Software Tools for UNIX/Linux Systems

Part 9: Visualization and Documentation

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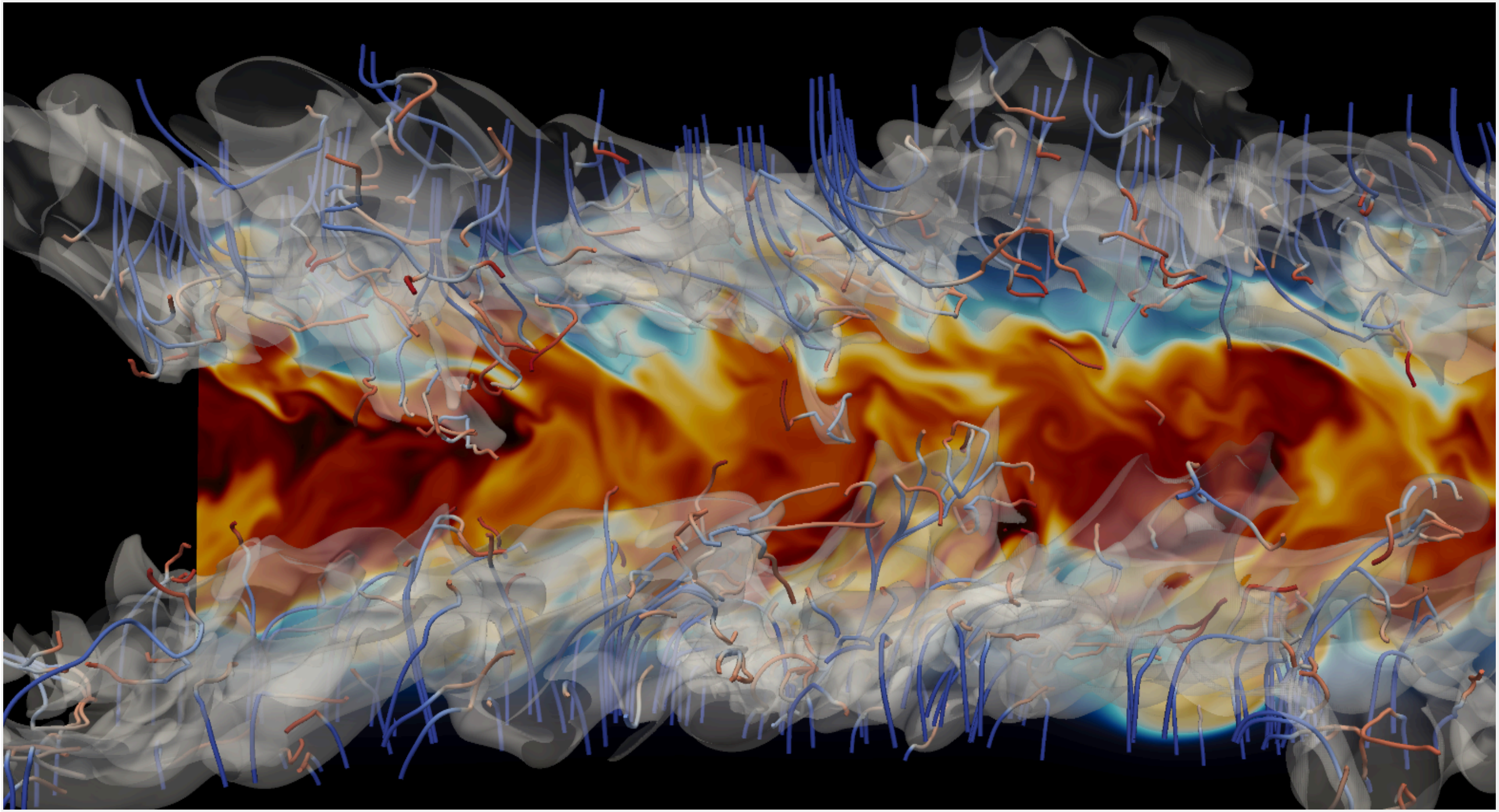
STFS



Visualization using gnuplot

Overview

1. Basics
    1. gnuplot
    2. Basic Commands
    3. Local – Global Definitions

2. Plotting Data from Files
    1. File Structure
    2. Plot Settings

3. Layout
    1. Axis, grid
    2. Multiplots
    3. Linestyles

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Basics

General Information about gnuplot

- Plotting program (gnu *not* from GNU-Licence)
- Probably widest used open source tool
  dates back to 1986
- able to plot functions and data 2D and 3D
- Interactive or using input Files

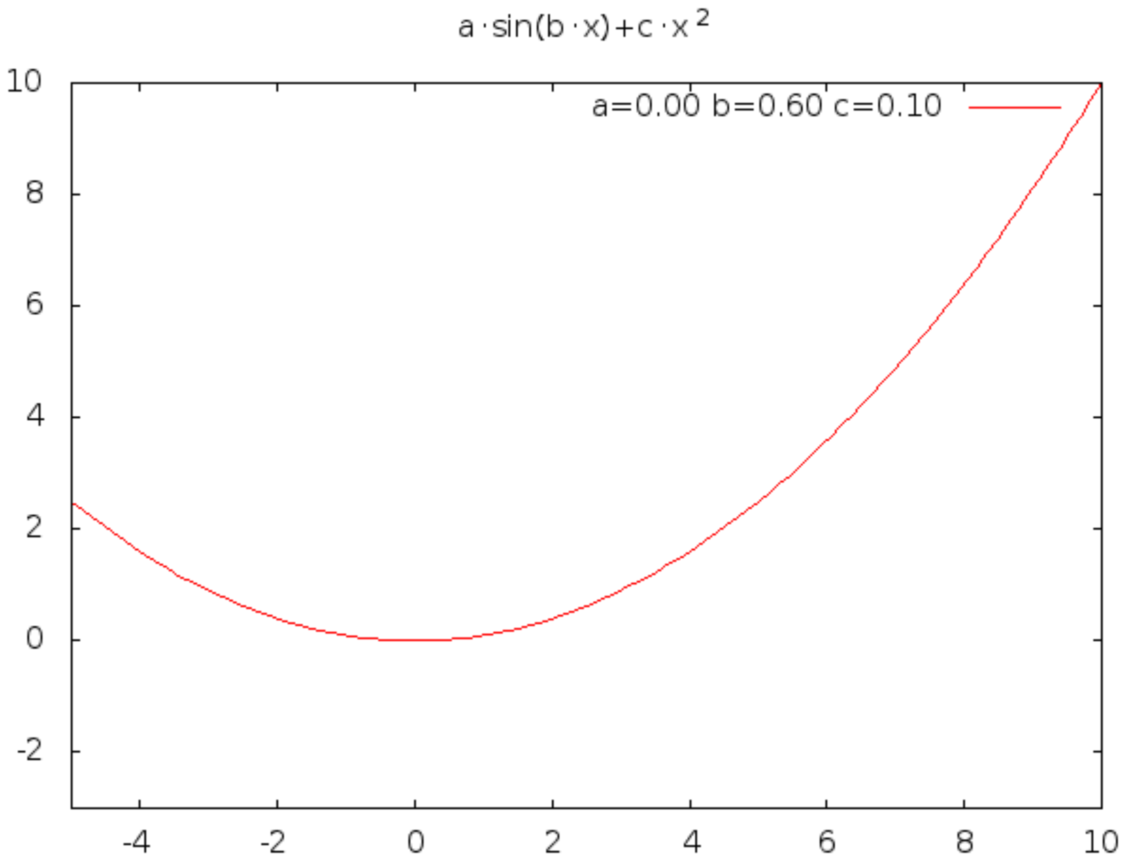
1.1 General Information about gnuplot

- Advantages:
  - Open Source (close to)
  - platform variable
  - robust to input data
  - allows handling/modification of input data

- Disadvantages:
  - 3D Data (→ better Paraview etc.)

