

Class Progress

Basics of Linux, gnuplot, C

Visualization of numerical data

Roots of nonlinear equations

(Midterm 1)

Solutions of systems of linear equations

Solutions of systems of nonlinear equations

Monte Carlo simulation

Interpolation of sparse data points

Numerical integration

(Midterm 2)

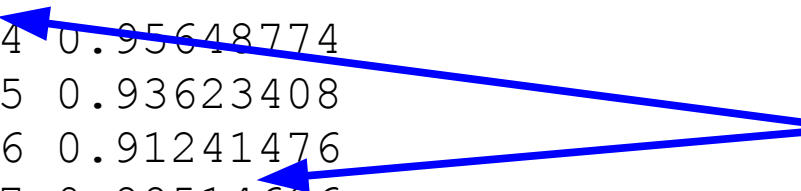
Solutions of ordinary differential equations

Sample from Two-Column Data File

```
0 1
0.01 0.99489625
0.02 0.9859006
0.03 0.9730729
0.04 0.95648774
0.05 0.93623408
0.06 0.91241476
0.07 0.88514606
0.08 0.85455715
0.09 0.82078945
0.1 0.78399606
0.11 0.74434104
0.12 0.70199872
0.13 0.65715293
0.14 0.60999621
0.15 0.56072903
0.16 0.50955892
0.17 0.45669961
0.18 0.40237016
0.19 0.34679405
0.2 0.29019828
```

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Two columns of data
values, separated by a
space character



Sample from Three-Column Data File

```
0 1 0
0.01 0.99177147 0.062593808
0.02 0.97969266 0.1245493
0.03 0.96383521 0.18562674
0.04 0.94428517 0.24559133
0.05 0.92114259 0.30421413
0.06 0.89452102 0.3612729
0.07 0.86454698 0.41655298
0.08 0.83135939 0.46984801
0.09 0.79510894 0.52096076
0.1 0.75595744 0.5697038
0.11 0.71407709 0.61590022
0.12 0.66964974 0.65938422
0.13 0.62286614 0.70000172
0.14 0.57392509 0.73761088
0.15 0.52303266 0.77208256
0.16 0.47040128 0.80330082
0.17 0.41624891 0.83116321
0.18 0.36079812 0.85558112
0.19 0.3042752 0.87648008
0.2 0.24690923 0.8937999
```

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Three columns of data
values, separated by a
space character

Starting gnuplot Plotting Tool

```
$ gnuplot
```

```
G N U P L O T
```

```
Version 4.6 patchlevel 1      last modified 2012-09-26
```

```
Build System: Linux i686
```

```
Copyright (C) 1986-1993, 1998, 2004, 2007-2012
```

```
Thomas Williams, Colin Kelley and many others
```

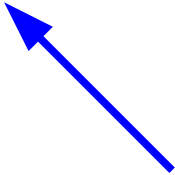
```
gnuplot home:      http://www.gnuplot.info
```

```
faq, bugs, etc:    type "help FAQ"
```

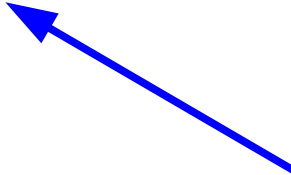
```
immediate help:    type "help"   (plot window: hit 'h')
```

```
Terminal type set to 'wxt'
```

```
gnuplot> plot 'damped_osc.dat' using 1:2 with lines
```



