

## LESSON 05: PLOTTING

We’ve toyed a lot with how to perform calculations, but it’s not awfully useful if we can’t visualize them. Thankfully, MATLAB offers us a wide array of plotting functionality to help us visualize our data.

### Graphic Objects

MATLAB organizes graphical objects into a hierarchical structure<sup>1</sup>:

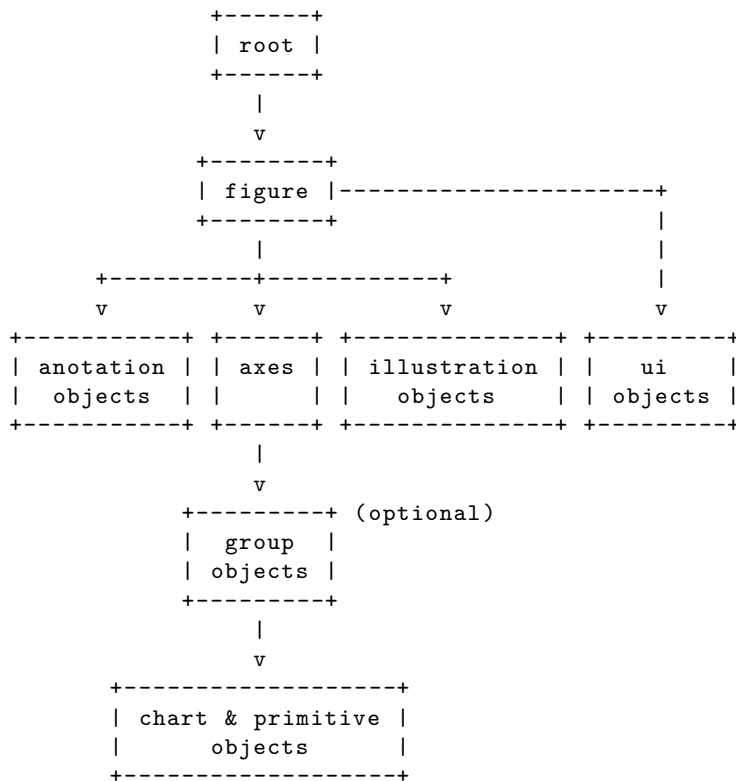


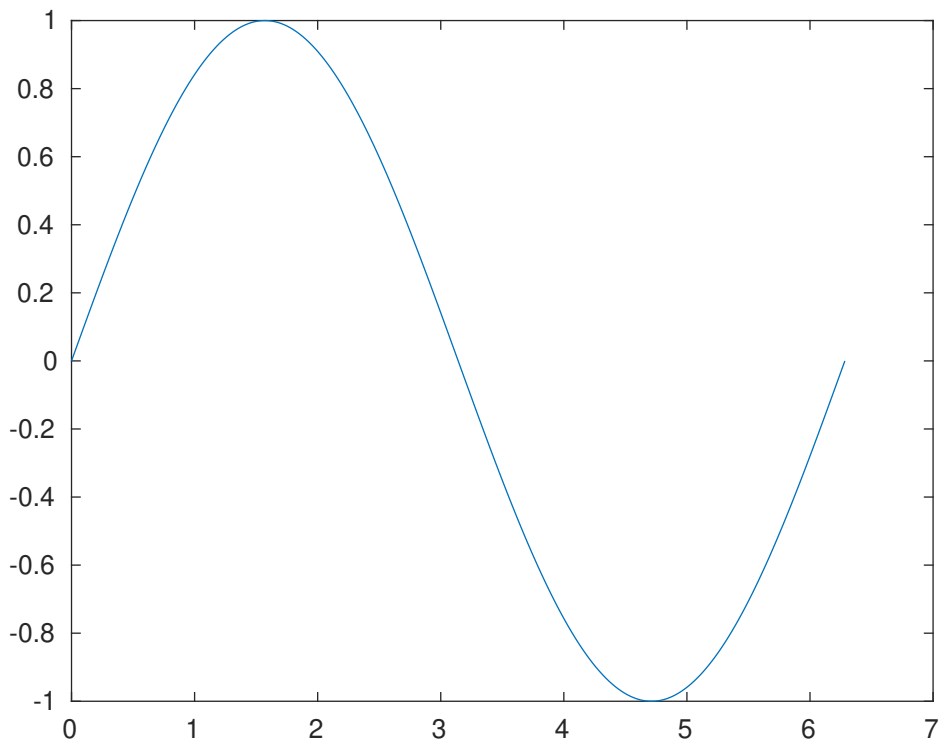
Figure 1: Organization of Graphics Objects