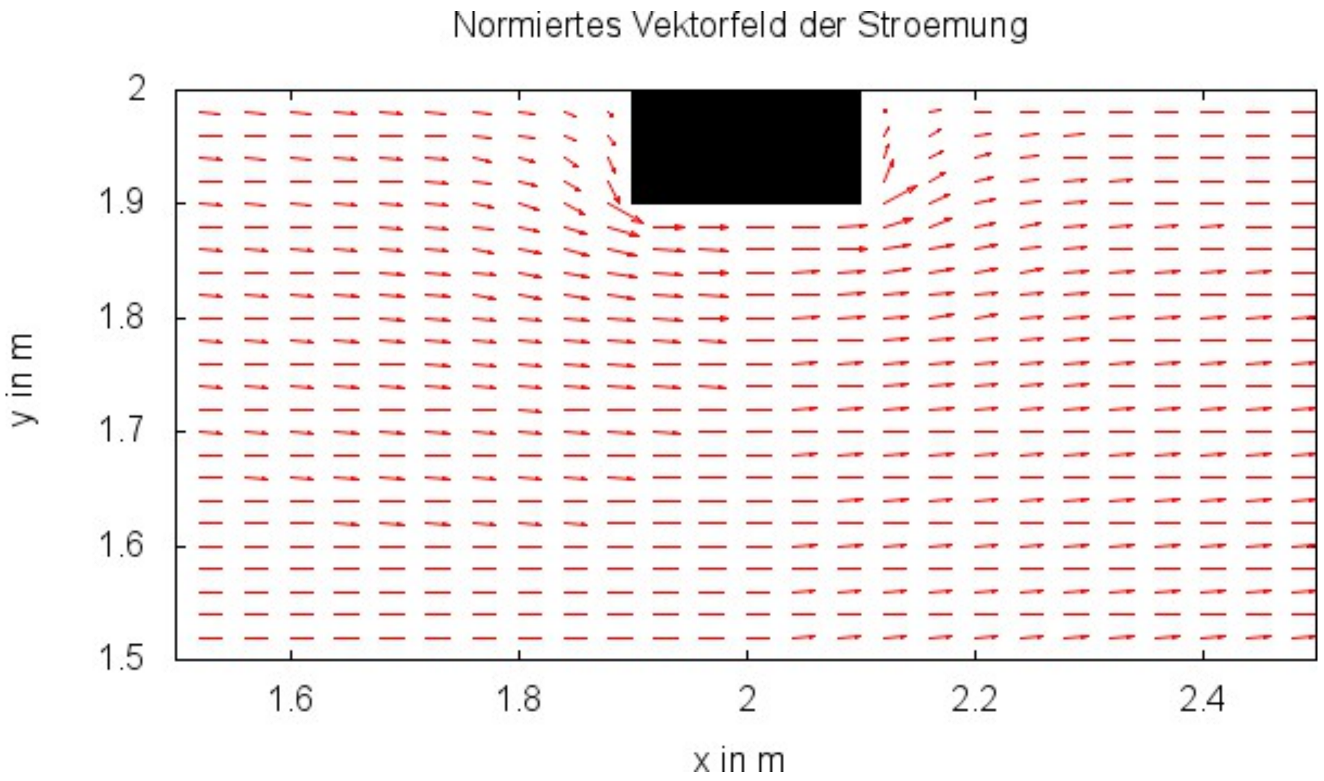
Examples:

- animated plots:



Examples:

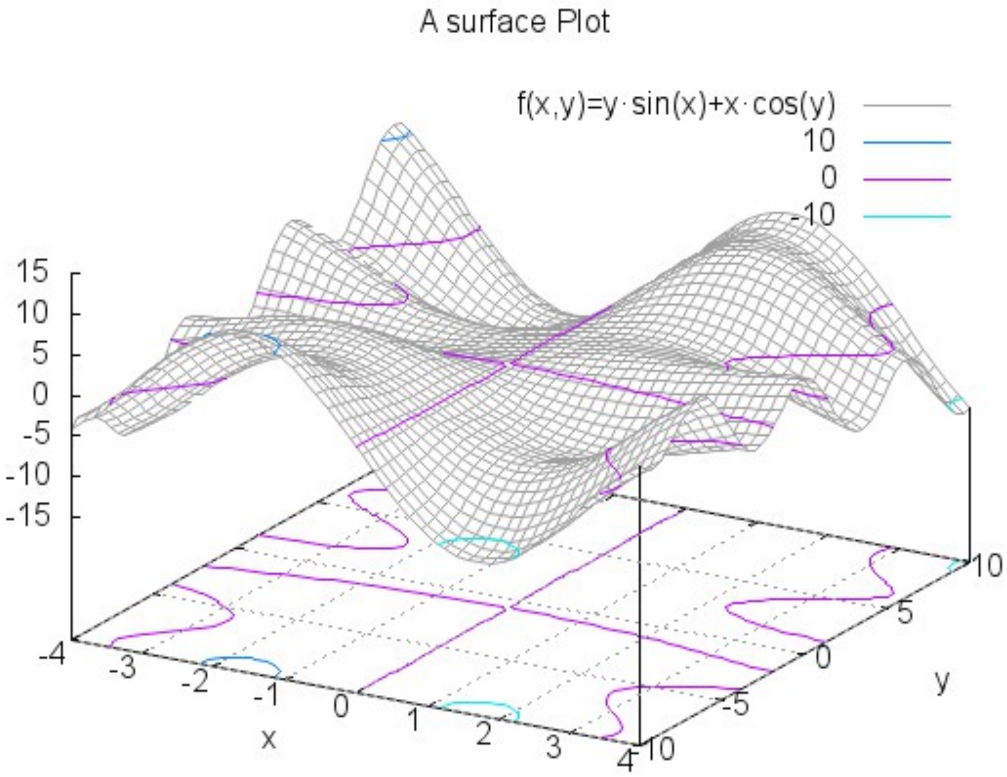
- animated plots
- vector plots



Introduction

Examples:

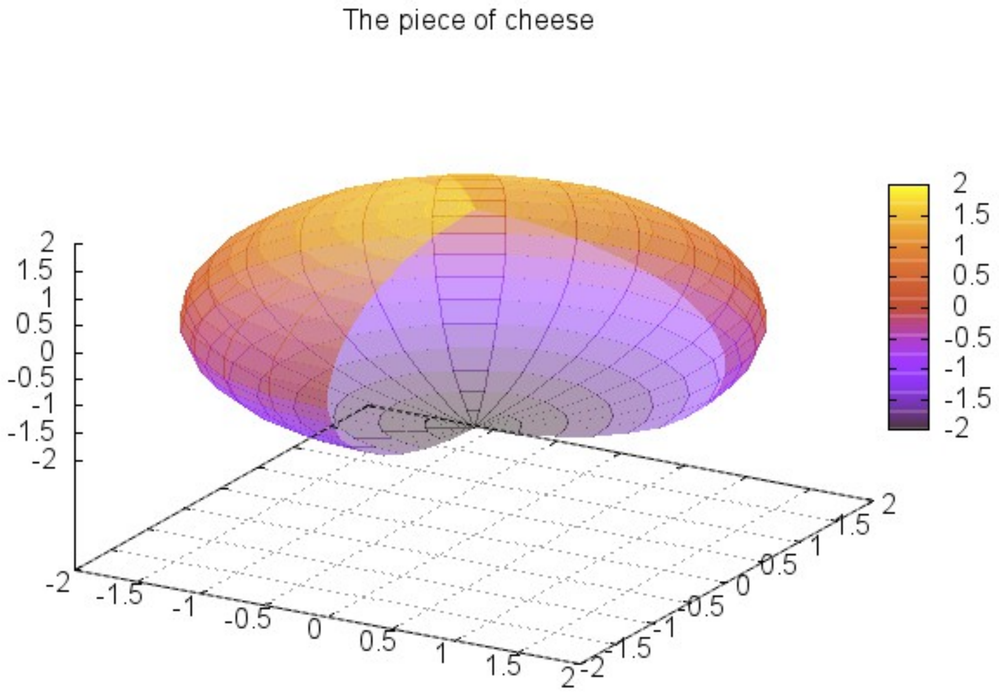
- animated plots
- vector plots
- surface plots



