

## Graphing

February 17, 2017 (originally created - 2014)

Occasionally a graph is asked for in the homework – not a “sketch”, but an accurate graph on graph paper. Alternatively, sometimes it is easiest to find the solution to a problem by making a graph and pulling the number off the graph; this can be easier than working out algebra, and has the benefit that you won’t miss the fact that there are sometimes multiple solutions.

There are a number of free programs available over the internet that allow you to make a graph without much fuss.

I use Gnuplot to make my graphs. You can use it in a simple and primitive manner for making x-y plots, or you can learn to make intricate 3-d color graphs; there are many detailed instructions for Gnuplot that can be found posted on the internet. I have a shortcut on my desktop that allows me to open the program directly:



Below is a snapshot of the interface in Gnuplot that comes up when I double-click on the shortcut:

```
gnuplot
File Plot Expressions Functions General Axes Chart Styles 3D Help
Replot Open Save ChDir Print PrtSc Prev Next
GNU PLOT
Version 4.2 patchlevel 4
last modified Sep 2008
System: MS-Windows 32 bit

Copyright (C) 1986 - 1993, 1998, 2004, 2007, 2008
Thomas Williams, Colin Kelley and many others

Type `help` to access the on-line reference manual.
The gnuplot FAQ is available from http://www.gnuplot.info/faq/

Send bug reports and suggestions to <http://sourceforge.net/projects/gnu>

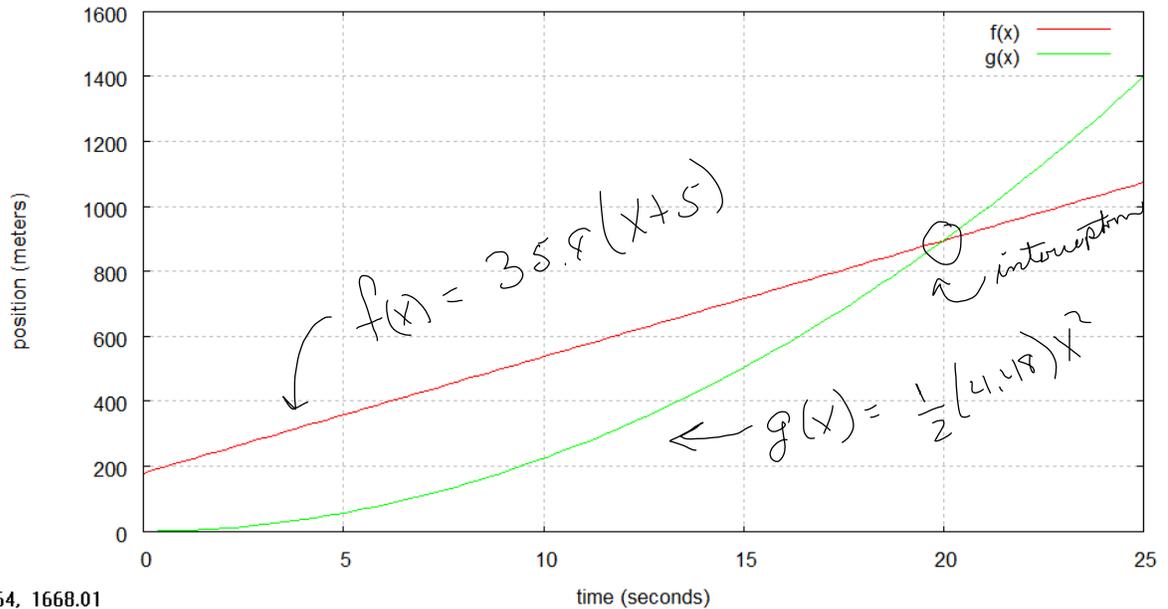
plot>

Terminal type set to 'windows'
gnuplot>
```

Let me illustrate the use of Gnuplot for simple plotting with an example from an old homework problem:

Suppose that a car passes by a parked police car going 35.8 m/s. After a 5 second delay, the police car takes off after the speeder. Assuming the police car undergoes constant acceleration of 4.48 m/s<sup>2</sup>, make a graph showing the position of the speeder as a function of time and superimpose on this a graph showing the position of the police as a function of time.

$$X_{\text{speeder}} = 35.8 \frac{\text{m}}{\text{s}} (t + 5 \text{ s})$$
$$X_{\text{police}} = \frac{1}{2} (4.48 \text{ m/s}^2) t^2$$