<sup>1</sup><https://www.mathworks.com/help/matlab/graphics-objects.html>

## 2-D Plots

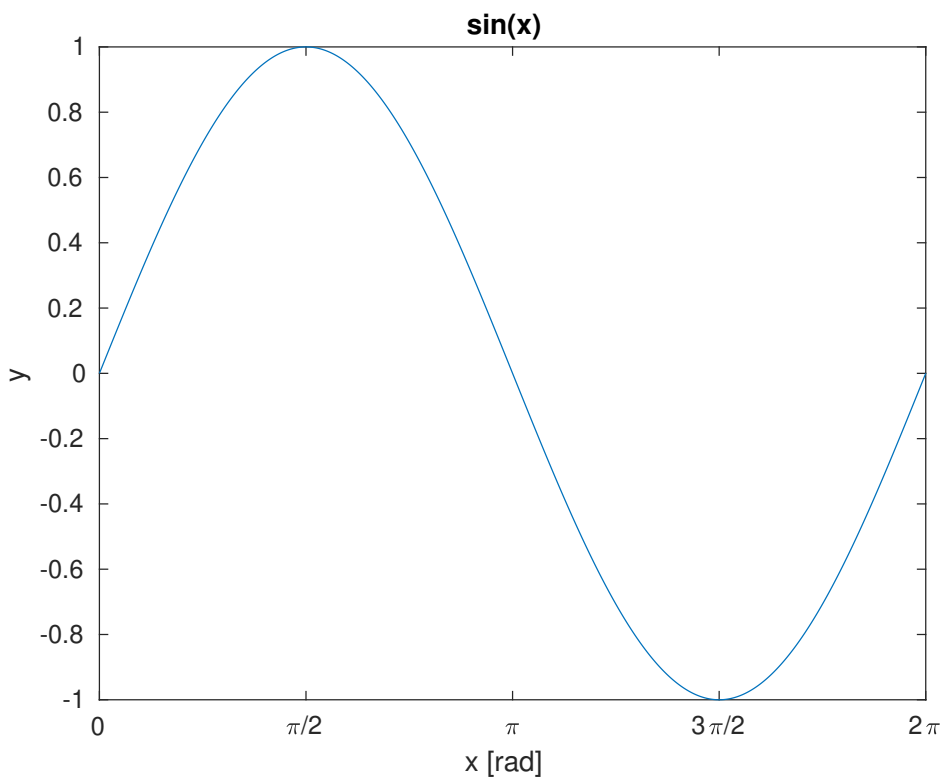
There's not much point in explaining. Let's jump right into an example.

```
1 x = linspace(0, 2 * pi, 1e3);  
2 y = sin(x);  
3  
4 figure;  
5 plot(x, y);
```



Here `figure` creates a new figure that `plot` can interact with. Although we successfully plotted our sine wave, it's quite ugly. Let's take the liberty to make it a little more pretty.

```
1 x = linspace(0, 2 * pi, 1e3);
2 y = sin(x);
3
4 figure;
5 plot(x, y);
6 title('sin(x)');
7 xlabel('x [rad]');
8 xlim([x(1), x(end)]);
9 xticklabels({'0', '\pi/2', '\pi', '3\pi/2', '2\pi'});
10 xticks([0, pi / 2, pi, 3 * pi / 2, 2 * pi]);
11 ylabel('y');
```