Introduction

Examples:

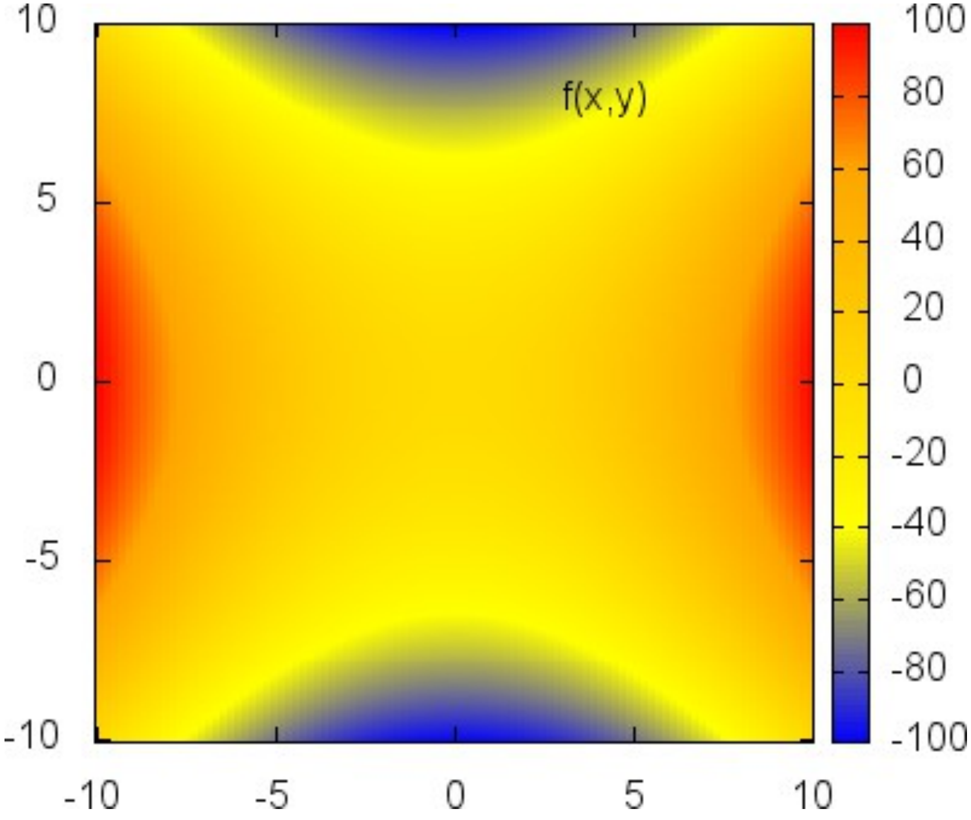
- animated plots
- vector plots
- surface plots
- parametric plots



The piece of cheese

Examples:

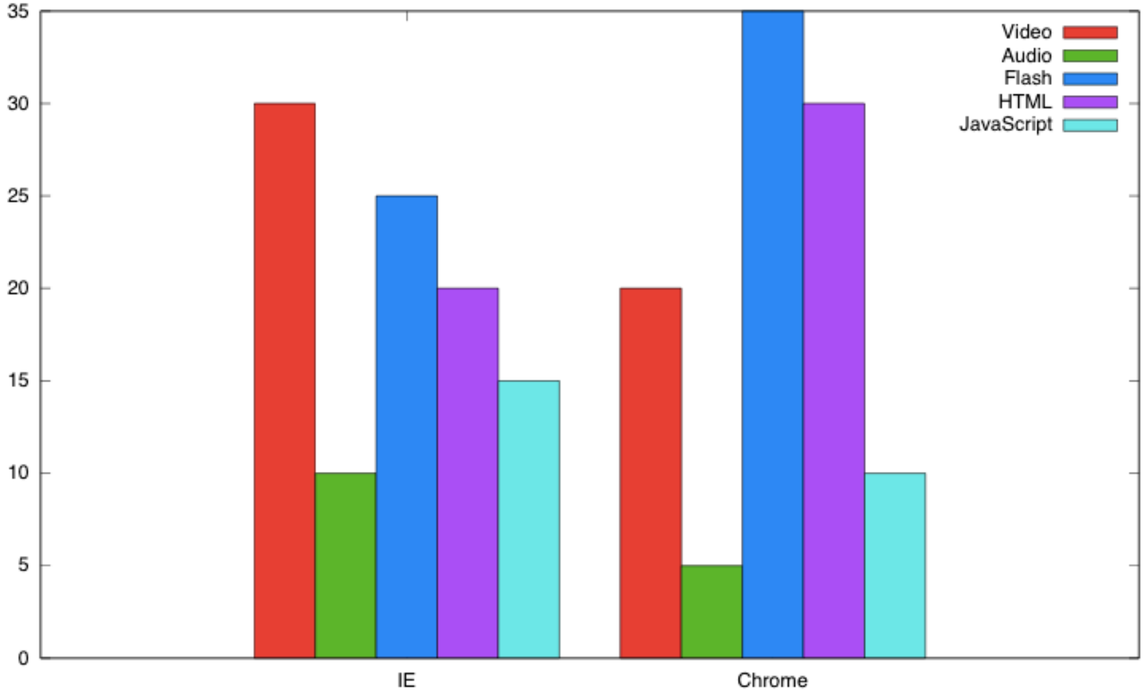
- animated plots
- vector plots
- surface plots
- parametric plots
- contour plots



Introduction

Examples:

- animated plots
- vector plots
- surface plots
- parametric plots
- contour plots
- bardiagrams
- …

