

# Lecture 3 for Math 398 Section 952: Graphics in Matlab

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**Fall 2002**

A good deal of this material comes from the text by Desmond Higman and Nicholas Higman, *Matlab Guide*, SIAM, Philadelphia, 2000.

## Two Dimensional Graphics

### Basic Graphics

Start Matlab. We'll plot as usual, but get help to guide us along. The plot command has many options. We'll hit the highlights. We'll also keep a help window open so we can peruse the help files as we go. After we open it, we'll move it to a corner.

```
helpwin
```

Now click on plot in the Help Window and examine the possibilities for the 1-3 character string S.

```
x = 0:0.01:1; % create array of abscissas and supress output
y1 = 4*x.*(1-x);
plot(x, y1, 'r+:')
```

A plot with multiple curves is possible without doing a "hold on":

```
y2 = sin(pi*x);
plot(x, y1, 'r+:', x, y2, 'g')
```

We can make it fancier. For example

```
xlabel('x')
ylabel('y')
title('Comparison of 4x(1-x) and sin(\pi x).')
```

As a matter of fact, you can massage your plot window quite a bit with the tools available in the tool bar. For example, click on the arrow icon and then draw an arrow on the inside of the curves pointing to the inner curve. Then click on the A icon (A for ascii) and click at the base of the arrow. Then type in "4\*x\*(1-x)". There are lots of other things one can do to a graph from the graph window itself.

You can even save your figures to many different formats. Click on the File button, then the menu choice Export. Select under "Save as type:" the choice Portable Document Format. Then browse to the directory you want, edit the name of the file, say to "junk.pdf." Then click on Save. Now use the Windows Explorer to find the file you've created and double click on it. Acrobat will now show you your picture.

There are a number of alternates to the plot command as well. Look in the Help Window. There's even an ezplot which is a Maple rip-off (or is it the other way around?). Try these:

```
ezplot('4*x*(1-x)')
polar(x,y2)
```

Interesting. Let's stretch it out.

```
x = 0:0.01:60;
y2 = sin(pi*x);
polar(x,y2)
```

## Axes and Other Controls

There are other ways to massage your graph. For example, start with

```
ezplot('4*x*(1-x)')
hold on
ezplot('sin(pi*x)')
```

Not very good. Let's fiddle it a bit:

```
axis equal
axis off
axis([0 1 0 1.2])
axis on
```

Well, let's just do it again:

```
x = 0:.01:1;
y1 = 4*x*(1-x);
y2 = sin(pi*x);
plot(x,y1,'--', x, y2, 'r:')
legend('4x(1-x)', 'sin(\pi x)')
title('\it Comparison of 4x(1-x) and sin(\pi x)')
```

What do you notice about the graph?

## Multiple Plots

Here is the way to construct multiple plots, along with another variation on plot:

```
subplot(2,2,1)
plot(x,y1)
subplot(222)
fplot('sin(x)', [0 1])
subplot(223)
fplot('sin(round(2*pi*x))', [0 1], 'r--')
subplot(224), polar(x,y2)
```

## Three Dimensional Graphics

### Curves and Surfaces

This gets a bit more complicated. Let's start with a 3-D parametric curve.

```
t = -5: 0.005: 5;
x = (1+t.^2).*sin(20*t);
y = (1+t.^2).*cos(20*t);
z = t;
plot3(x,y,z)
grid on
xlabel('x(t)'), ylabel('y(t)'), zlabel('z(t)')
title('A {\it plot3} example')
```

Now try the Tools button on the Figure window and click Rotate 3D. Then go to the figure with the cursor and move it about.

For functions of two variables, there are many graphing possibilities. Try the Help window for graph3d. One possibility is simply to do the graph. For example, suppose we want to see a surface graph of  $f(x, y) = \sin(3y - x^2 + 1) + \cos(2y^2 - 2x)$  on the square  $-1 \leq y \leq 1$ ,  $-2 \leq x \leq 2$ . The first problem is to generate a suitable “mesh” of  $x$ - and  $y$ -coordinates. Do the following:

```
x = -2:.01:2;
y = -1:.01:1;
[X,Y] = meshgrid(x,y);
Z = sin(3*Y - X.^2 + 1) + cos(2*Y.^2 - 2*X);
subplot(311)
plot3(X, Y, Z)
subplot(312)
mesh(X, Y, Z)
```

### Contour Graphs

There is another approach, namely the idea of level curves

```
subplot(313)
contour(x,y,Z,20)
```

There is also an ezcontour that does things automatically

```
subplot(312)
ezcontour('sin(3*y-x^2+1)+cos(2*y^2-2*x)', [-2 2 -1 1])
```

### Some Specialized Graphs

One can do bar graphs, pie graphs and area graphs. We'll just do a simple bar graph with the following calculations:

```

Y = [7 6 5; 6 8 1; 4 5 9; 2 3 4; 9 7 2]
subplot(2,2,1)
bar(Y)
title('bar(...,"grouped")')
subplot(2,2,2)
bar(0:5:20,Y)
title('bar(...,"grouped")')
subplot(2,2,3)
bar(Y,'stacked')
title('bar(...,"stacked")')
subplot(2,2,4)
barh(Y)
title('barh')

```

## Handle Graphics

### Getting a Handle on Things

Matlab graphics are strongly object oriented. Graphics builds everything from objects, organized into a hierarchy which is tree structured with the root object as the top parent. Every object has properties, that control its appearance and behavior. For example, close all graphics windows and type

```

clear
plot(1:10, 'o-')
h = findobj

```

What is returned are the “handles” (this is like a pointer or index) to all current objects. Of course, the first handle refers to root. The second is that of the subobject figure that we drew, etc. To get all the types, type

```

get(h,'type')

```

To see the properties of, say the axes, type

```

set(h(3))

```

This is a huge subject, and we'll just do one very simple application. Suppose we want to work with two figures. Here's how, from the object point of view.

```

fig1 = h(2)
fig2 = figure % create a new figure and get it's handle as fig2
ezplot('x*sin(x)', [0 10])
grid

```

Now suppose you want to address the first figure; make it active by the command:

```

figure(fig1)

```

```
grid
```

There is another, more GUI oriented, way to examine and manipulate objects and properties: either click on the Edit button in the figure in question, then click on Figure Properties, or type this command:

```
propedit(fig1)
```

Either way, you get a Property window. Now suppose you want to endow the window containing your figure with a title. Click on the Title tab, then simply type in your new title and click on Apply. Once open, you can use the propedit window to edit any object. Click on the down arrow of the Edit Properties For box and select the object axis. Now click on the labels tab, and change the Figure title to whatever you want. Browse around a bit, and you'll find just about any property that you would want to modify.

## Animation

One can animate by either saving a sequence of figures and replaying them as a movie, or by manipulating the XData, YDate and ZData properties of objects. Here is the movie approach:

```
figure
for j = 1:20
ezsurf('sin(x*y)', [-2-5+0.5*j 2-5+0.5*j -2 2]);
M(j) = getframe;
end
delete(gcf)
disp('Here comes the movie')
movie(M)
```

The second type of animation can be obtained, e.g., by using the comet function:

```
x = -20:.01:20;
y=x.*sin(x);
comet(x,y)
```

End of Lesson