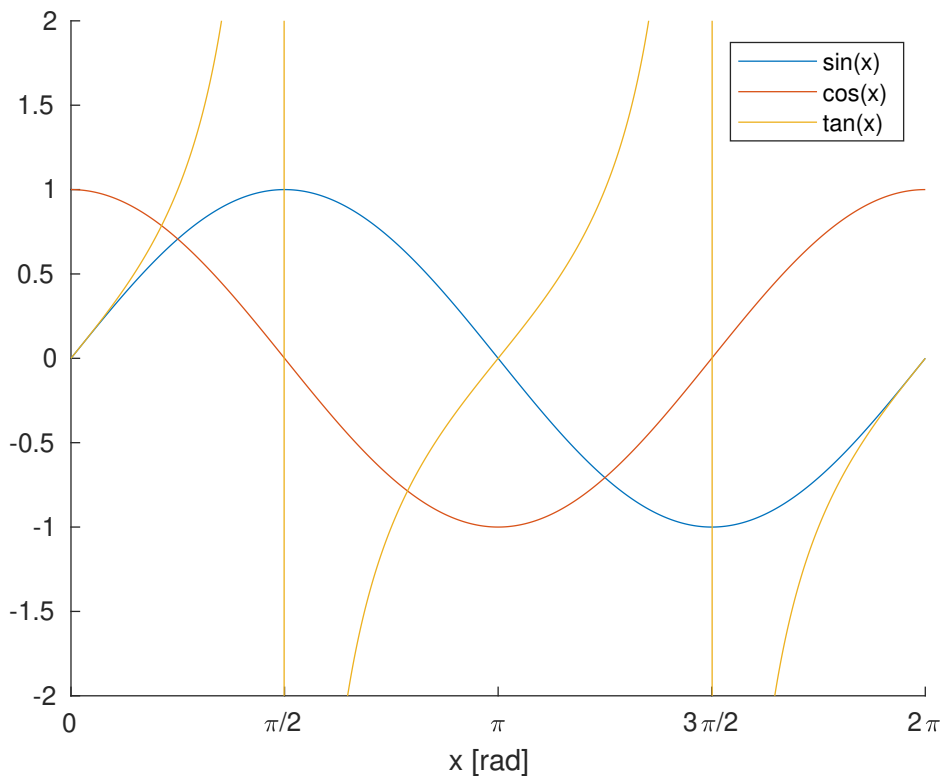


## Retaining Plots

Say we wanted to plot multiple functions on the same plot:

```
1 x = linspace(0, 2 * pi, 1e3);
2 f = {@sin, @cos, @tan};
3
4 figure;
5 hold on;
6 for i = 1:numel(f)
7     plot(x, f{i}(x));
8 end
9 xlabel('x [rad]');
10 legend('sin(x)', 'cos(x)', 'tan(x)');
11 xlim([x(1), x(end)]);
12 xticklabels({'0', '\pi/2', '\pi', '3\pi/2', '2\pi'});
13 xticks([0, pi / 2, pi, 3 * pi / 2, 2 * pi]);
14 ylim([-2, 2]);
```

**Aside—**  
`hold on` can be a back stabber! Sometimes you may experience buggy behavior if you call it before the first plot.

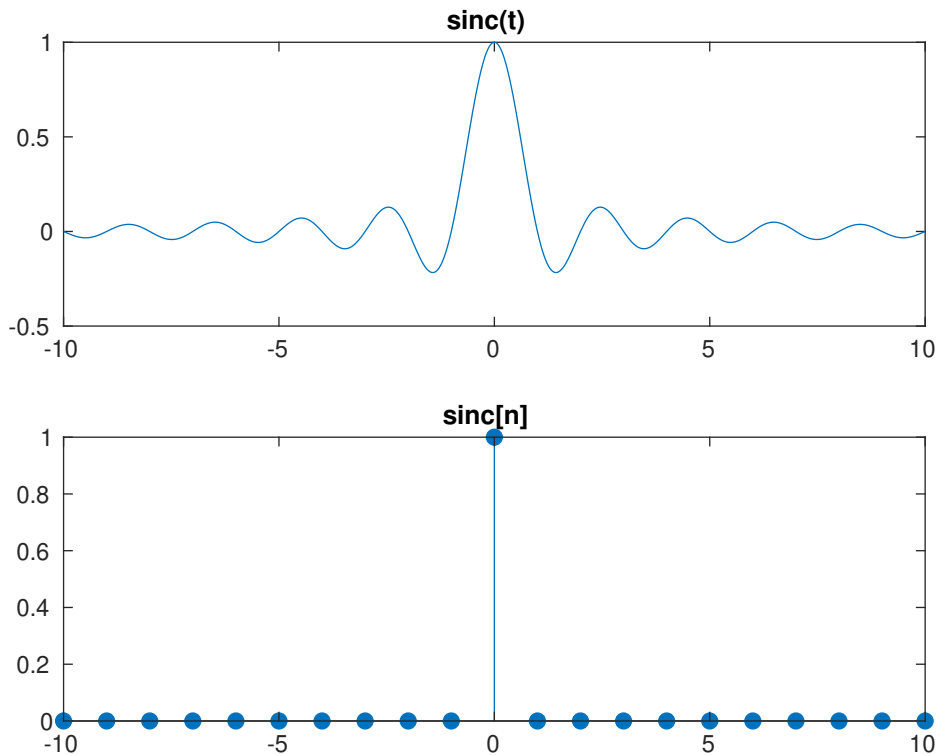


## Subplots

We can have multiple plots in a figure by doing the following:

```
1 t = linspace(-10, 10, 1000);
2 n = -10:10;
3
4 figure;
5
6 subplot(2, 1, 1);
7 plot(t, sinc(t));
8 title('sinc(t)');
9
10 subplot(2, 1, 2);
11 stem(n, sinc(n), 'filled');
12 title('sinc[n]');
```