Interactive prompt to gnuplot



Typed command to gnuplot

gnuplot Command Language Example

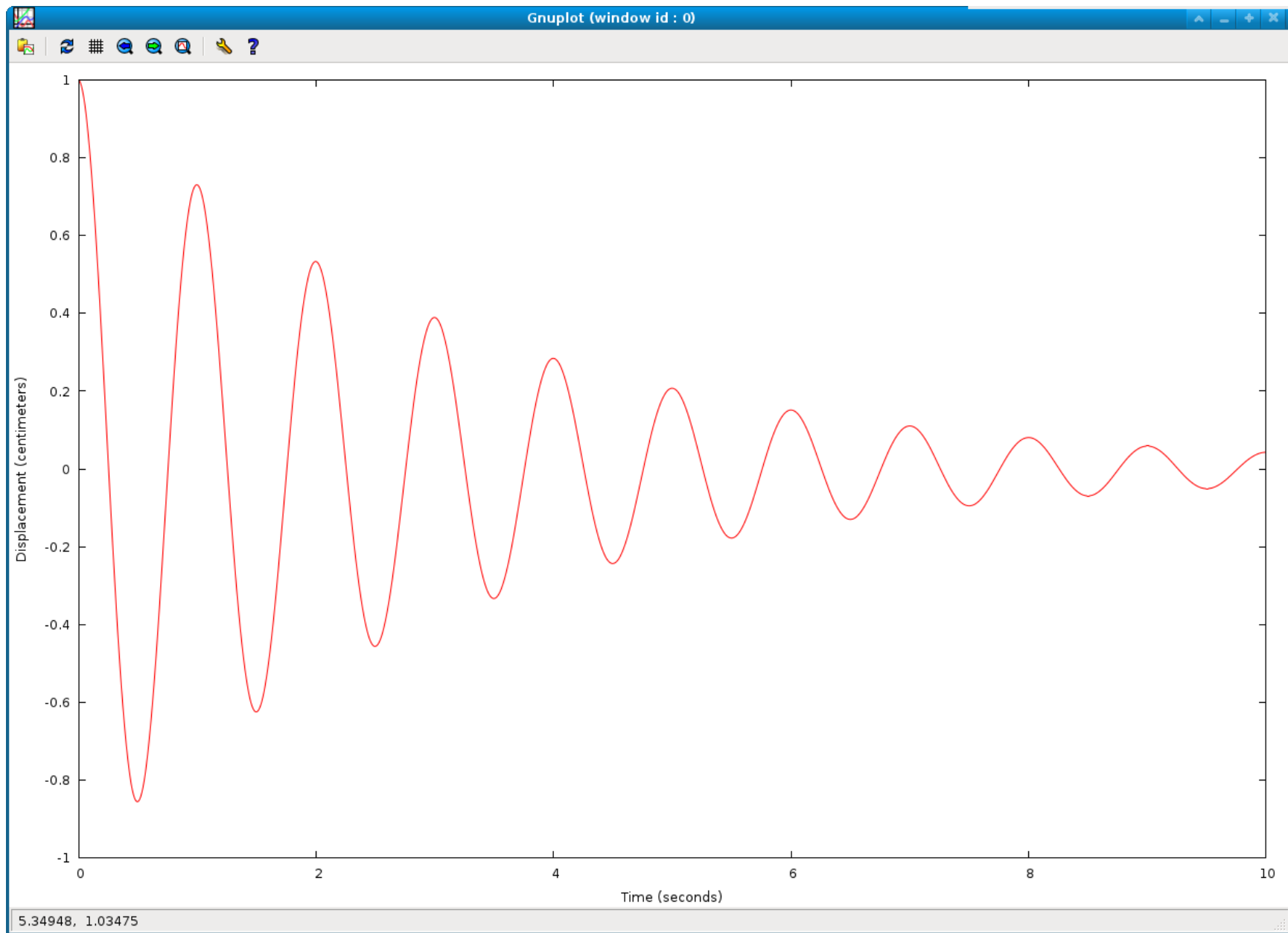
Set label text for x and y axes

Remove file name key (optional)

```
gnuplot> set xlabel 'Time (seconds) '  
gnuplot> set ylabel 'Displacement (centimeters) '  
gnuplot> unset key  
gnuplot> plot 'damped_osc.dat' using 1:2 with lines
```

Generate plot from data in file, using column 1 for the x coordinates and column 2 for the y coordinates, and connect data points with lines

