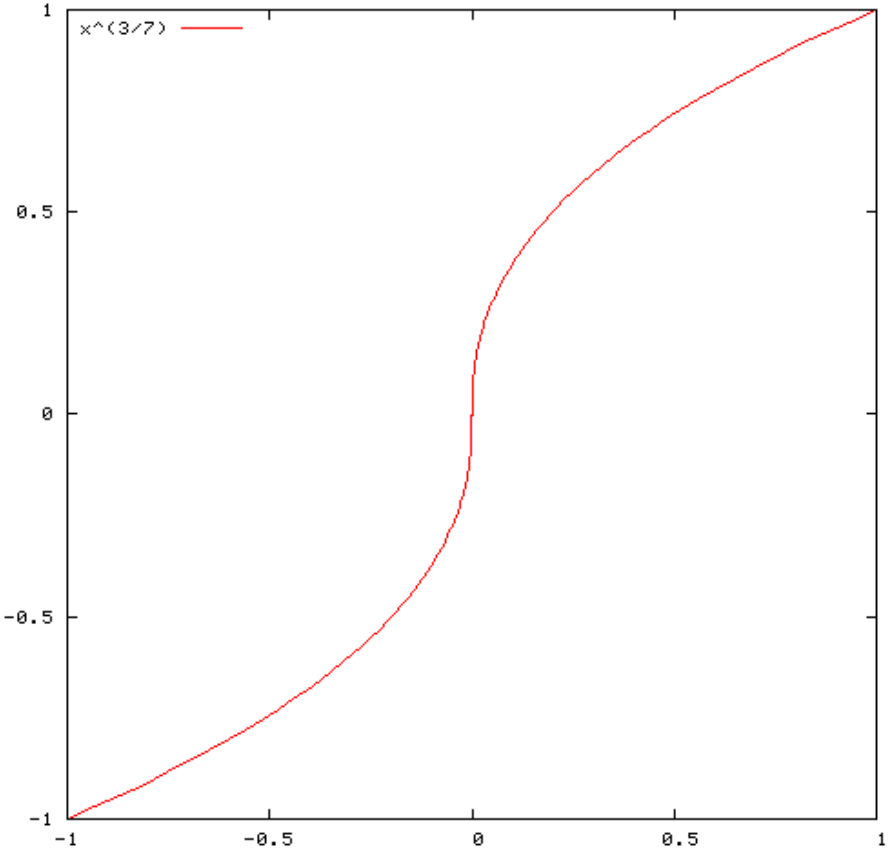
Don't have to use column 1

```
plot "powers.dat" \
using 4:2 \
title "x^(3/7)"
```



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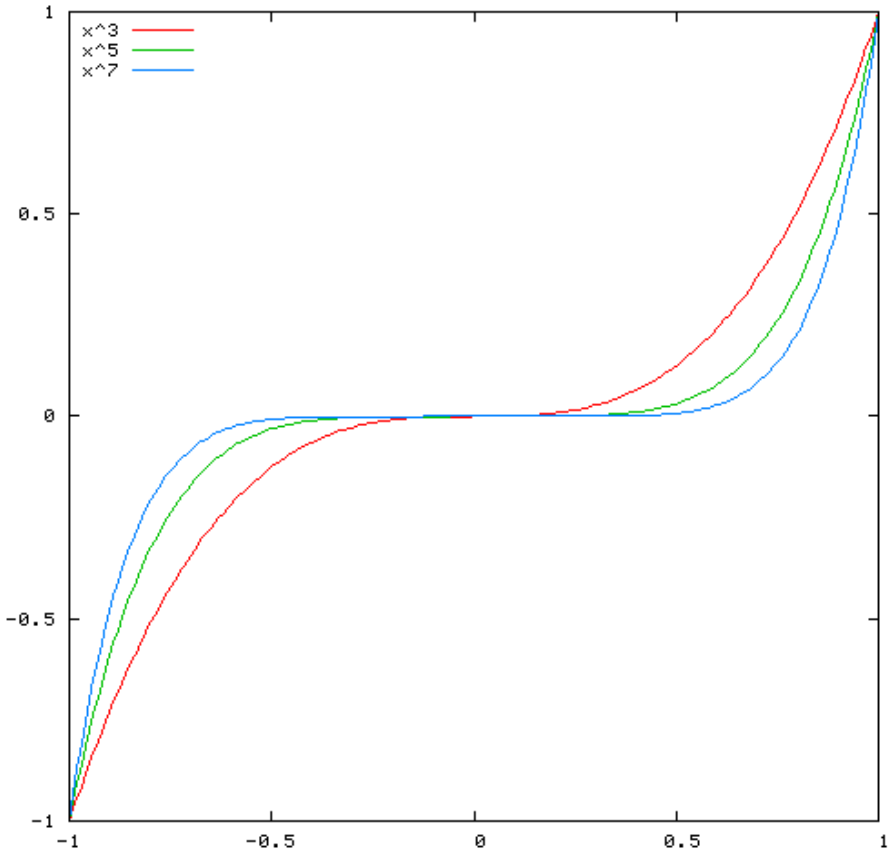
Problems with graph