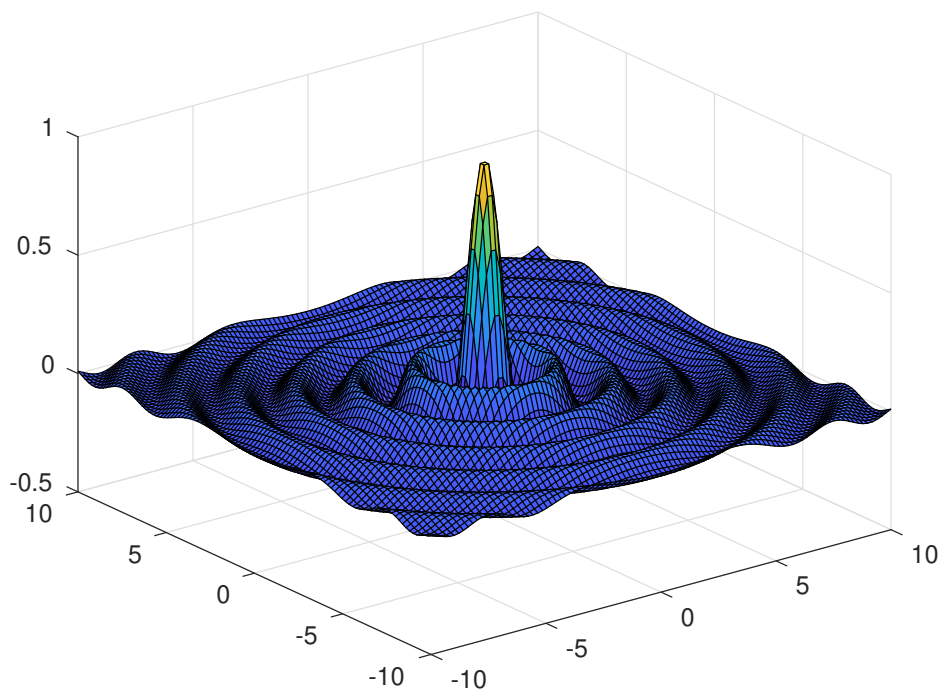
**Aside—**  
Notice the  
zero-crossing  
property of  
the sinc  
function!



## 3-D Plots

MATLAB is also capable of making 3-D plots:

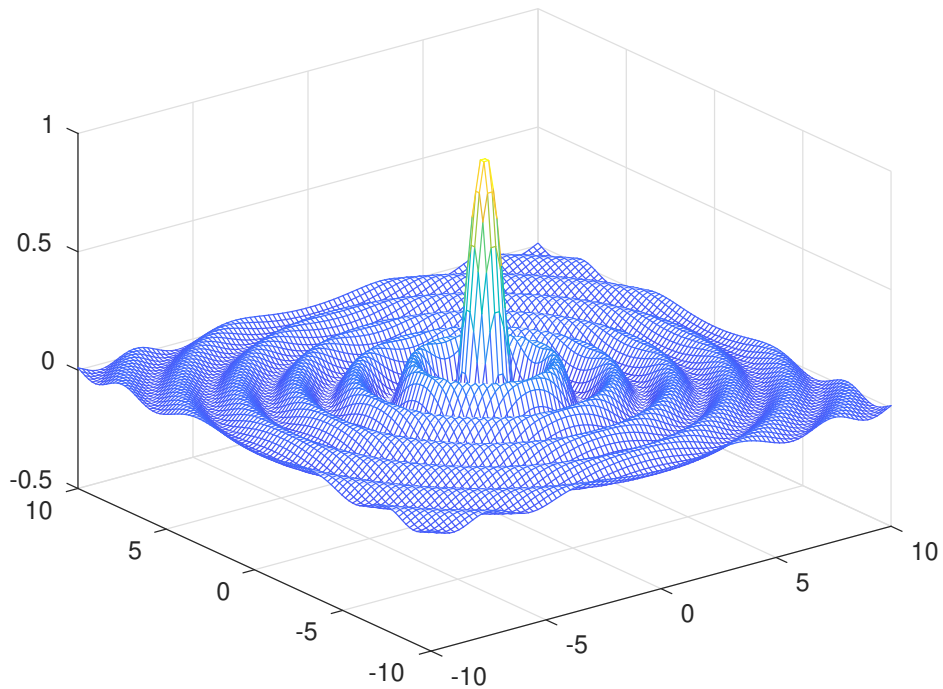
```
1 x = linspace(-10, 10, 100);  
2 y = x;  
3  
4 [X, Y] = meshgrid(x, y);  
5 R = sqrt(X.^2 + Y.^2);  
6  
7 figure;  
8 surf(X, Y, sinc(R));
```



You can think of `meshgrid` as the Cartesian product of the two input vectors split over two output matrices. Having these matrices allows us to evaluate functions over a 2-D plane.

We can also use a mesh instead:

```
1 figure;  
2 mesh(X, Y, sinc(R));
```



## More Plotting Functionality

This barely scratches the surface of MATLAB's extensive plotting functionality. Once again, the online documentation is a great starting point for the interested reader: <https://www.mathworks.com/help/matlab/2-and-3d-plots.html>