gnuplot Graphical Output Window



gnuplot Command Language Example

Set overall plot title

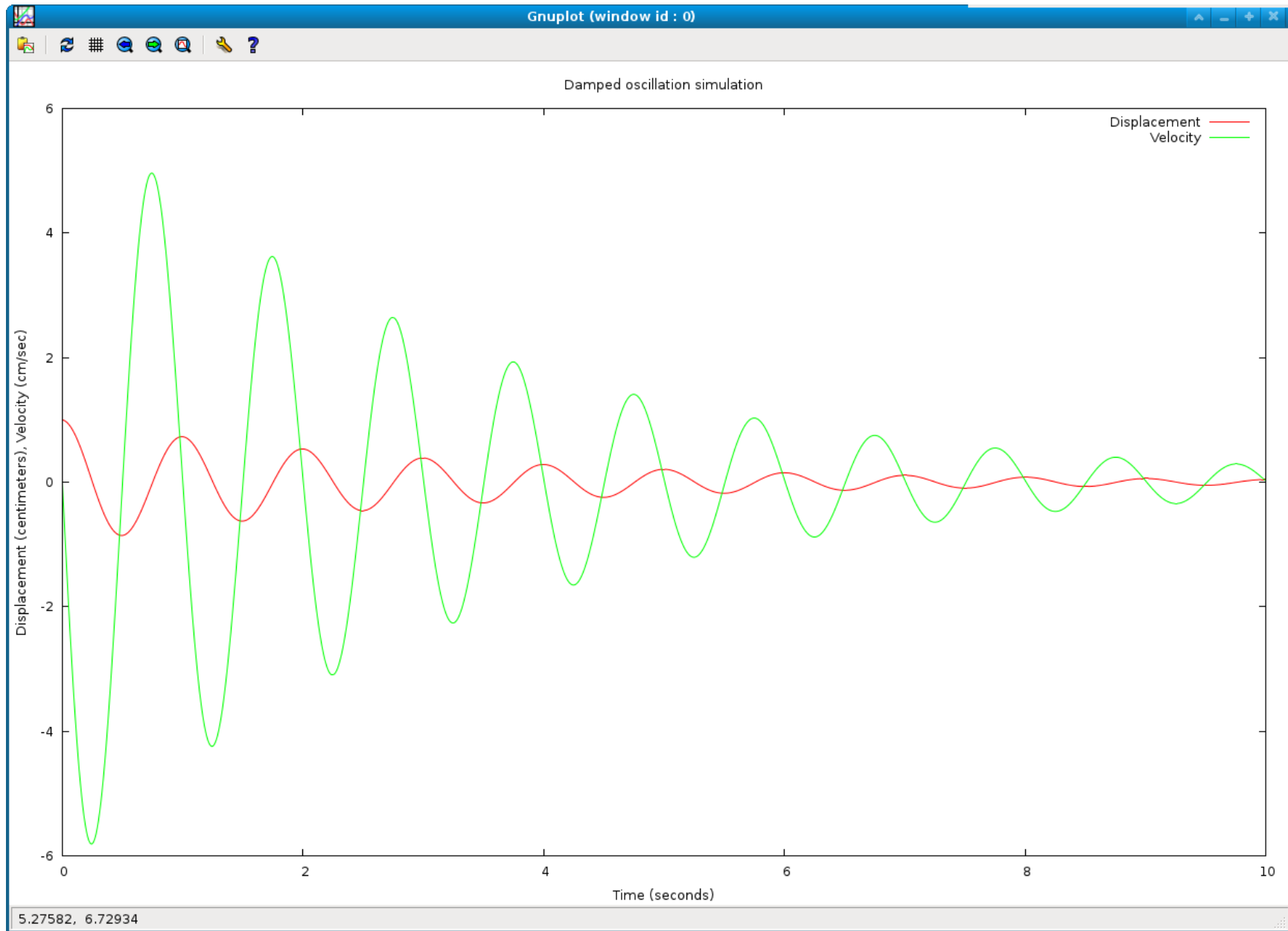
Set label text for x and y axes

Restore file name key

```
gnuplot> set title 'Damped oscillation simulation'
gnuplot> set xlabel 'Time (seconds)'
gnuplot> set ylabel 'Displacement (centimeters), Velocity (cm/sec)'
gnuplot> set key default
gnuplot> plot 'damped_osc.dat' using 1:2 with lines title
'Displacement', '' using 1:3 with lines title 'Velocity'
```

Generate plot from data in file, using column 1 for the x coordinates and column 2 for the y coordinates, and connect data points with lines

