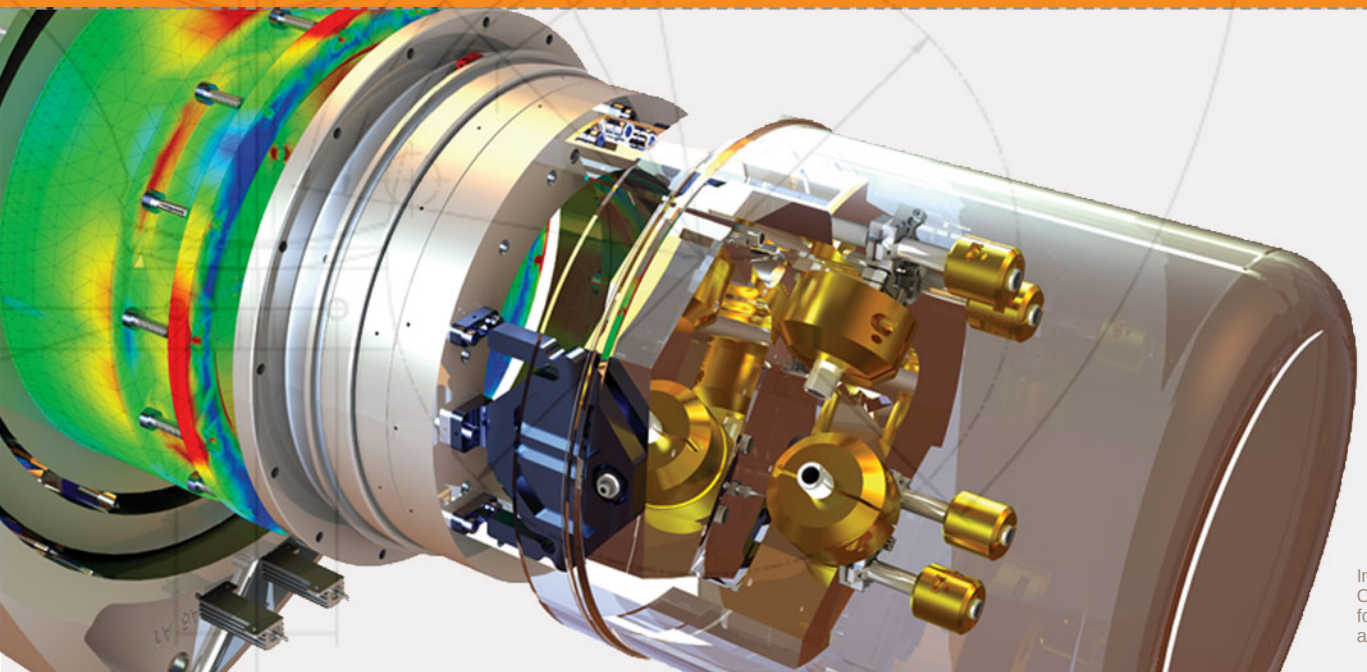
Wichita State University
College of Engineering
Biomedical Engineering

Introduction to Graphing Using MATLAB



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Line Graphs

- Useful for graphing functions
- Useful for displaying data trends over time
- Useful for showing how one variable depends on another

Line Graphs

The MATLAB command for creating a line graph is ***plot***.

General Form:

% A single Function

plot(x-coordinates, y-coordinates, optional formatting)

