MATLAB Tutorial

Chapter 3. Basic graphing routines
3.1. 2-D plots

The basic command for making a 2-D plot is "plot". The following code makes a plot of the function \( \sin(x) \).
\[
x = \text{linspace}(0, 2\pi, 200);
f_1 = \sin(x);
\text{plot}(x, f_1)
\]

we now add a title and labels for the x and y axes
\[
\text{title('Plot of } f_1 = \sin(x)');
\text{xlabel('x');}
\text{ylabel('f_1');}
\]

Let us change the axes so that they only plot x from 0 to 2\(\pi\).
\[
\text{axis([0 2*\pi -1.1 1.1])}
\]

Next, we make a new figure with \( \cos(x) \)
\[
f_2 = \cos(x);
\text{figure;}
\text{plot}(x, f_2);
\text{title('Plot of } f_2 = \cos(x)');
\text{xlabel('x');}
\text{ylabel('f_2');}
\text{axis([0 2*\pi -1.1 1.1])}
\]

Now, we make a single graph with both plots
\[
\text{figure;}
\text{plot}(x, f_1);
\text{hold on;}
\text{plot}(x, f_2, 'r');
\text{title('Plots of } f_1 = \sin(x), f_2 = \cos(x)');
\text{xlabel('x');}
\text{ylabel('f_1, f_2');}
\text{axis([0 2*\pi -1.1 1.1])}
\]

What happens if you forget to type hold on? "hold off" removes the hold.
\[
\text{plot}(x, f_2, 'r');
\text{title('Plots of } f_1 = \sin(x), f_2 = \cos(x)');
\text{xlabel('x');}
\text{ylabel('f_1, f_2');}
\text{axis([0 2*\pi -1.1 1.1])}
\]

Now we add a legend.
\[
\text{legend('f_1', 'f_2');}
\]

If we want to move the legend, we can go to the "Tools" menu of the figure window and turn on "enable plot editing" and then drag the legend to where we want it.

Finally, we use the command "gtext" to add a line of text that we then position on the graph using our cursor.
\[
\text{gtext('f_1=f_2 at two places');}
\]

The command "help plot" tells how to make a graph using various types of points instead of lines and how to select different colors.

\[
\text{clear all}
\]
3.2. 3-D plots

First, we generate a grid containing the x and y values of each point.
\[ x = 0:0.2:2*pi; \] create vector of points on x-axis
\[ y = 0:0.2:2*pi; \] create vector of points on y-axis

Now if \( n = \text{length}(x) \) and \( m = \text{length}(y) \), the grid will contain \( N = n \times m \) grid points. XX and YY are \( n \) by \( m \) matrices containing the x and y values for each grid point respectively.
\[ [XX,YY] = \text{meshgrid}(x,y); \]

The convention in numbering the points is apparent from the following lines.
\[ x2 = 1:5; \quad y2 = 11:15; \]
\[ [XX2,YY2] = \text{meshgrid}(x2,y2); \]
XX2, YY2

This shows that \( XX2(i,j) \) contains the \( j \)th component of the x vector and \( YY2(i,j) \) contains the \( i \)th component of the y vector.

Now, we generate a function to save as a separate z-axis value for each \((x,y)\) 2-D grid point.
\[ Z1 = \sin(XX) \times \sin(YY); \] calculate value of function to be plotted

create a colored mesh plot
\[ \text{figure; mesh}(XX,YY,Z1); \]
\[ \text{xlabel('x'); ylabel('y'); zlabel('z'); title('sin(x)*sin(y)');} \]

create a colored surface plot
\[ \text{figure; surf}(XX,YY,Z1); \]
\[ \text{xlabel('x'); ylabel('y'); zlabel('z'); title('sin(x)*sin(y)');} \]

create a contour plot
\[ \text{figure; contour}(XX,YY,Z1); \]
\[ \text{xlabel('x'); ylabel('y'); zlabel('z'); title('sin(x)*sin(y)');} \]

create a filled contour plot with bar to show function values
\[ \text{figure; contourf}(XX,YY,Z1); \text{colorbar}; \]
\[ \text{xlabel('x'); ylabel('y'); zlabel('z'); title('sin(x)*sin(y)');} \]

create a 3-D contour plot
\[ \text{figure; contour3}(XX,YY,Z1); \]
\[ \text{xlabel('x'); ylabel('y'); zlabel('z'); title('sin(x)*sin(y)');} \]

clear all

3.3. Making complex figures

Using the subplot command, one can combine multiple plots into a single figure. We want to make a master figure that contains \# of rows of figures and \# of figures per row. \text{subplot}(nrow,ncolumn,i) makes a new figure window within the master plot, where \( i \) is a number denoting the position within the master plot according to the following order:
\[ 1 \quad 2 \quad 3 \quad \ldots \quad \text{ncol} \]
\[ \text{ncol}+1 \quad \text{ncol}+2 \quad \text{ncol}+3 \quad \ldots \quad 2\times\text{ncol} \]

First, generate the data to be plotted.
\[ x = 0:0.2:2*pi; \]
\[
y = 0:0.2:2*pi;
f1 = \sin(x);
f2 = \cos(y);
[XX,YY] = \text{meshgrid}(x,y);
Z1 = \sin(XX) .* \cos(YY);
\]

The following code creates a figure with four subplots.

```matlab
figure; % create a new figure

subplot(2,2,1); % create 1st subplot window
plot(x,f1); title('\sin(x)');
xlabel('x'); ylabel('\sin(x)'); axis([0 2*pi -1.1 1.1]);

subplot(2,2,2); % create 2nd subplot window
plot(y,f2); title('\cos(y)');
xlabel('y'); ylabel('\cos(y)'); axis([0 2*pi -1.1 1.1]);

subplot(2,2,3); % create 3rd subplot window
surf(XX,YY,Z1); title('\sin(x)\times\cos(y)');
xlabel('x'); ylabel('y'); zlabel('z');

subplot(2,2,4); % create 4th subplot window
contourf(XX,YY,Z1); colorbar; title('\sin(x)\times\cos(y)');
zlabel('x'); ylabel('y');

clear all
```