Graphical Output Window



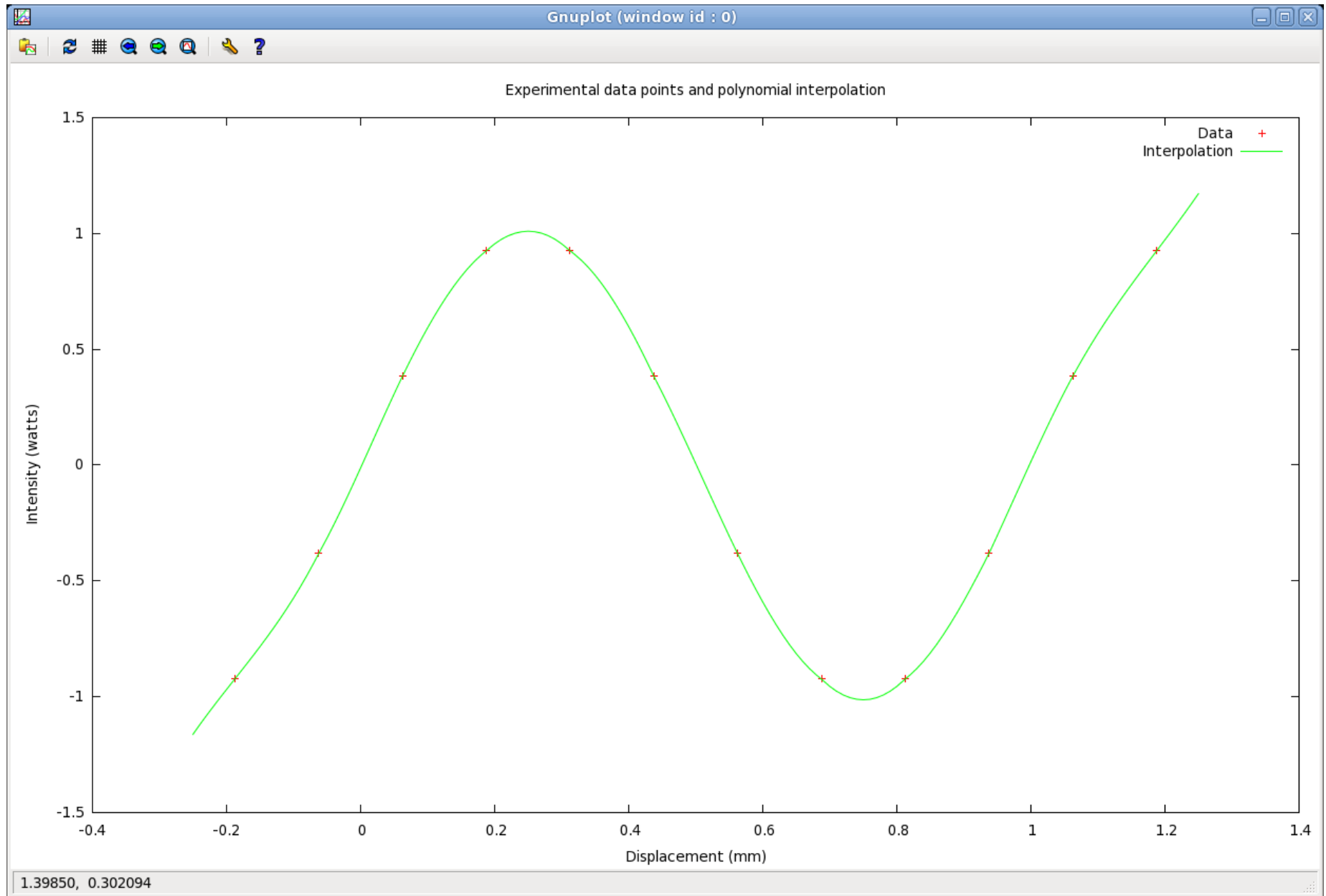
gnuplot Command Language Example

```
gnuplot> set title 'Experimental data points and polynomial  
interpolation'  
gnuplot> set xlabel 'Displacement (mm) '  
gnuplot> set ylabel 'Intensity (watts) '  
gnuplot> set key default  
gnuplot> plot 'exp_data.dat' using 1:2 with points title 'Data',  
'interpolation.dat' using 1:2 with lines title 'Interpolation'
```



Generate plot from data in file, using column 1 for the x coordinates and column 2 for the y coordinates, plotting raw data points individually but connecting interpolated data points with lines