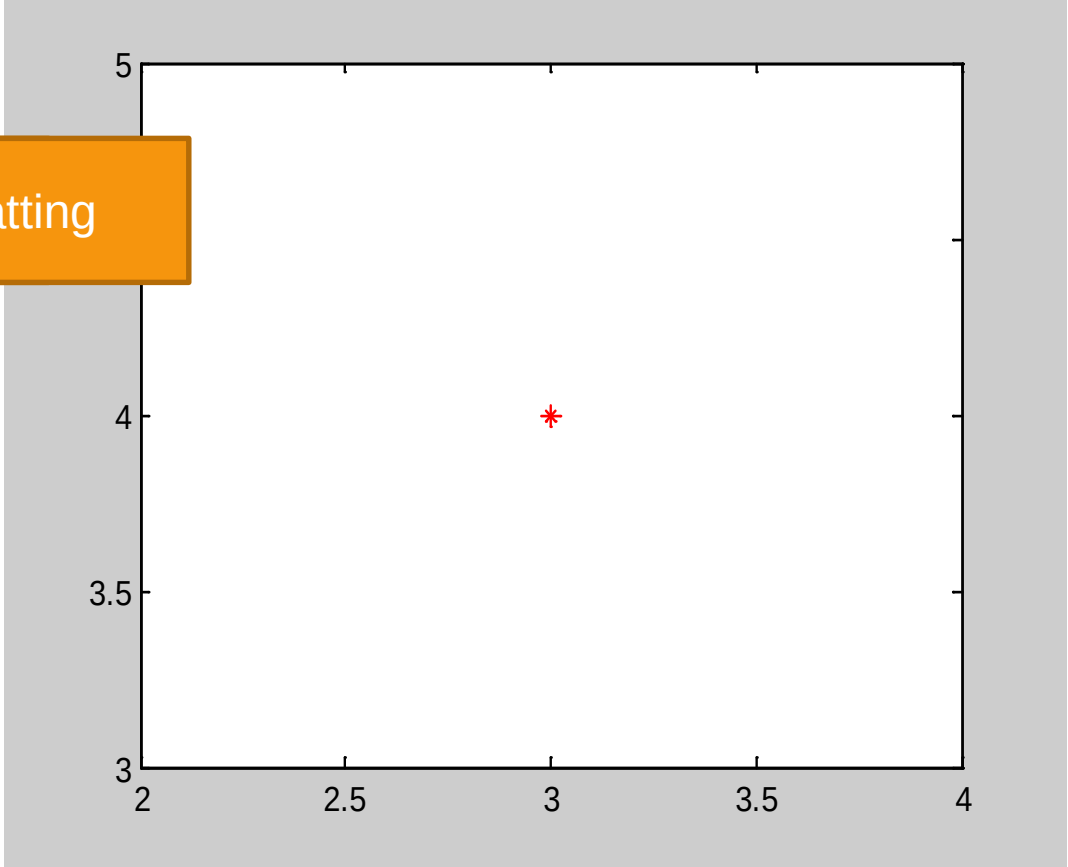
% Multiple Functions

plot(x-values of f_1, y-values of f_1, formatting for f_1, x-values of f_2, y-values of f_2, formatting for f_2, …)