Problems with graph:

- Curve colours
- Red, Green, Blue

Want to have:

- Our curve colours
- Red, Purple, Blue

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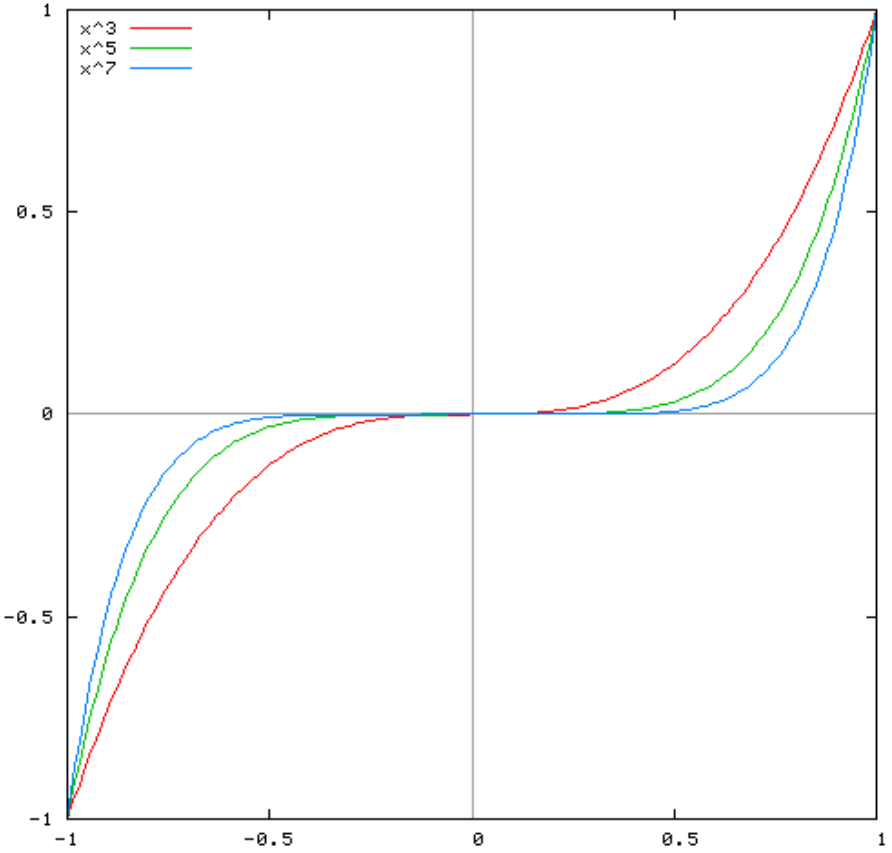
Colours we have seen so far

- Background (white)
- Borders (black)
- Axes (grey)
- Curve one (red)
- Curve two (green)
- Curve three (blue)



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How Gnuplot uses colours

- Numbered colours for particular purposes
- Maximum of 256 colours

Purpose	**Number**	**Default colour**
Background	0	White
Borders	1	Black
Axes	2	Grey
First curve	3	Red
Second curve	4	Green