Graphical Output Window



Generating Graphics for Documents

Temporarily set output terminal type to "Extended Windows Metafile"

Define and open output file name for writing

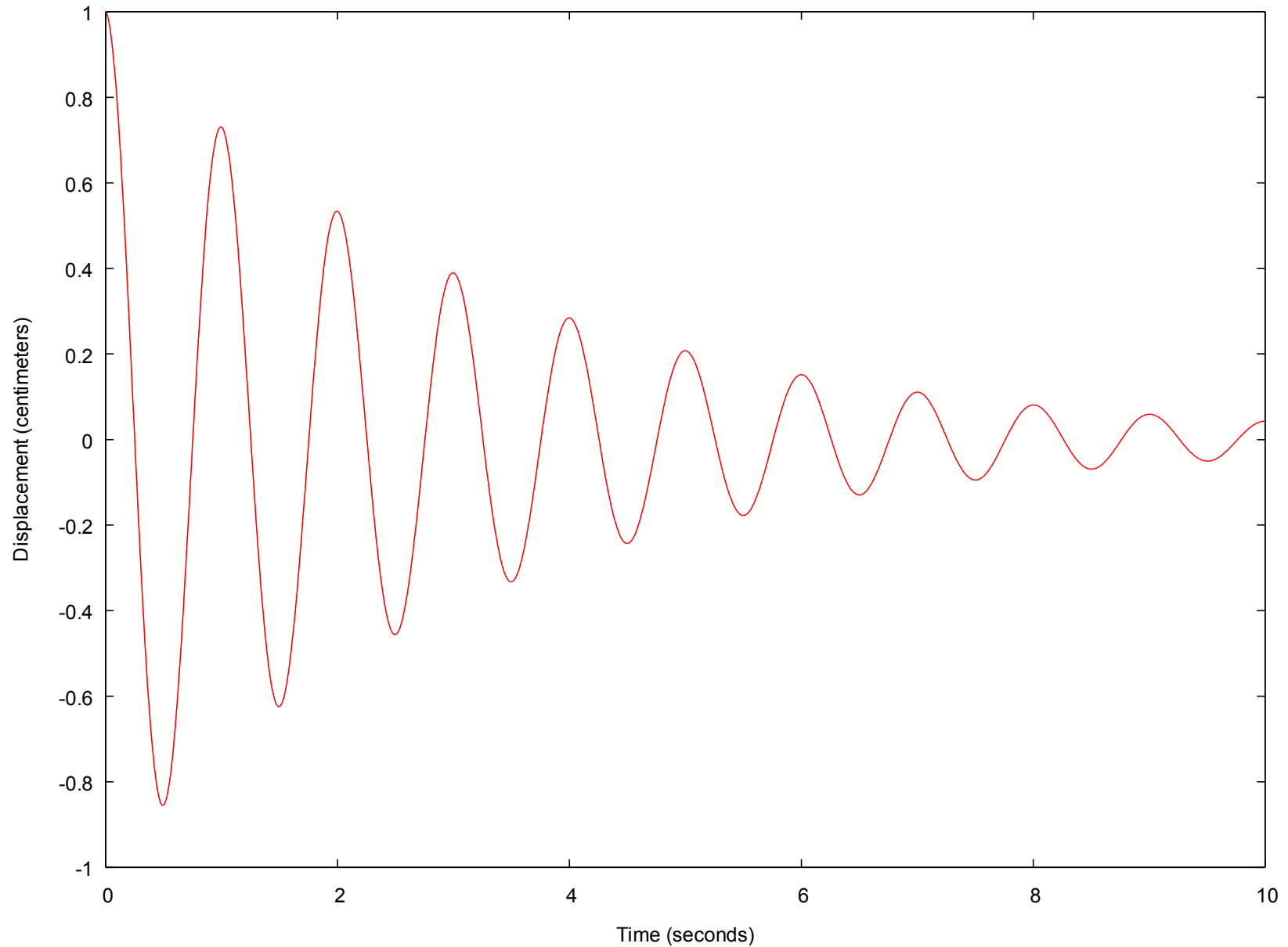
Generate plot from data in file, using column 1 for the x coordinates and column 2 for the y coordinates, and connect data points with lines

```
gnuplot> set terminal emf
Terminal type set to 'emf'
Options are 'color dashed "Arial" 12'
gnuplot> set output 'damped_osc.emf'
gnuplot> plot 'damped_osc.dat' using 1:2 with lines
gnuplot> unset output
gnuplot> set terminal wxt
Terminal type set to 'wxt'
Options are '0'
```