Simple Examples

X Y-C Formatting

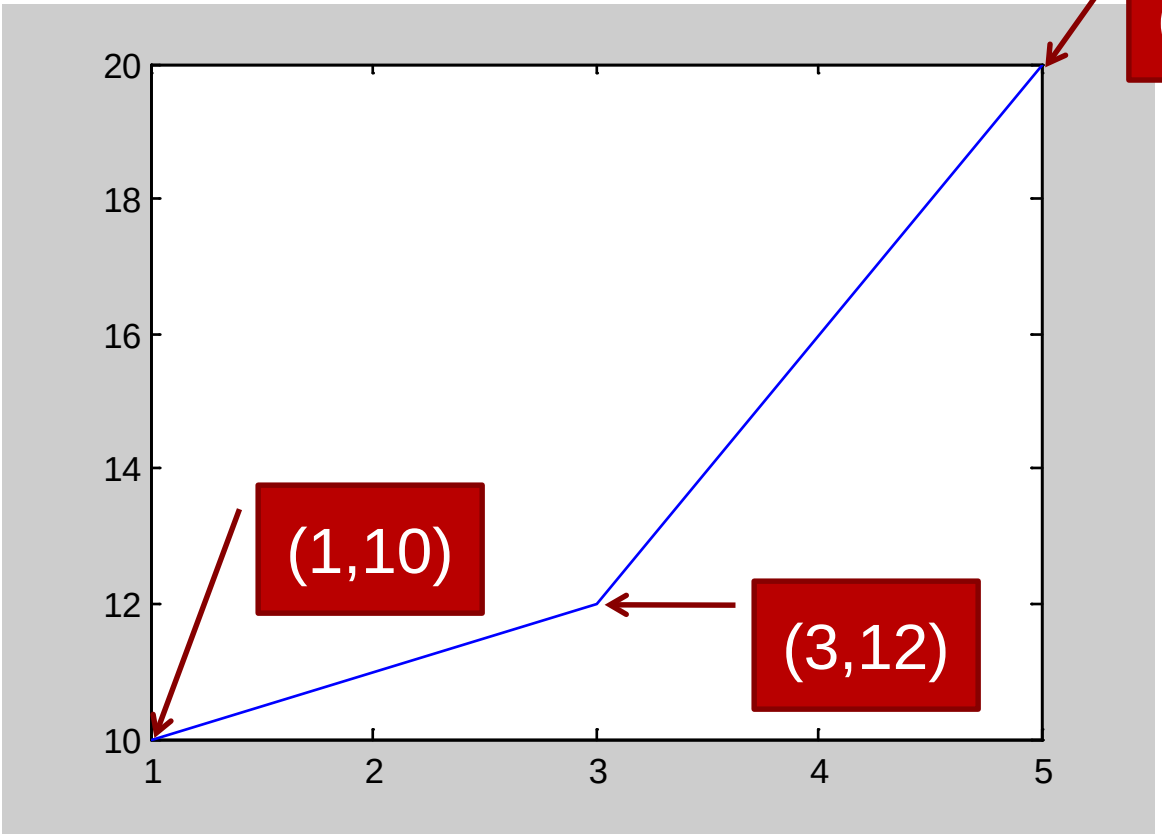
```
>> plot(3,4,'r*')
```



Simple Examples

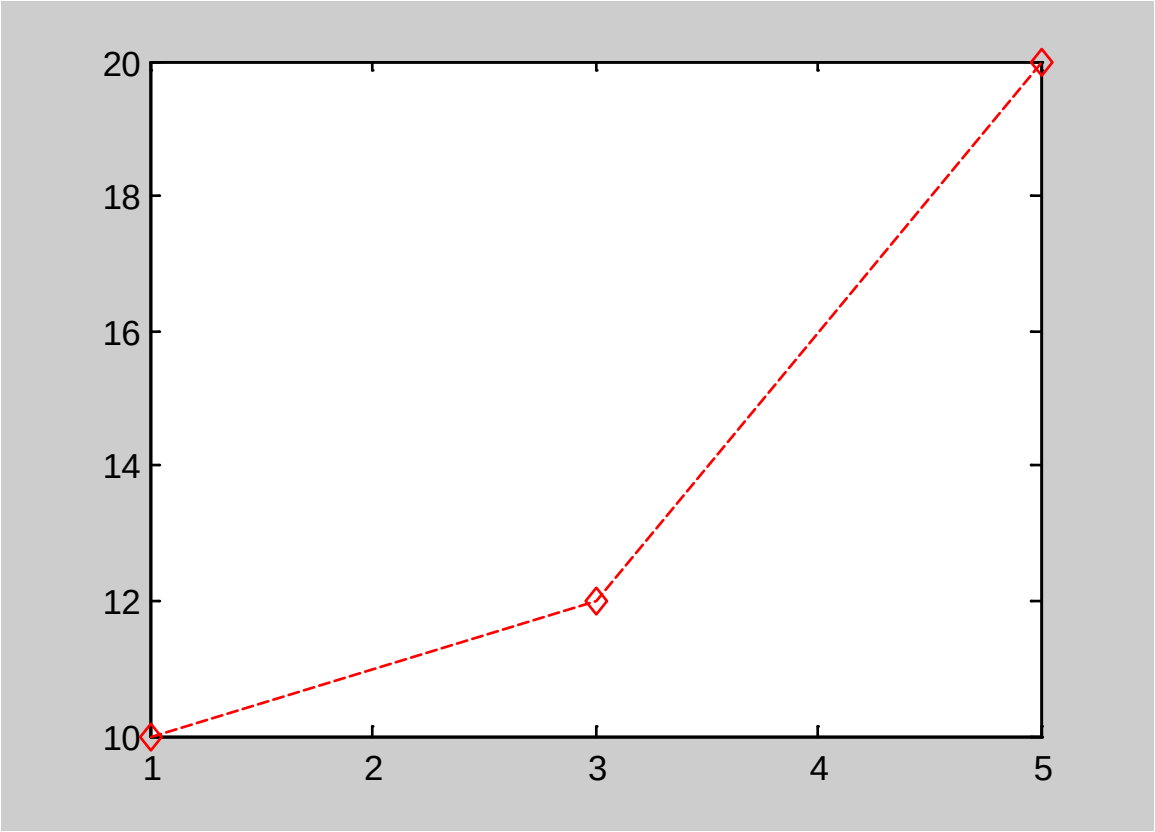
X-Coordinates | Y-Coordinates

```
>> plot([1 3 5],[10 12 20])
```