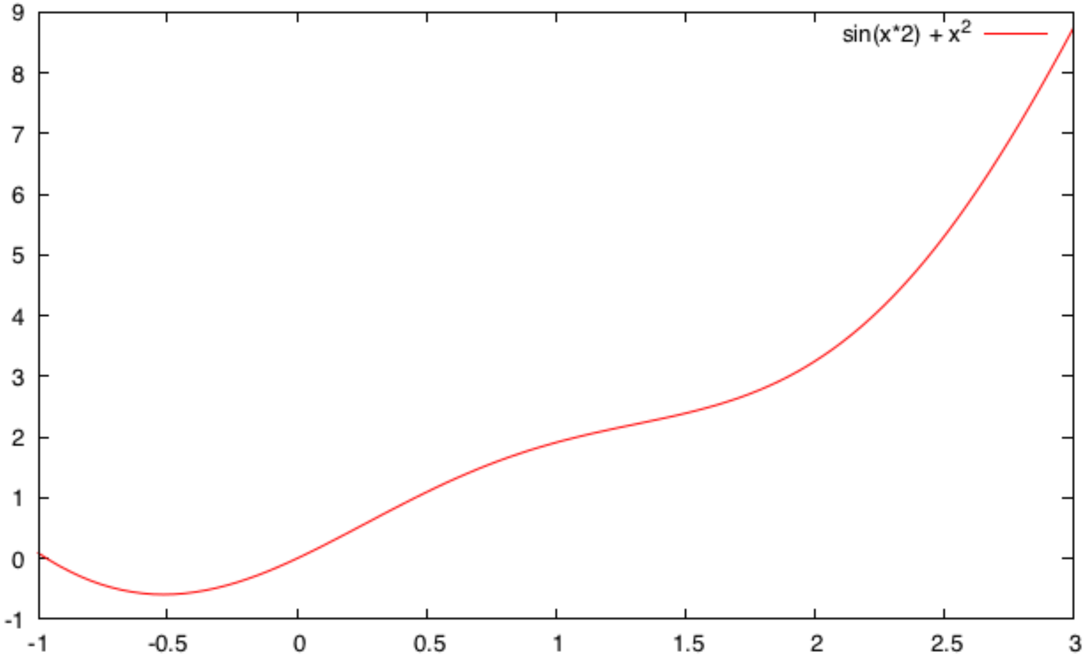


Basics

1.2 Basic Commands:

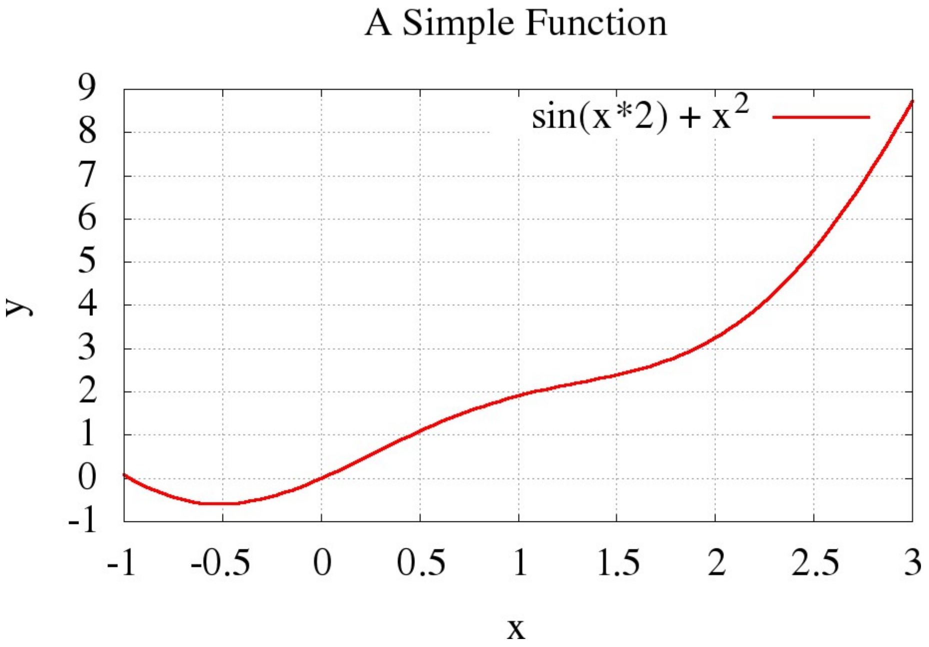
Example:

```
$> gnuplot
gnuplot> plot [-1:3][]  sin(2*x) + x**2 with lines title "sin(2*x) + x^2"
```



1.2 Basic Commands:

Example (pretty up):



1. reset
2. set title "A Simple Function"
3. set xlabel "x"
4. set ylabel "y"
5. set grid
6. plot [-1:3][] sin(2*x) + x**2 with lines lw 3 title "sin(x*2) + x^2"

Basics

Basic Commands:

- *set <object> <option/parameter/value>*
- define settings for an object
- set xlabel "x"

- unset *<object>*
- sets object to standard setting
- unset xlabel

- reset
- sets everything back to standard setting

Basics

Basic Commands:

- plot [*xrange*][*yrange*] {*fct / "File"*} axes {*x1y1*} title ""
- plots the function 2D

- replot
- repeat the previous plot command

- splot [*xrange*][*yrange*][*zrange*] {*fct / "File"*} title ""
- Surface plots (3D)

Basics

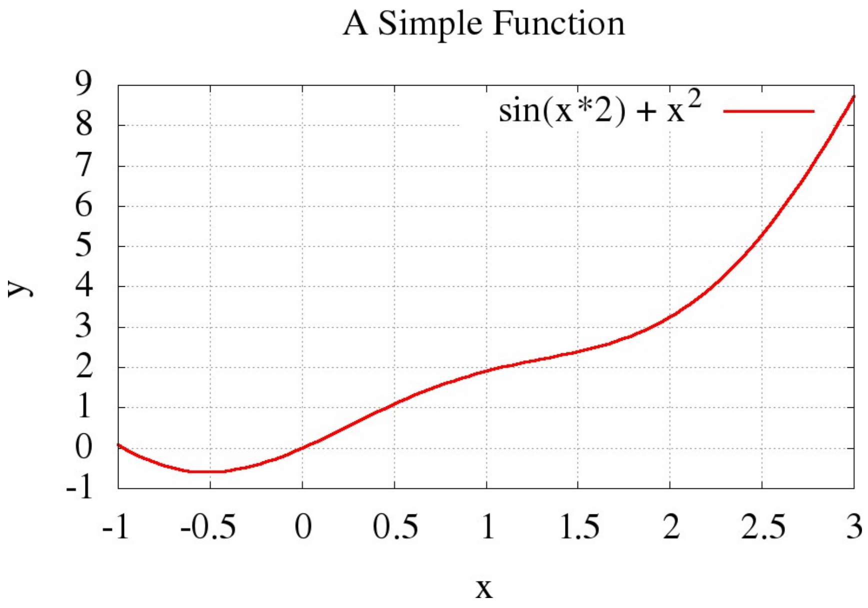
Example (recap):

```
reset
# make global definitions
set terminal jpeg enhanced
set output "1_Sin.jpeg"

set title "A Simple Function"
set xlabel "x"
set ylabel "y"

set grid

plot [-1:3][]  sin(2*x) + x**2 with lines lw 3 title
"sin(x*2) + x^2"
```



Basics

define the output:

- set terminal <*format*> <*options*>
- set output "filename"

selection of Output formats <format>

x11, wxt (Linux); windows (MS)	screen
postscript	*.ps, *.eps
latex, epslatex	*.tex , and *.eps
svg	Scalable Vector Graphics
jpeg, gif, png	raster graphics image

Basics

define the output:

- set terminal <*format*> <*options*>
- set output "filename"

selection of Output formats options <options>	
enhanced	improved scripts
crop	fill whole area, no outer space
size <*int pixel width*> <*int pixel hight*>	resolution (for jpeg, png, gif)
size <*int cm/inch*> <*int cm/inch*>	resolution (for vector graphics)
font "type" <*letter size*>	sets global font option, e.g. font "Times" 30
color	Color (otherwise black-white in many formats)