Below are the commands I used to make this graph:

```

gnuplot
File Plot Expressions Functions General Axes Chart Styles 3D Help
Replot Open Save ChDir Print PrtSc Prev Next
GNU P L O T
Version 4.2 patchlevel 4
last modified Sep 2008
System: MS-Windows 32 bit

Copyright (C) 1986 - 1993, 1998, 2004, 2007, 2008
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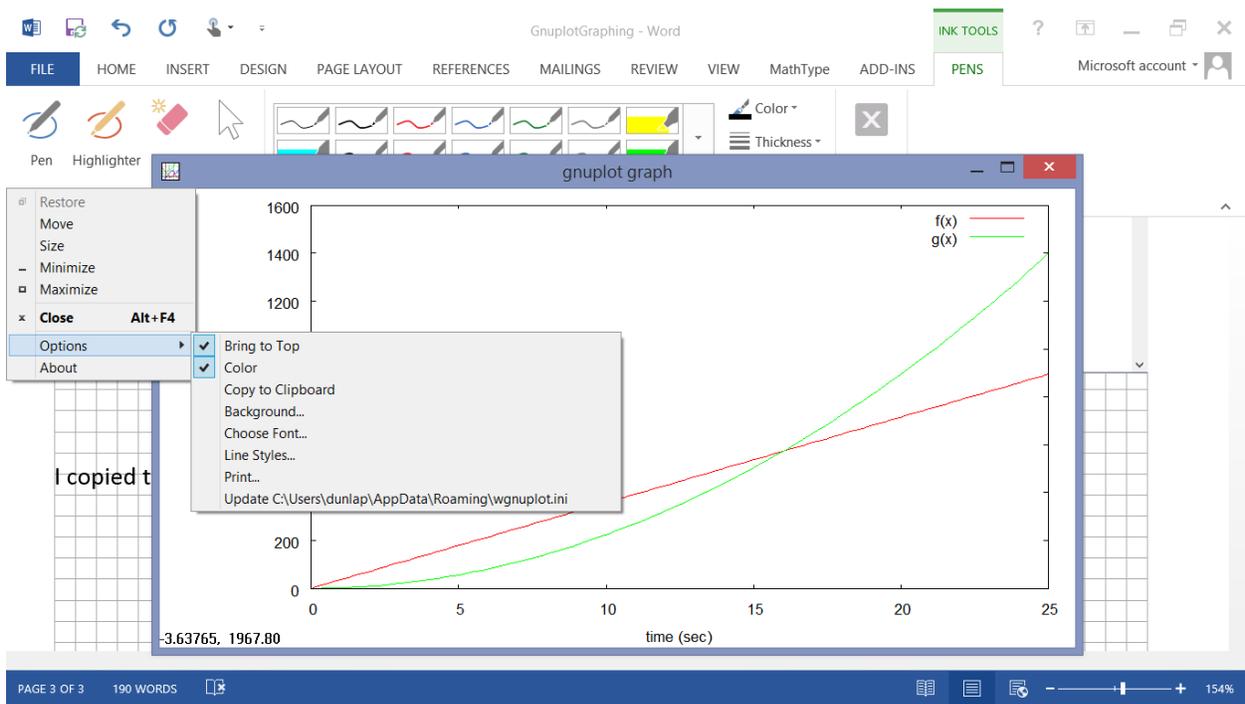
Type `help` to access the on-line reference manual.
The gnuplot FAQ is available from http://www.gnuplot.info/faq/

Send bug reports and suggestions to <http://sourceforge.net/projects/gnu
plot>

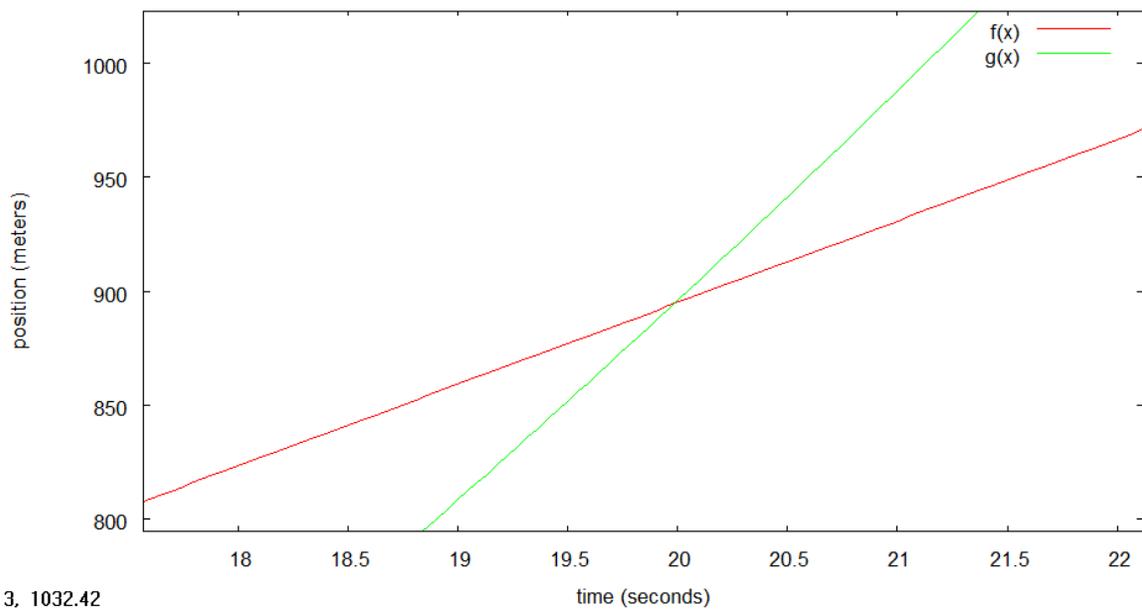
Terminal type set to 'windows'
gnuplot> f(x)=35.8*(x+5)
gnuplot> g(x)=0.5*4.48*x**2
gnuplot> plot f(x)
gnuplot> replot g(x)
gnuplot> set xrange [0:25]
gnuplot> replot
gnuplot> set xlabel "time (seconds)"
gnuplot> set ylabel "position (meters)"
gnuplot> replot
gnuplot>

```

To make these instructions, I copied the plot to the clipboard, and then pasted it into MS Word. The menu for the version of gnuplot I am using is found by left-clicking on the upper left hand corner of the graph. Pull down to "options", and then choose "copy to clipboard". See the screen-shot I have pasted below, but be warned that other (newer) versions of Gnuplot might have this menu hidden in a different manner.



You can zoom in by left-clicking on the graph, and then dragging a box around the region of the graph that would like to highlight. (To un-zoom, you might have to press escape, or ctrl-A, or just A; something like this I believe.)



17.3713, 1032.42

You can hold the mouse over any point on the graph and it will show the x,y coordinates. Below I have held the cursor over the intersection point. The coordinates of the intersection point are displayed in the lower left corner. In this case, you can see that the police catch the speeder in 20 seconds, at the location 894 meters away from the point the police car was parked.