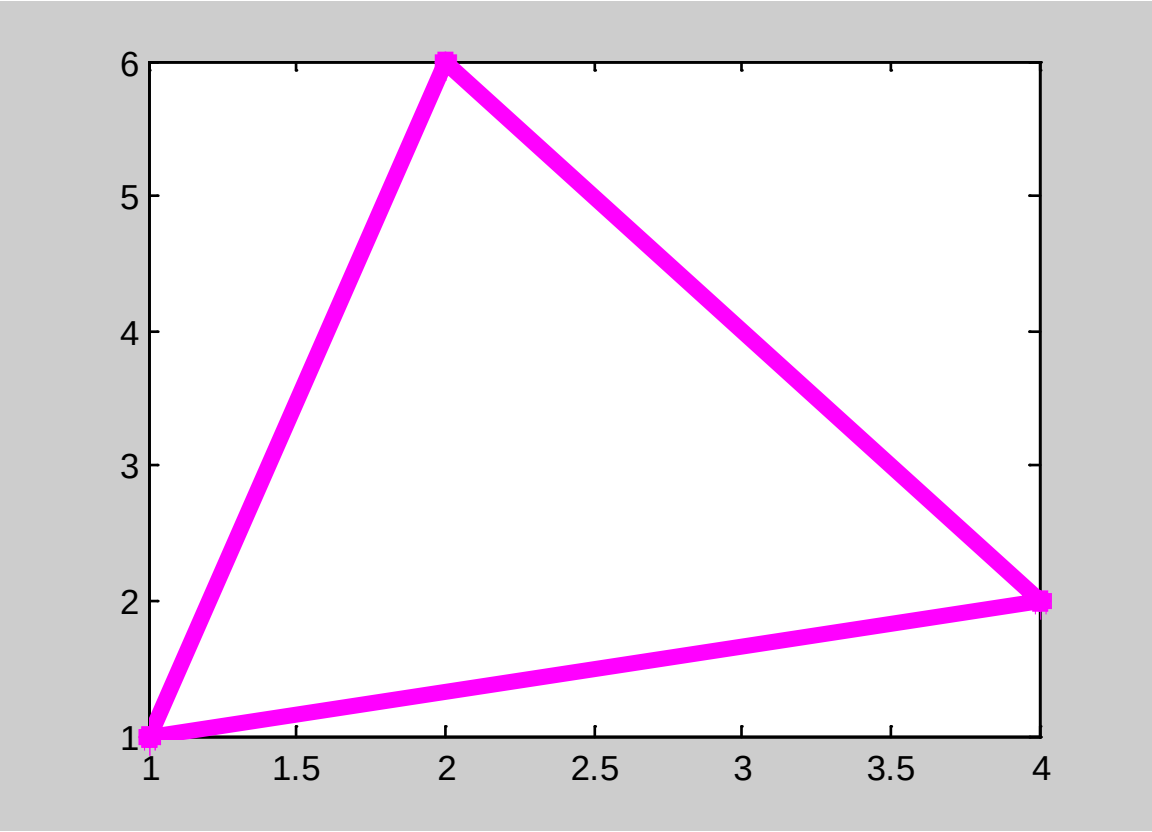
Simple Examples

```
>> plot([1 3 5],[10 12 20],'rd--')
```



Simple Examples

```
>> plot([1 2 4 1],[1 6 2 1],'m*-','LineWidth',5)
```



Format Options (color, linestyle, …)

At the command prompt, type: >> help plot

Scroll up to see this table of options:

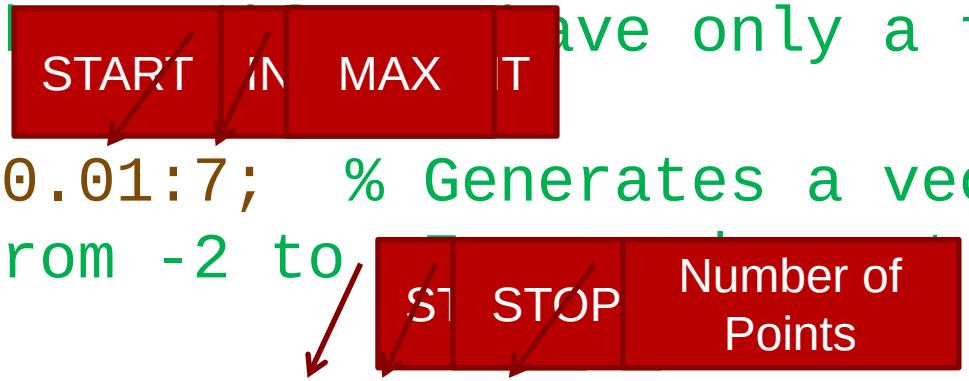
b	blue	.	point	-	solid
g	green	o	circle	:	dotted
r	red	x	x-mark	-.	dashdot
c	cyan	+	plus	--	dashed
m	magenta	*	star	(none)	no line
y	yellow	s	square		
k	black	d	diamond		
w	white	v	triangle (down)		

Graphing Functions

Graph the polynomial function $y = t^3 - 6t^2 + 3t + 10$

Must generate a set of t-values to go on the x-axis then calculate the corresponding y-values. A few options:

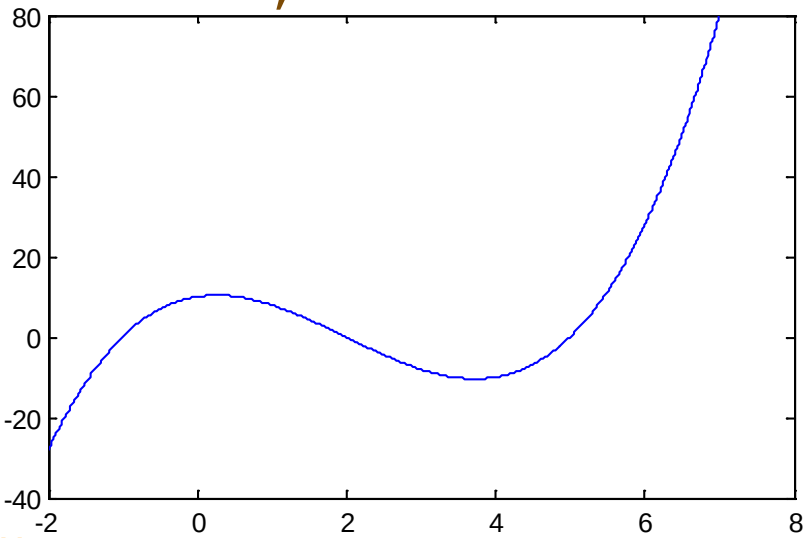
```
>> t = [-2 -1.5 -1 -0.5 0 0.5 1 1.5 2]
% This wor                    ave only a few t-values

>> t = -2:0.01:7;  % Generates a vector of 901
t-values from -2 to                    by 0.01

>> t = linspace(-2,7,500); % Generates a vector
of 500 t-values evenly spaced from -2 to +7
```



Graphing Functions

Graph the polynomial function $y = t^3 - 6t^2 + 3t + 10$

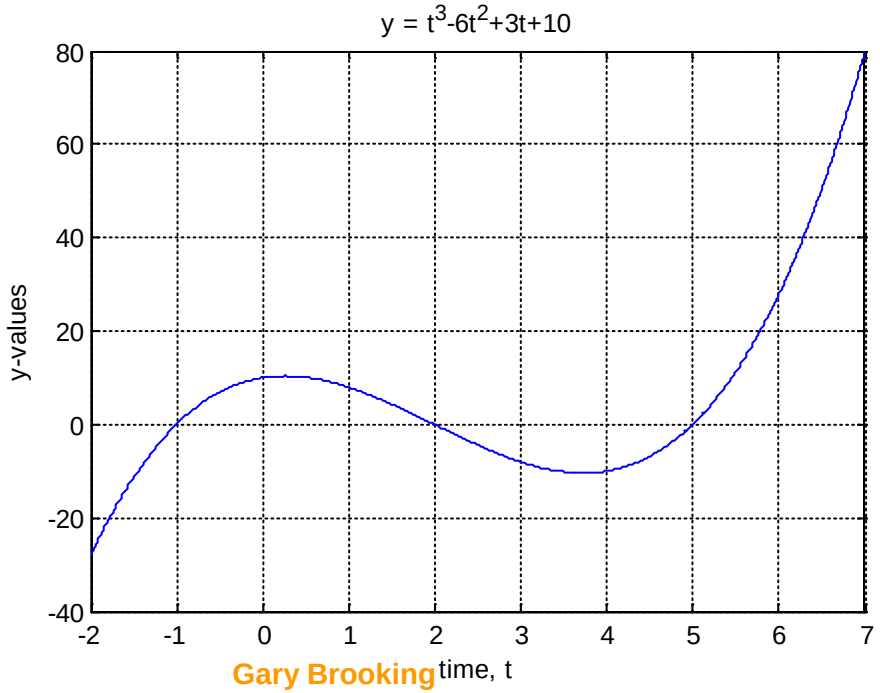
```
%  Gen          ct          values for x-axis
>> t
%  Plu          va          e equation to get
a vector of y-valu
>> y = t.^3 - 6*t.^2 + 3*t + 10;

>> plot(t,y)
```