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Gnuplot commands

- Extension to set terminal
- List colours at end of command
- Hexadecimal specification: xrrggbb

```
set terminal png picsize 512 512 \
xffffff x000000 x404040 \
xff0000 x800080 x0000ff
```

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A few colours

	green	x00ff00		black	x000000
	turquoise	x00ffff			x404040
	blue	x0000ff		grey	x808080
	magenta	xff00ff			xc0c0c0
	red	xff0000		white	xffffff

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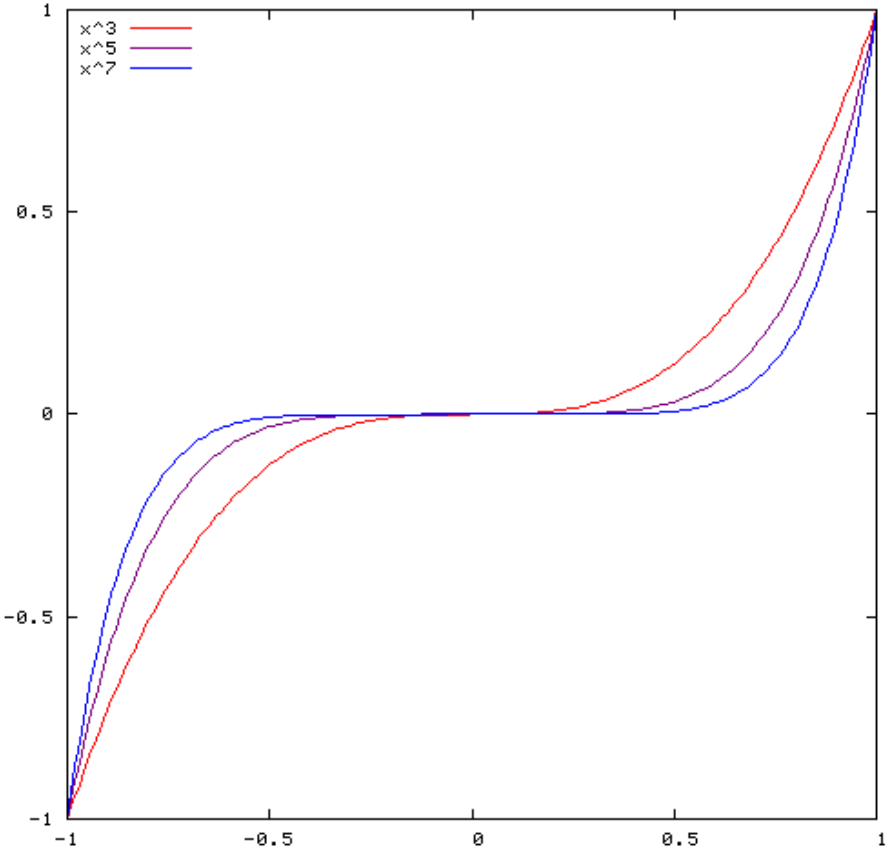
Next version of graph

```
set terminal png \
picsize 512 512 \
xffffff x000000 x404040 \
xff0000 xff00ff x0000ff
...
```