Basics

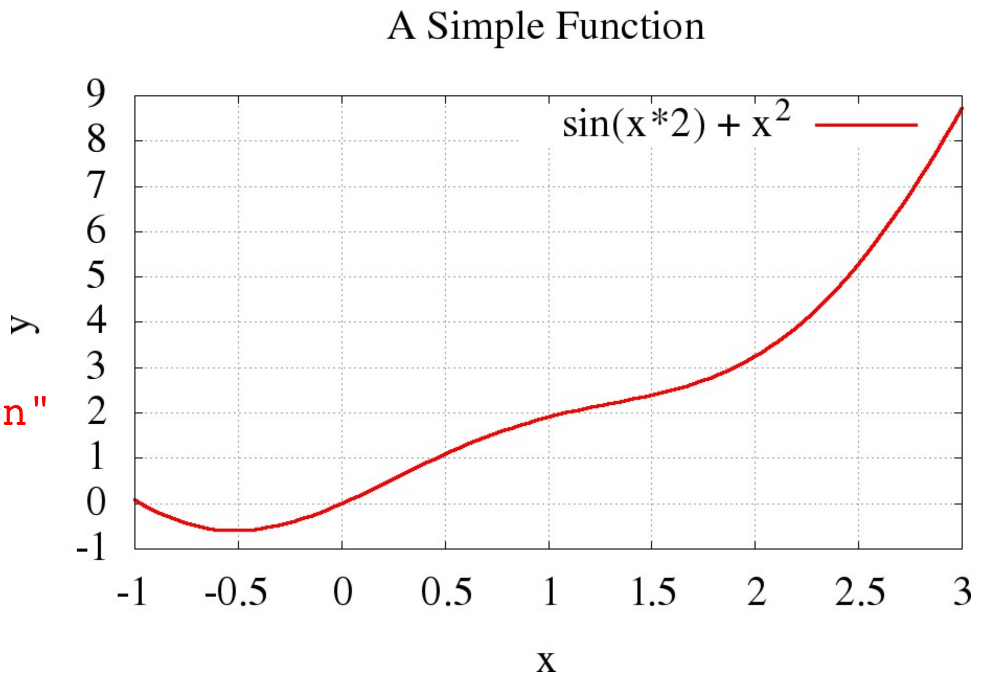
Example (recap):

```
reset
# make global definitions
set terminal jpeg enhanced
set output "1_Sin.jpeg"

set title "A Simple Function"
set xlabel "x"
set ylabel "y"

set grid

plot [-1:3][]  sin(2*x) + x**2 with lines lw 3 title
"sin({x}*{2}) + x^2"
```



Basics

A (small !) selection of layout definitions

1. set title “text” font “fontname” <*fontsize*> <*color*>

2. set _label “text” font “fontname*”* <*fontsize*> “color” rotate by <*int:degrees*>

3. set grid [no]_tics [no]m_tics linewidth <*float linewidth*>

Basics

Example (recap):

```
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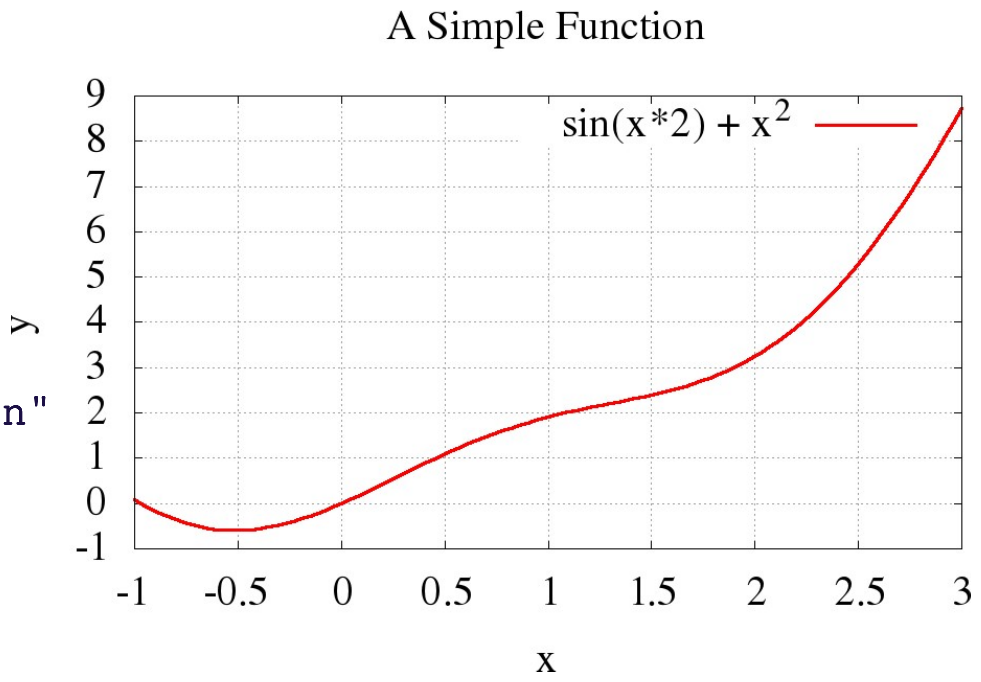


Basics

Basic Commands:

- # comment the string behind in the line
- selection of operators:

Operators (numbers)	
**	Exponentation (see Fortran, Python)
%	Modulo
<, <=, ==	less, less equal, equal

Operators	
!	Logical not
a ? b : c	Ternary (see C)
eq	Equality (strings)

Basics

Basic Commands:

- implemented Functions (selection):

Mathmatical Functions	
exp	exponential function
log, log10	logarithm (basis e, 10)
sin, cos, asinh	trigonometic functions
erf, erfc	error fct, complementary ~
abs	absolute value

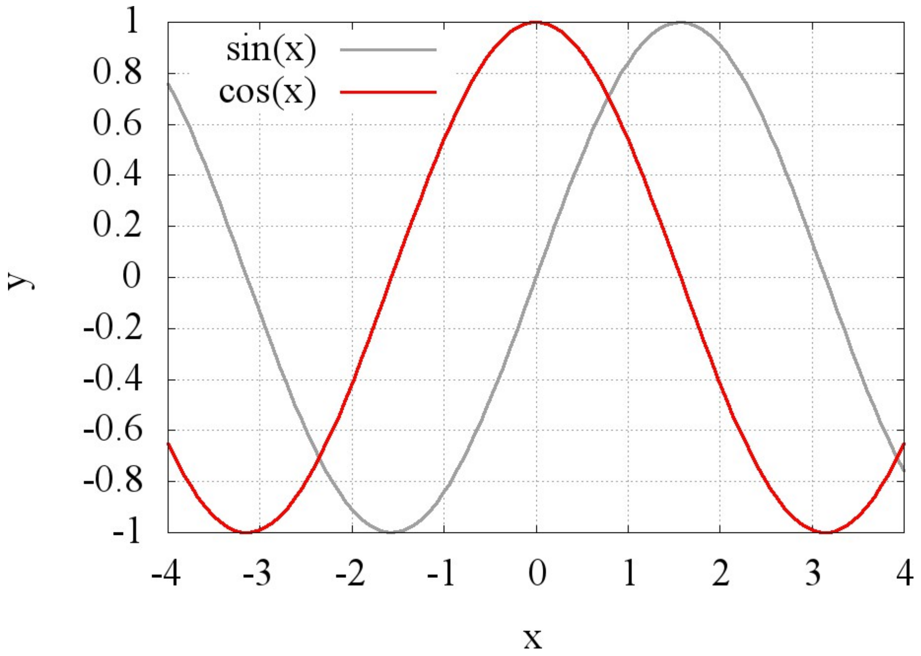
Program Functions	
sprintf	return formatted str, (see C)
system	executes input str in subshell

1.3 Local – Global Definitions:

Example global definitions:

```
set style line 1 linewidth 3 linecolor 0
set style line 2 lw 3        lc 1
f(x) = sin(x)
g(x) = cos(x)
title1 = "sin(x)"
title2 = "cos(x)"
set xrange[-4:4]

plot f(x) with lines linestyle 1 title title1, \
     g(x) w l        ls 2        t title2
```



Global Definitions:

- set <…> valid until:
  - reset
  - unset <…>
  - set <…> # re-definition

Local – Global Definitions:

Example local definitions:

```
plot [-4:4] sin(x) with lines linewidth 3 linecolor 0 title "sin(x)" ,\
            cos(x) w l        lw 3        lc 1        t  "cos(x)"
```

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Plotting Data from Files

2.1 Structure of data files:

- # Comments, not considered by gnuplot
  - set datafile commentschar “!”
- Files structured *columnwise*:
  - selectable by using col1:col2:…
  - space separated
    - set datafile separator “,”
  - index starting at 1

- *single* blank line:
  - discontinuity in data
  - line keeps style but not connected

Plotting Data from Files

- *double* blank line:
  - different sets of data
  - selectable by index
    - starts at 0,
      so index 2 selects the third set in a file
    - further possible parameters:
      index <*int start*> : <*int end*> : <*int step*>

- every allows to select lines interval (e.g. if data is mixed)

Plotting Data from Files

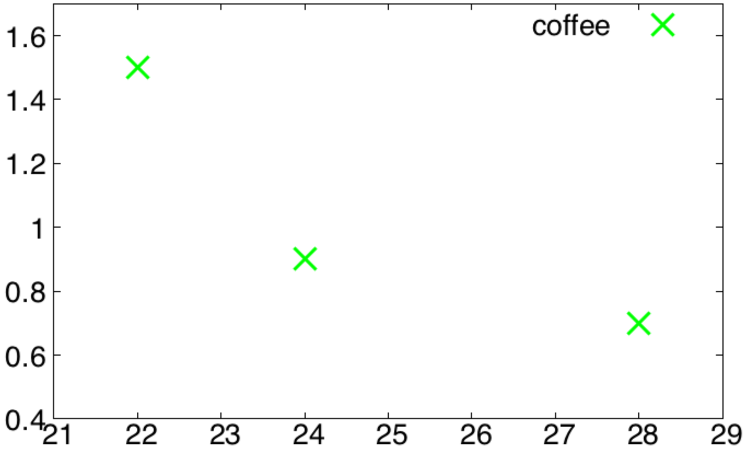
- using allows to access to columns, e.g. using 2:4
- calculate with columns in files:
  - () implies values, e.g. plots using 1:(2.1) a constant value of y=2.1 over x
  - using 1:(2*$3) plots the doubled value of column 3 over column 1
  - special columns indicies:
    - 0 is the line number in file
    - -2 the index

Plotting Data from Files

```
$> cat food.dat
12:22   22     19    #Number of Cookies
12:22   22     1.5   #liters of coffee
12:22   22     3.0   #liters of water


12:24   24     14    #Number of Cookies
12:24   24     0.9   #liters of coffee
12:24   24     2.8   #liters of water

…
$>gnuplot
gnuplot> plot “food.dat" index 0:4:1 every 4::1 u 2:3 ls 2 t
"coffee”
```



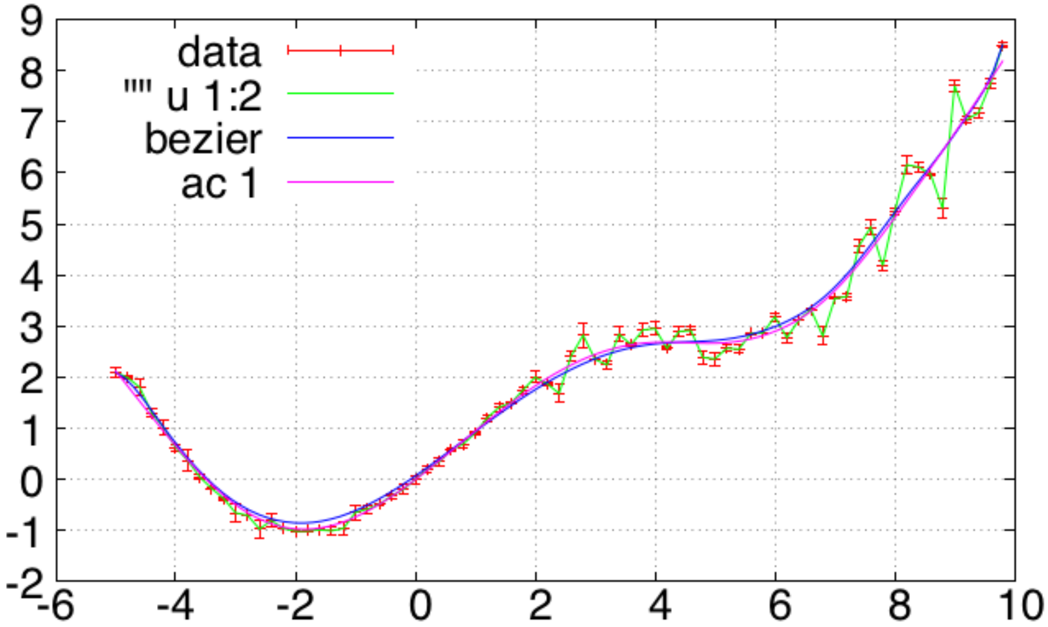
Plotting Data from Files

2.2 options for data plotting:

- smooth
  - unique
    - sorts the elements in a column
    - points are directly linear connected
  - bezier
    - Bézier curve through all points
  - acsplines
    - weighted cubic spline approximation
    - weights defined in third column
- $>cat norm.dat
- x   y   error
- -5.0000000e+00   2.0922396e+00 -8.5687486e-02
- -4.8000000e+00   1.9912158e+00   3.9218173e-02
- .....

Plotting Data from Files

```
$> gnuplot
gnuplot> plot "norm.dat" using 1:2:3 w yerrorbars t "data" ,\
>                  "" u 1:2 w l,\
>            "" u 1:2 smooth bezier t "bezier" ,\
>            "" u 1:2:(1) s acs t "ac 1"
```



Plotting Data from Files

options for data input:

- fit <fct> “datafile” {index …} {every …} {using …} via param1,…
  - fits data file using least square

- use file data headers as title:
  - plot for [col=2:3] ’norm.dat’ u 1:col with lines title columnheader
  - plot “norm.dat” u (column(' x')):(column(' y')) w l

Plotting Data from Files

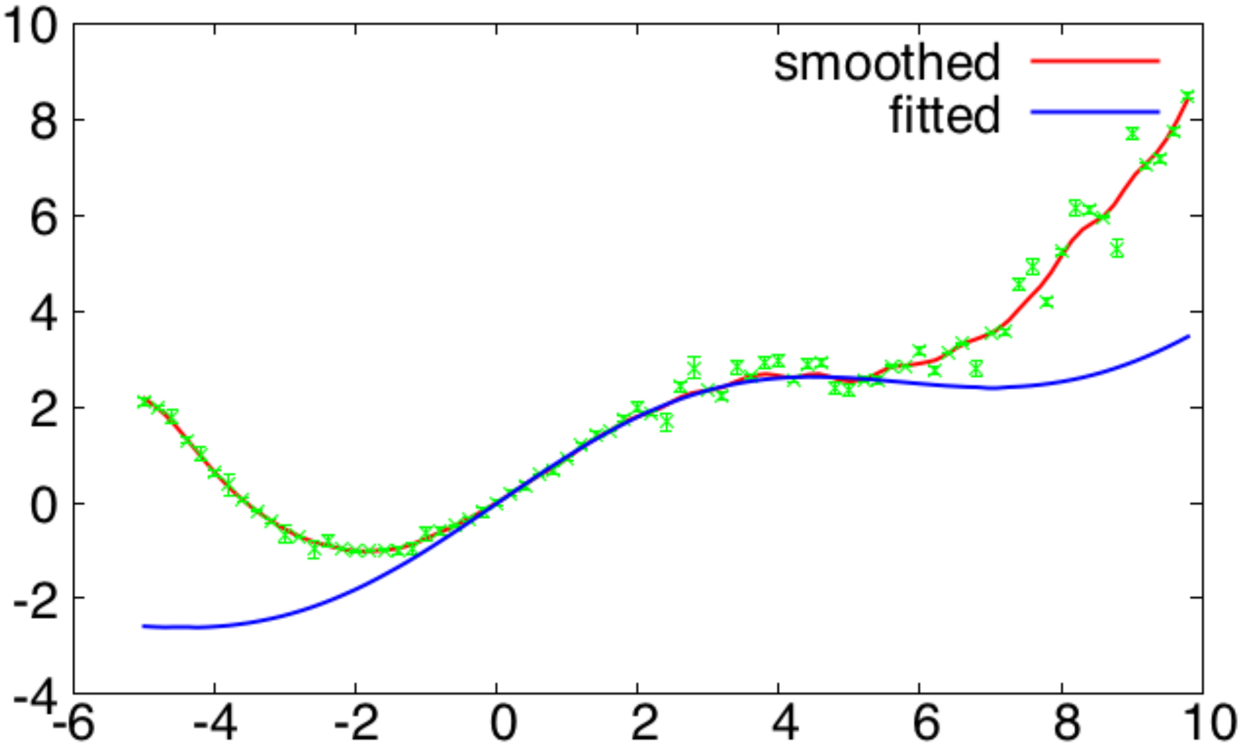
```
$>cat fit.gplt
# fitting function
fitfct(x) = p1*cos(p2*x + p3) + p4*x