Graphing Functions

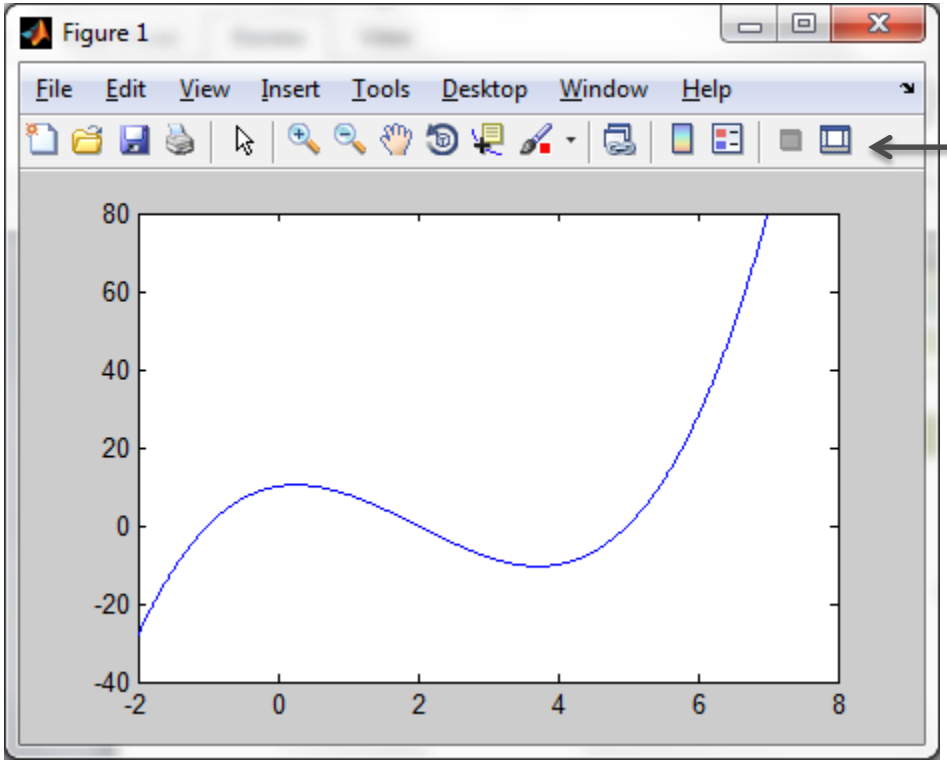
Plots should be labeled and titled. This can be done using MATLAB commands or by using plot tools. Commands:

```
>> xlabel('time, t'); ylabel('y-values');
>> title('y = t^3-6t^2+3t+10'); grid
```



Plot Tools

Plot Tools is another nice option for editing graphs.



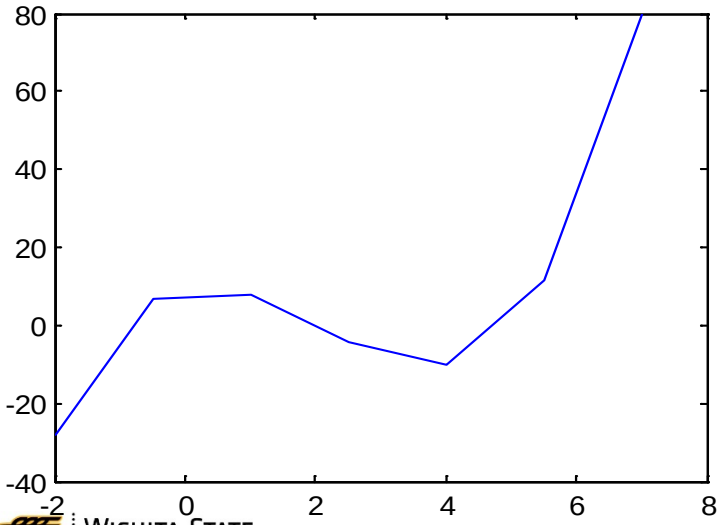
Click this icon to open plot tools

Common Errors

Choosing the x-axis values poorly.

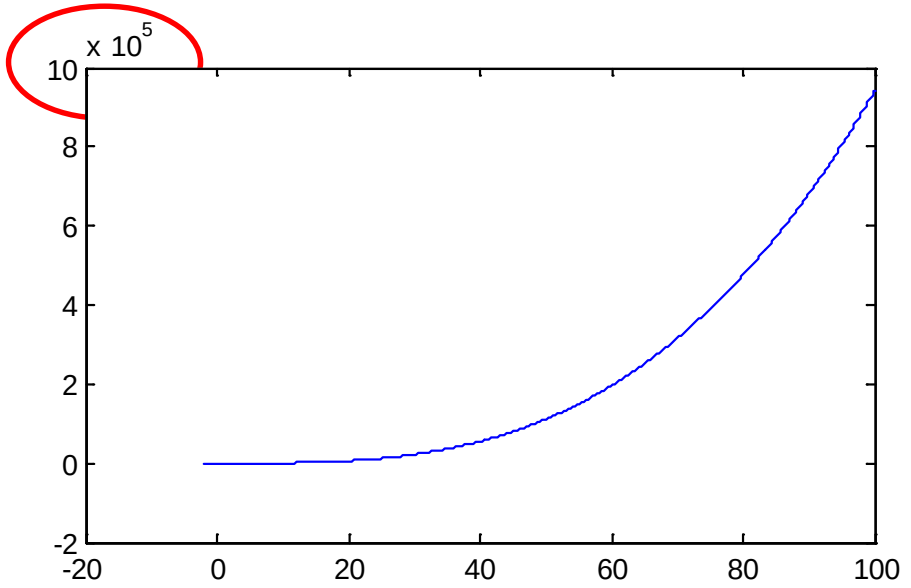
Increment too large:

```
>> t = -2:1.5:7;
>> y = t.^3-6*t.^2+3*t+10;
>> plot(t,y)
```



Poor choice for range of x-axis:

```
>> t = -2:0.01:100;
>> y = t.^3-6*t.^2+3*t+10;
>> plot(t,y)
```