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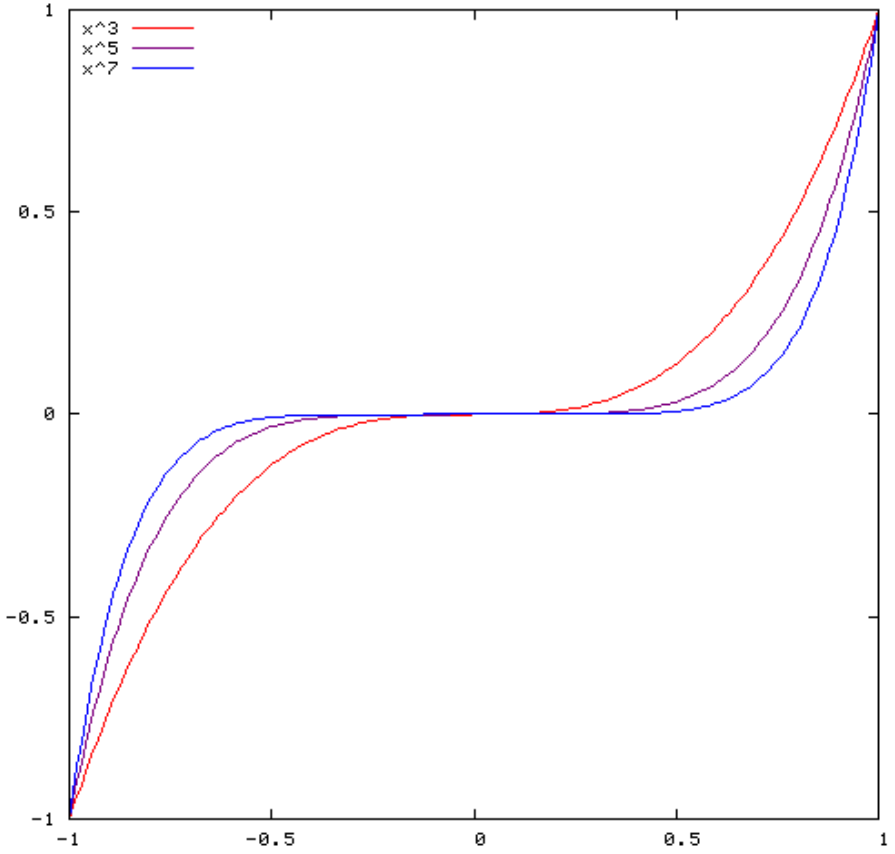
Problems with graph



Problems with graph:

- No axis labels
- No main title

Want to have:

- Axis labels
- Main title

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Gnuplot commands

Setting main title:

set title "Powers"

- Do not confuse with
  plot … title "x^3"