Close output file

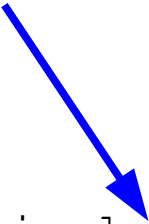
Reset output terminal type to 'wxt' to display subsequent plots in a screen window

Graphics File to Import into Document



Generating Graphics for Web Pages or Email

Temporarily set output terminal type to a bitmap format such as PNG

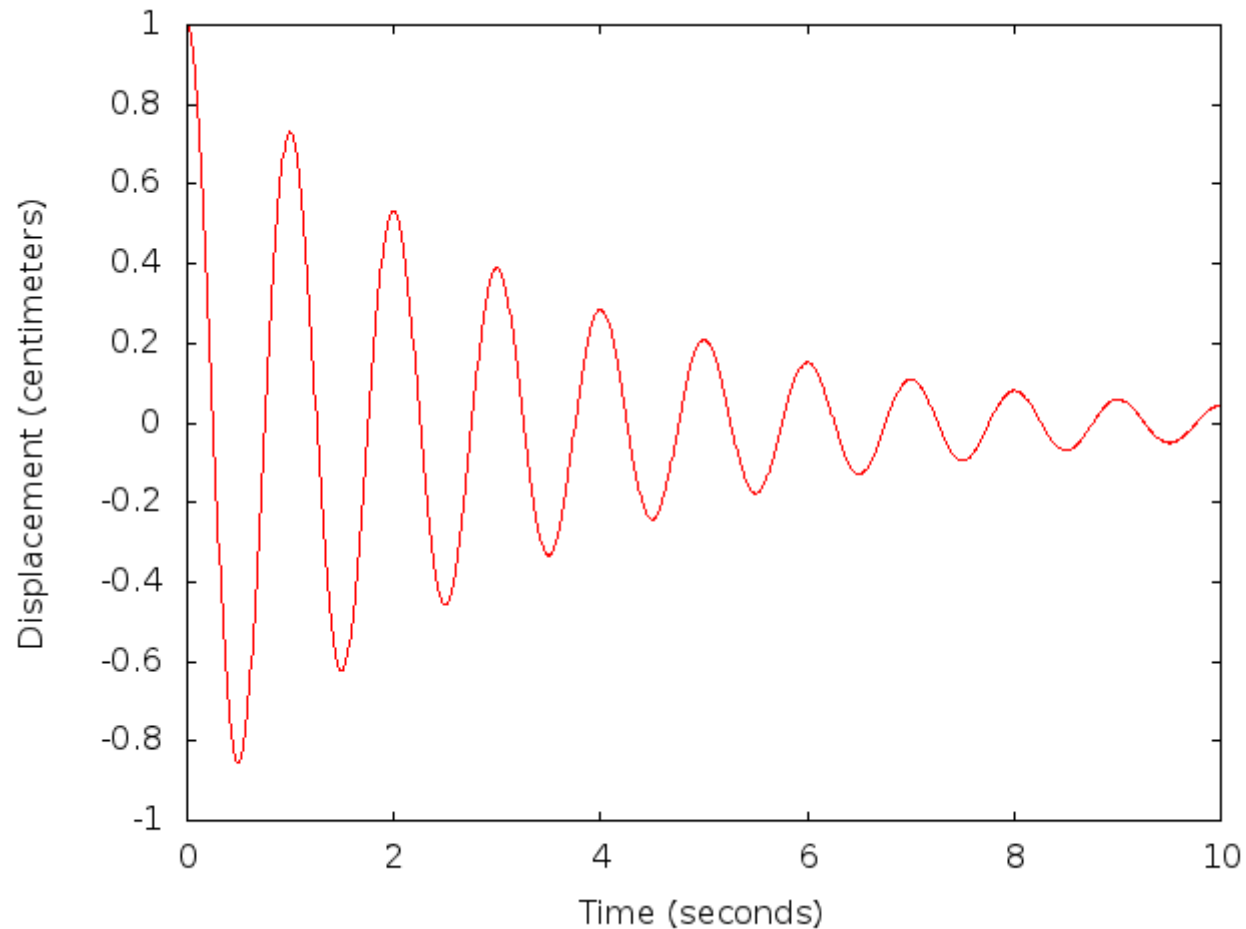


```
gnuplot> set terminal png size 640,480
Terminal type set to 'png'
Options are 'nocrop font /usr/share/fonts/dejavu/DejaVuSans.ttf 12
size 640,480 '
gnuplot> set output 'damped_osc.png'
gnuplot> plot 'damped_osc.dat' using 1:2 with lines
gnuplot> unset output
gnuplot> set terminal wxt
Terminal type set to 'wxt'
Options are '0'
```