Solving Equations Graphically

Suppose a capacitor is charging in an RC circuit and the voltage across the capacitor is given by:

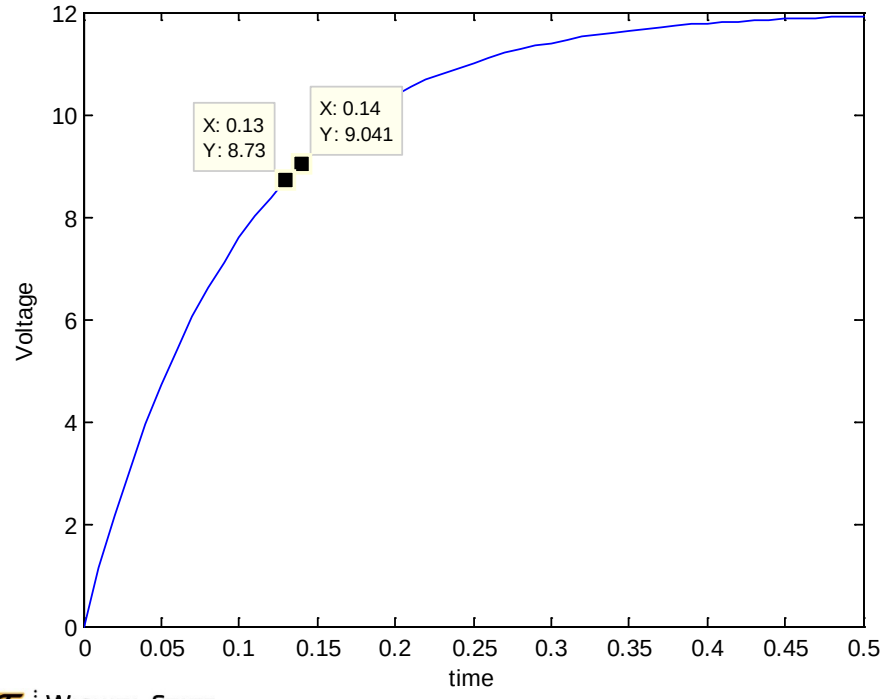
$$V_c = 12(1 - e^{-10t})$$

Vc is in volts and t is in seconds. Plot the voltage across the capacitor versus time then determine the time at which the capacitor voltage reaches 9 volts.

```
>> t = 0:0.01:0.5;
>> y = 12*(1-exp(-10*t));
>> plot(t,y);xlabel('time');ylabel('Voltage');
```

Solving Equations Graphically

In the Figure Window, Click on Tools then select Data Cursor. Click on graph – move data cursor if needed using arrow keys. To add additional datatips, right click on an existing datatip and select add new datatip.



The capacitor reaches 9 volts between t = 0.13 seconds and t = 0.14 seconds.

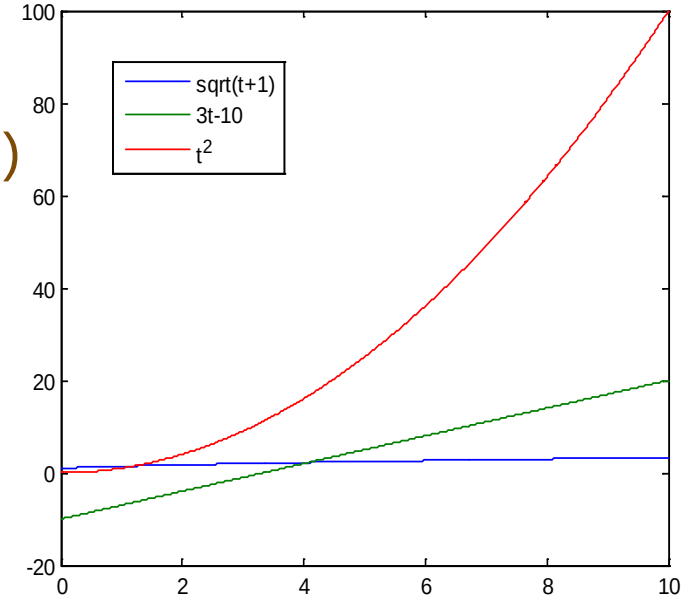
Note: Our precision is limited by the increment chosen for t which was 0.01 seconds in this example.