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Gnuplot commands

Setting axis labels:

```
set xlabel "x"
set ylabel "power of x"
```

Next version of graph

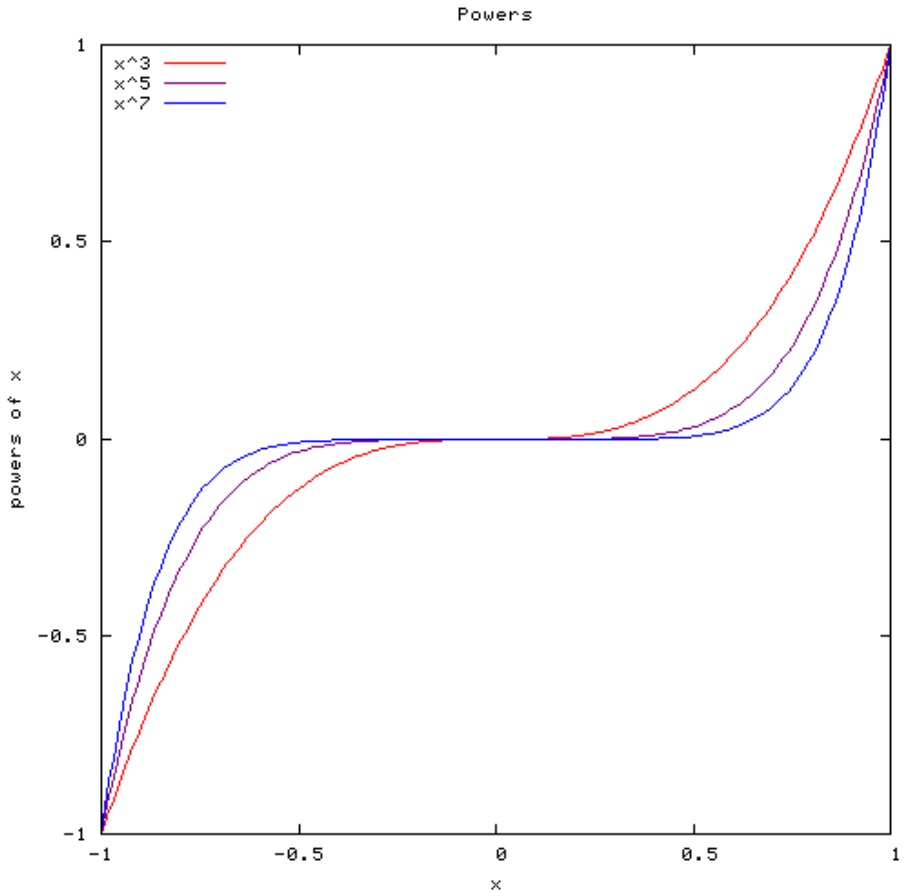
…

set title "Powers"

set xlabel "x"

set ylabel "powers of x"

plot "powers.dat"…



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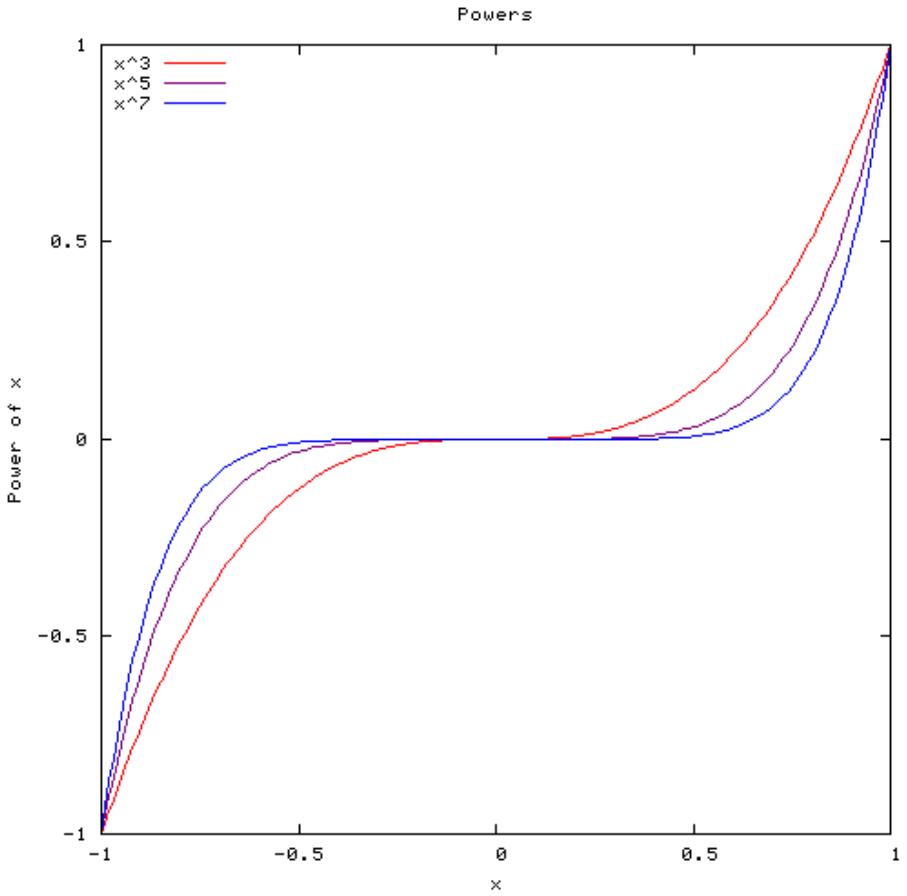
Problems with graph



Problems with graph:

- Surround border

Want to have:

- Left border
- Bottom border

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Gnuplot commands

Border edges:

set border *N*

N = 1+2+4+8

1	bottom
2	left
4	top
8	right

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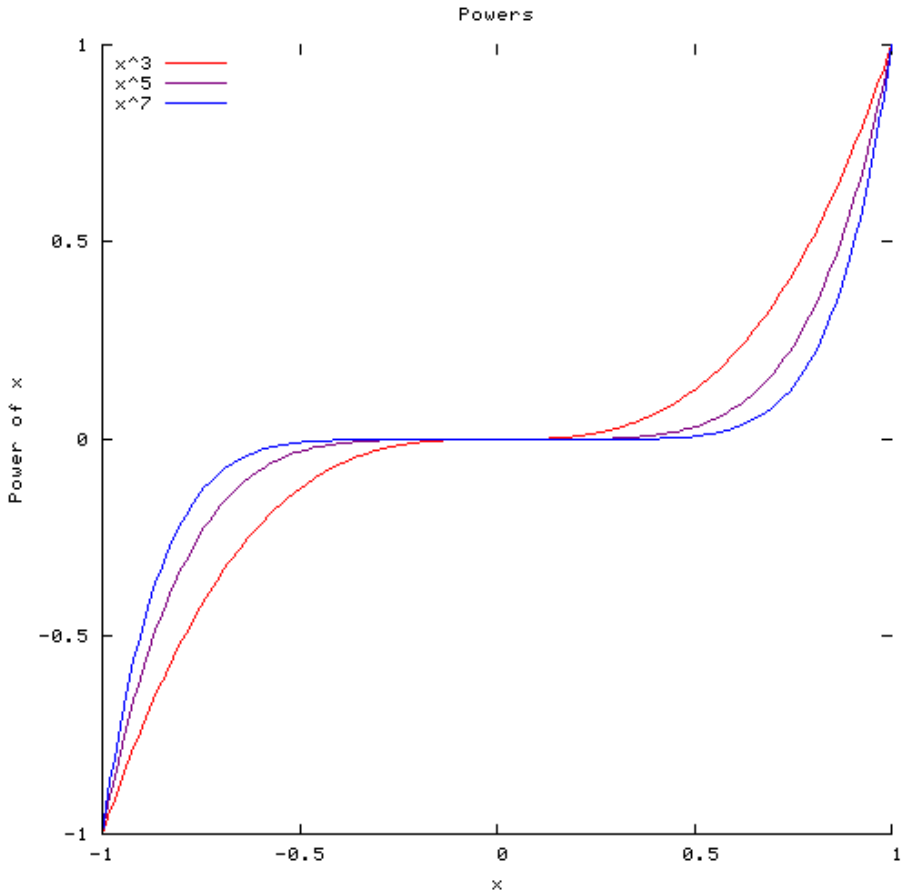
Setting border not enough

set border 3

- Set border correctly
- Free-floating ticks!



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Gnuplot commands

Ticks:

Independent of borders!

```
set xtics  nomirror
set xtics  1.0  nomirror
set xtics  -1.0,0.5,1.0  nomirror
```