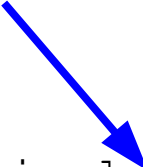
Reset output terminal type to 'wxt' to display subsequent plots in a screen window

Graphics File for Internet



Generating Graphics for Hardcopy

Temporarily set output terminal type to Postscript



```
gnuplot> set terminal postscript
Terminal type set to 'postscript'
Options are 'landscape noenhanced defaultplex \
    leveldefault monochrome colortext \
    dashed dashlength 1.0 linewidth 1.0 butt noclip \
    palfuncparam 2000,0.003 \
    "Helvetica" 14 '
gnuplot> set output 'damped_osc.ps'
gnuplot> plot 'damped_osc.dat' using 1:2 with lines
gnuplot> unset output
gnuplot> set terminal wxt
Terminal type set to 'wxt'
Options are '0'
```



Reset output terminal type to 'wxt' to display subsequent plots in a screen window

Generating 3-Dimensional Surface Plots

Set label text for x, y and z axes

```
gnuplot> unset key
gnuplot> set title 'Electrical Potential with Two Point Charges'
gnuplot> set xlabel 'X coordinate (mm)'
gnuplot> set ylabel 'Y coordinate (mm)'
gnuplot> set zlabel 'Potential (V)' rotate by 90
gnuplot> set hidden3d
gnuplot> splot 'potential.dat' using 1:2:3 with lines
```

Generate surface plot from data in file, using column 1 for the x coordinates, column 2 for the y coordinates, and column 3 for the z coordinates, and connect data point grid corners with lines