# initial guess
p1 = 1.
p2 = 0.5
p3 = pi/4.
p4 = 0.2

fit [0:5][] fitfct(x) "norm.dat" u 1:2:3 via p1,p2,p3,p4    # third col treated as std deviation
plot "norm.dat" u 1:2:(1./column("error")**2) smooth acsplines t "smoothed" ,\
        "" u "x":(column("y")):3 w yerrorbars notitle ,\
        fitfct(x) t "fitted"
```

Plotting Data from Files

```
$> gnuplot
gnuplot> load ‘fit.gplt’
```



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Layout

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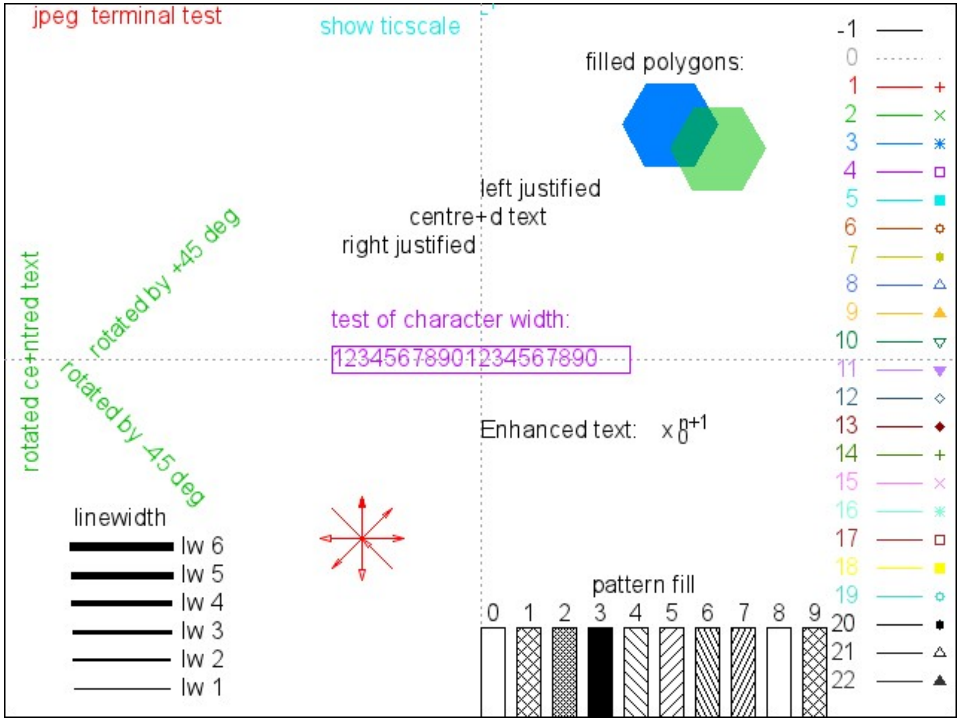
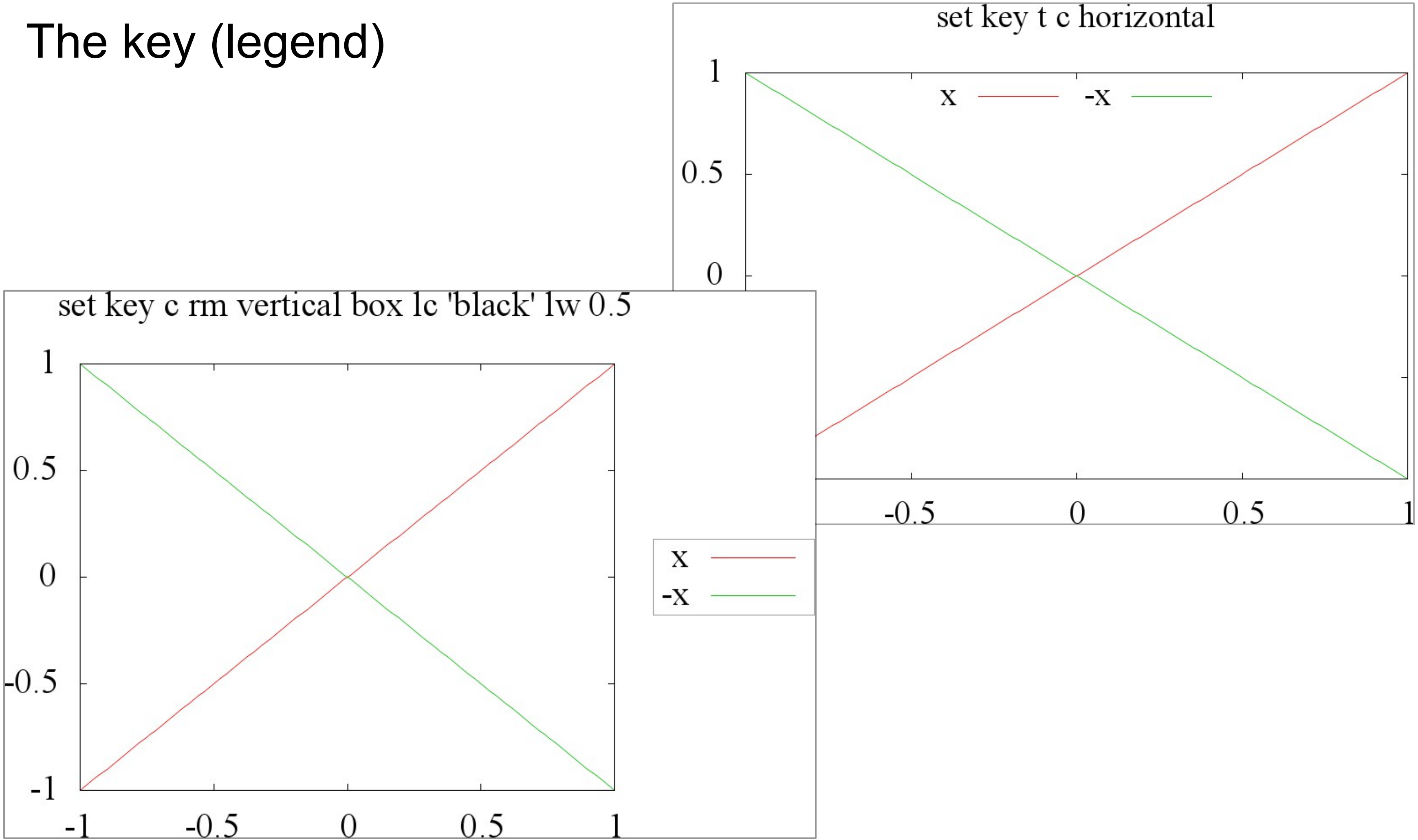
1. Layout

- General:
  - output style depends on terminal
  - command *test* in gnuplot outputs overview of layout options:



Layout

The key (legend)