Final version of graph

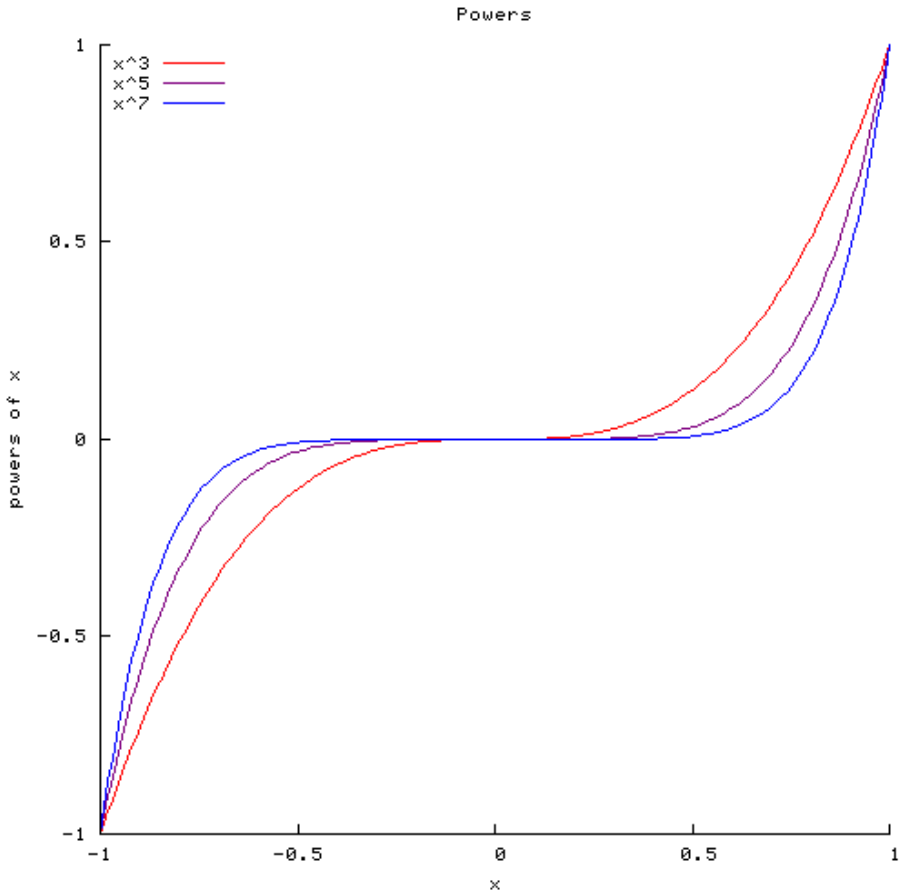
…

set border 3

set xtics nomirror

set ytics nomirror

plot "powers.dat"…



UCS

Recap: How to do a graph

1. Define the terminal

```
set terminal png \
picsize 512 512 …
```

- Output format
- Image size
- Colour list

UCS

Recap: How to do a graph

1. Define the terminal — set output "…"
2. Output file
   - File name in quotes
   - Suffix matches format

UCS

Recap: How to do a graph

1. Define the terminal — set size ratio …
2. Output file
3. Aspect ratio
   - +ve: Whole graph
   - -ve: Scale of units

UCS

Recap: How to do a graph

1. Define the terminal
2. Output file
3. Aspect ratio
4. Points or lines

set style data lines

set style data points

set style data dots

- Points are the default

UCS

Recap: How to do a graph

1. Define the terminal
2. Output file
3. Aspect ratio
4. Points or lines
5. Place the key

set key top left

unset key

- Default: top right

Recap: How to do a graph

1. Define the terminal
2. Output file
3. Aspect ratio
4. Points or lines
5. Place the key
6. Graph title

set title "…"

- Title in quotes

Recap: How to do a graph

2. Output file
3. Aspect ratio
4. Points or lines
5. Place the key
6. Graph title
7. Axis labels

set xlabel "…"

set ylabel "…"

- Text in quotes

Recap: How to do a graph

3. Aspect ratio — set border 3
4. Points or lines
5. Place the key — • 1+2+4+8
6. Graph title
7. Axis labels
8. Set border

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Recap: How to do a graph

4. Points or lines
5. Place the key
6. Graph title
7. Axis labels
8. Set border
9. Set data range

```
set xrange [-1.5:1.5]
set yrange [-1.5:1.5]
```

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Recap: How to do a graph

5. Place the key — set xtics -1.0,0.5,1.0
6. Graph title — set ytics -1.0,0.5,1.0
7. Axis labels
8. Set border — set xtics 0.25 nomirror
9. Set data range — unset ytics
10. Set major ticks

Recap: How to do a graph

6. Graph title
7. Axis labels
8. Set border
9. Set data range
10. Set major ticks
11. Set minor ticks

set mxtics 5

set mytics 5

set mxtics 5 nomirror

unset mytics

- Minor ticks per major

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Recap: How to do a graph

7. Axis labels
8. Set border
9. Set data range
10. Set major ticks
11. Set minor ticks
12. Plot data sets

plot "…"
  using x:y
  title "…"

- File names in quotes
- Column specifiers
- Title in key
- Commas
- Backslashes

UCS

How to do a graph

1. Define the terminal
2. Output file
3. Aspect ratio
4. Points or lines
5. Place the key
6. Graph title
7. Axis labels
8. Set border
9. Set data range
10. Set major ticks
11. Set minor ticks
12. Plot data sets

UCS

Final exercise

- Create graph
- Details in notes

lissajou2.dat +

lissajou2.gplt

↓

lissajou2.png