Enable hidden line algorithm

Sample from Three-Column Data File for Surface Plots

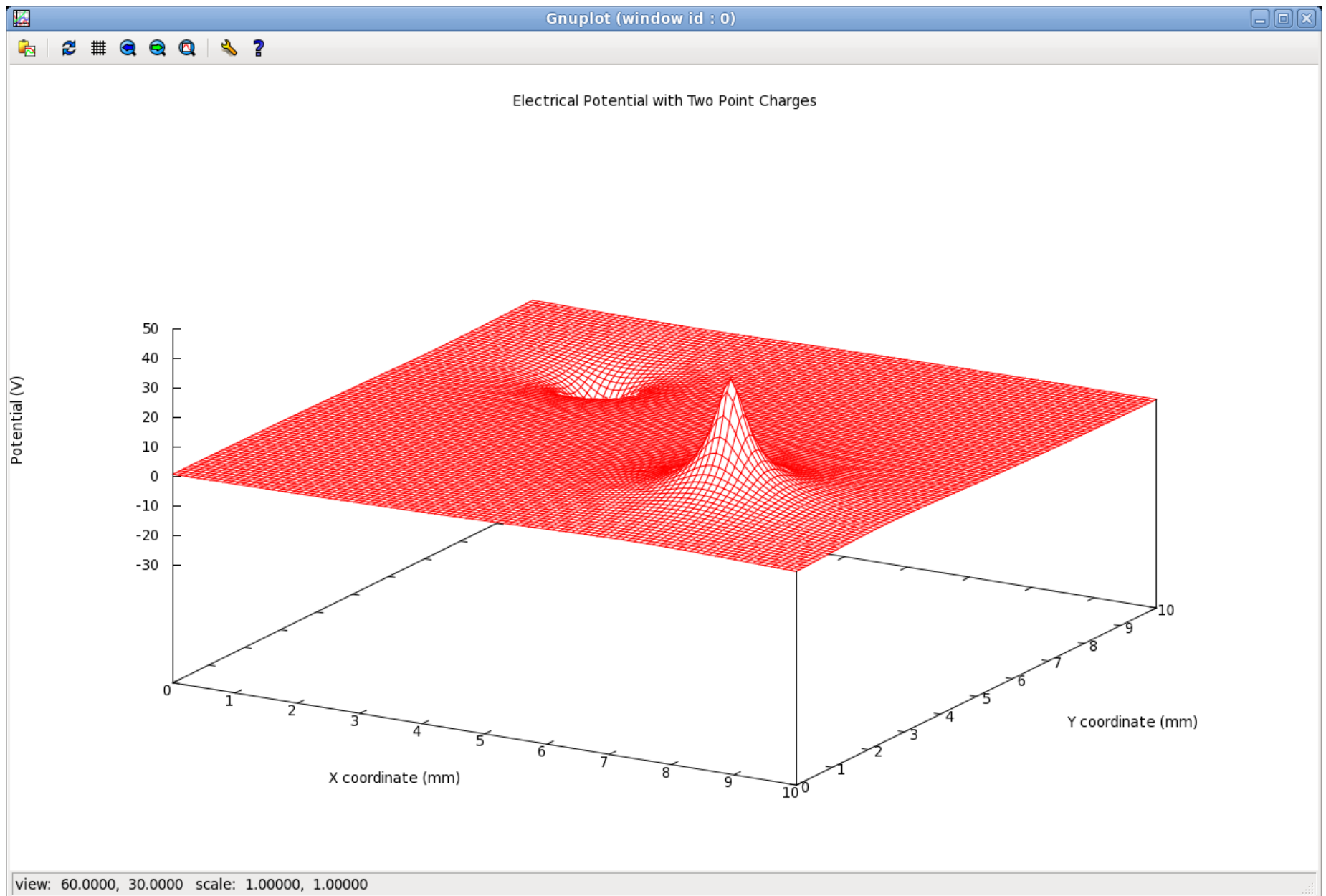
.
. .
0.0 9.2 -0.6552452293220407
0.0 9.3 -0.631272845282253
0.0 9.4 -0.6072971039890444
0.0 9.5 -0.5834334717832502
0.0 9.6 -0.5597816068599372
0.0 9.7 -0.5364264207748183
0.0 9.8 -0.513439259073437
0.0 9.9 -0.4908791387863177
0.0 10.0 -0.4687939940705331

Three columns of data values, separated by a space character

0.1 0.0 0.6450459744405919
0.1 0.1 0.6424527870764164
0.1 0.2 0.6395263557147667
0.1 0.3 0.6362543123414272
0.1 0.4 0.6326241103885756
0.1 0.5 0.6286230331714869
0.1 0.6 0.6242382023415871
0.1 0.7 0.6194565862586873
0.1 0.8 0.6142650081818134

Blank line indicates where y coordinate “retraces”, returning to 0

gnuplot Graphical Output Window



Plotting Multiple “Data Sets” in gnuplot

```
plot 'file name' index 0 using 1:2 with lines, '' index 1 using 1:2 with lines, '' index 2 using 1:2 with lines
```

Data file layout:

```
0 -1
0.01 -0.99408343
0.02 -0.97639595
...
9.98 -0.6537779
9.99 -0.56664162
10 -0.47813884
```

'index' keyword selects data set for each plot, starting from 0

Data set 0 for mass 1

Two blank lines separate data sets

```
0 1
0.01 0.99605605
0.02 0.98427087
...
9.98 -0.78828116
9.99 -0.7875189
10 -0.77954301
```

Data set 1 for mass 2

Two blank lines separate data sets

```
0 1
0.01 0.99802608
0.02 0.99210435
...
9.98 0.85595068
9.99 0.82072393
10 0.77591669
```

Data set 2 for mass 3

Other Useful gnuplot Commands

```
gnuplot> set xrange [x-low:x-high]
gnuplot> set yrange [y-low:y-high]
gnuplot> set logscale x
gnuplot> set logscale y
gnuplot> set logscale xy
gnuplot> unset logscale
gnuplot> set loadpath 'path'
gnuplot> quit
```

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and **many** others!