```
set key t c horizontal
```

```
set key c rm vertical box lc 'black' lw 0.5
```

Layout

3.1 Axis

- logarithmic axes:

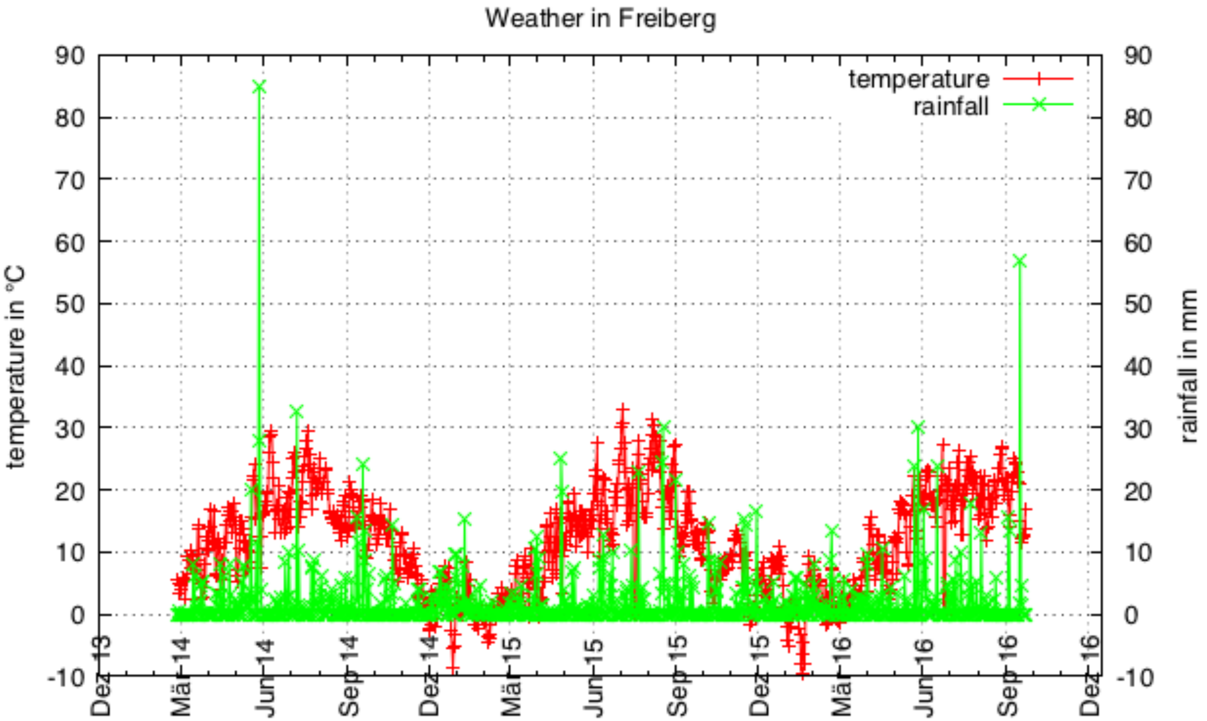
  ```
  set logscale     # double logarithmic plots
  set logscale x   # only x axis
  set logscale y   # only y axis
  ```

- for multiple axes

  ```
  plot "" u 1:2 axes x1y1
  ```

Layout

```
$> gnuplot
gnuplot> load “WeatherTrendFG.gplt”
```



source of data: *http://www.chemie.tu-freiberg.de/wetterdaten/ddaten_anzeige.php*

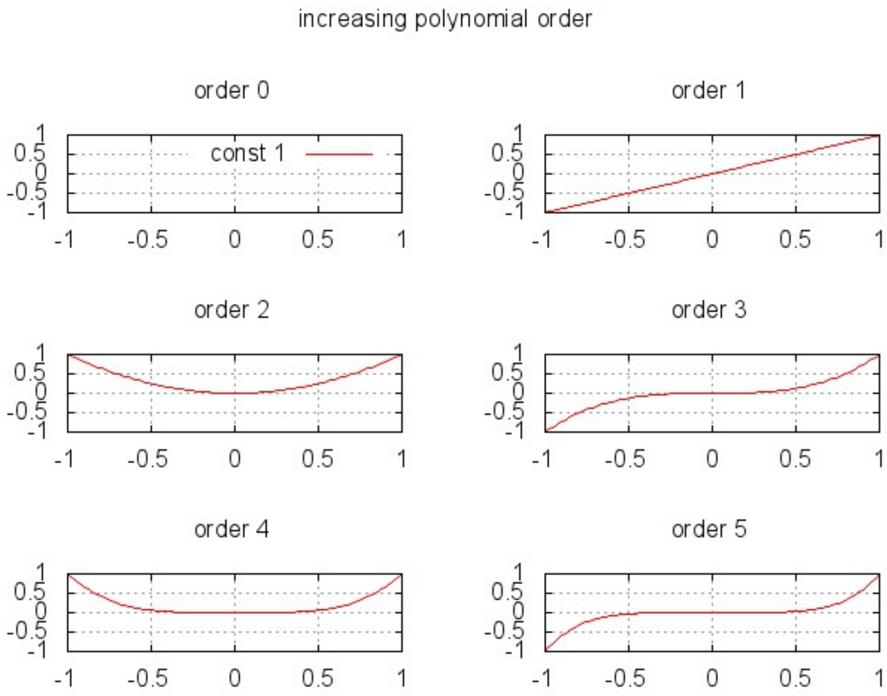
Layout

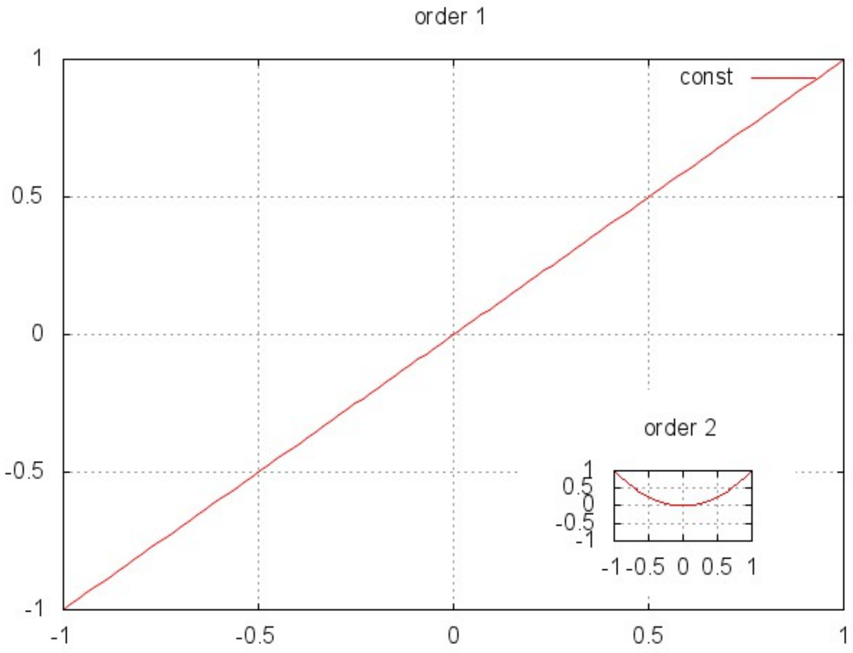
3.2 multiplots

- if many coordinate systems
  - two main options:

(1) array

(2) insets





Layout

3.3.Linestyles

plot with <type> <linestyle> <linewidth> <linecolor>

Types

- Lines
- Points
- Linepoints
- Impulses
- boxes

Links and Literature

- gnuplot homepage: (see *demos*)
  - http://gnuplot.sourceforge.net/

- very detailed documentation:
  gnuplot> help [command]

- *Gnuplot in Action, Understanding Data with Graphs*; Philipp K. Janert; Manning Publications; 2009

- list with commands and corresponding examples:
  http://www.chemie.fu-berlin.de/chemnet/use/info/gnuplot/gnuplot_toc.html

- many (advanced) examples:
  http://gnuplot-tricks.blogspot.de/