Multiple Plots on a Single Graph

Plot each of the following functions on the same graph:

$$f_1 = \sqrt{t+1} \qquad f_2 = 3 * t - 10 \qquad f_3 = t^2$$

```
>> t = 0:0.01:10;
>> f1 = sqrt(t+1); f2 = 3*t-10; f3 = t.^2;

>> plot(t,f1,t,f2,t,f3);
>> legend('sqrt(t+1)','3t-10','t^2')
```



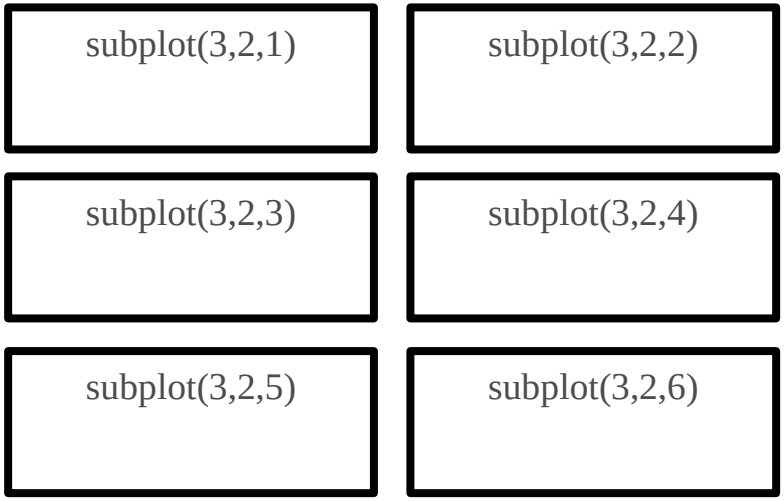
Note: These functions don't look so great on the same plot. The function t^2 increases so much faster than the square root function it causes the square root function to look pretty flat.

Subplot Command

subplot(m,n,k)

The subplot command splits the figure window into several sub-windows. The first two entries in subplot show how the window is to be split up by specifying number of rows and number of columns. The third entry points to a particular sub-window.

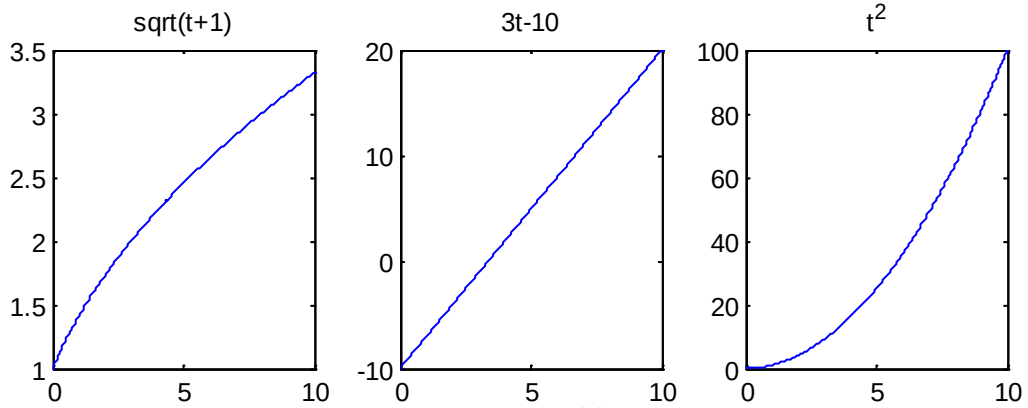
Subplot(3,2,4) would divide the plot window into 3 rows and 2 columns allowing for 6 smaller plot windows and would point to the 4th sub-window as shown in the diagram.



Multiple Plots Using Subplot

Repeat the previous example but put each plot in a separate sub-window of the figure using subplot.

```
>> t = 0:0.01:10;
>> f1 = sqrt(t+1); f2 = 3*t-10; f3 = t.^2;
>> subplot(1,3,1);
>> plot(t,f1);title('sqrt(t+1)')
>> subplot(1,3,2);plot(t,f2);title('3t-10')
>> subplot(1,3,3);plot(t,f3);title('t^2')
```



Some Useful Commands for Plotting

```
plot(x-coordinates, y-coordinates, formatting)
title('Insert Desired Title for Plot')
xlabel('Insert label for x-axis')
ylabel('Insert label for y-axis')
legend('Plot1 Label','Plot2 Label', …)
grid   % Adds a grid
close  % Closes the current figure window
figure % Creates a new figure window
subplot(m,n,k) %Subdivides a figure window into
m by n subwindows & points to the kth subwindow
axis([xmin xmax ymin ymax]) %Set axis scale
hold on  %Holds current plot on & allows add-ons
hold off  % Turns off the hold
```

Your Turn …

Try these commands (one at a time) in MATLAB. Explain what each command does.

```
>> t = -4:0.001:4;
>> y1 = t.^2;
>> plot(t,y1); xlabel('t')
>> close

>> y2 = (t-1).^2;
>> plot(t,y1,t,y2); legend('t^2','(t-1)^2');
>> close

>> subplot(2,1,1);plot(t,y1);title('t^2');
>> subplot(2,1,2); plot(t,y2);title('(t-1)^2');
```