# 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>:

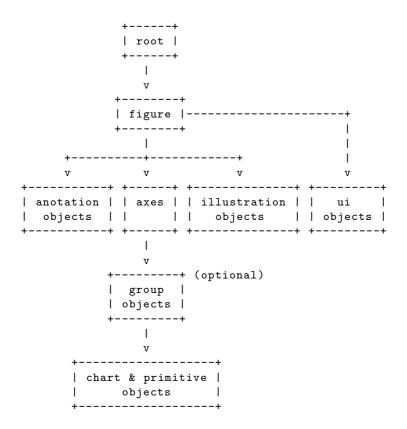


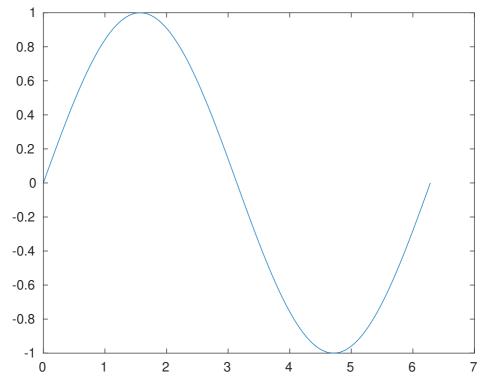
Figure 1: Organization of Graphics Objects

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

### 2-D Plots

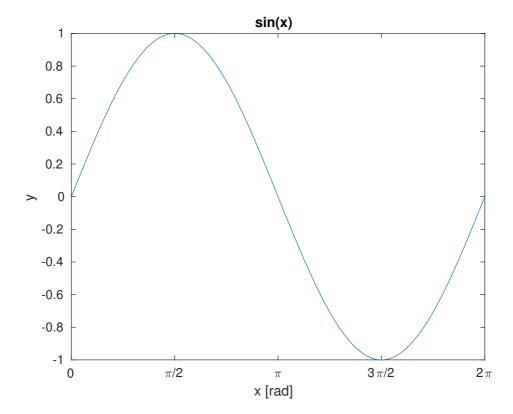
There's not much point in explaining. Let's jump right into an example.

```
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:

```
x = linspace(0, 2 * pi, 1e3);
   f = {@sin, @cos, @tan};
2
   figure;
   hold on;
5
   for i = 1:numel(f)
        plot(x, f{i}(x));
   end
8
   xlabel('x [rad]');
9
   legend('sin(x)', 'cos(x)', 'tan(x)');
10
   xlim([x(1), x(end)]);
11
   xticklabels({'0', '\pi/2', '\pi', '3\pi/2', '2\pi'});
12
   xticks([0, pi / 2, pi, 3 * pi / 2, 2 * pi]);
13
   ylim([-2, 2]);
14
      2
                                                                   sin(x)
                                                                   cos(x)
    1.5
                                                                   tan(x)
      1
    0.5
      0
   -0.5
     -1
```

x [rad]

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

 $\pi/2$ 

-1.5

-2 <sup>L</sup>

 $2\pi$ 

 $3\pi/2$ 

# Subplots

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

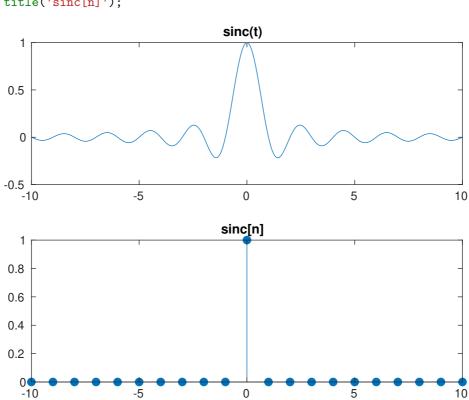
```
t = linspace(-10, 10, 1000);
n = -10:10;

figure;

subplot(2, 1, 1);
plot(t, sinc(t));
title('sinc(t)');

subplot(2, 1, 2);
tem(n, sinc(n), 'filled');
title('sinc[n]');
```

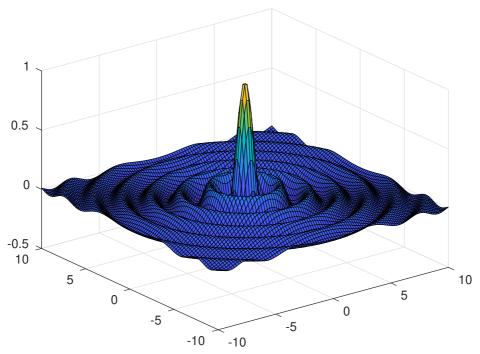
Aside— Notice the zero-crossing property of the sinc function!



#### 3-D Plots

MATLAB is also capable of making 3-D plots:

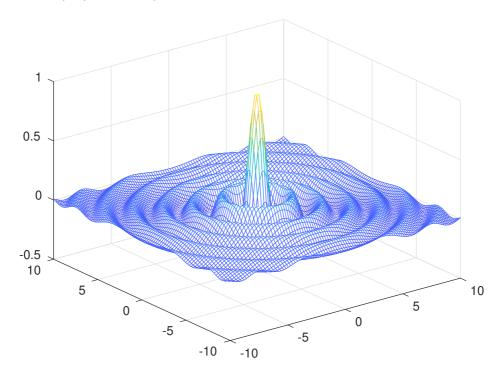
```
1  x = linspace(-10, 10, 100);
2  y = x;
3
4  [X, Y] = meshgrid(x, y);
5  R = sqrt(X.^2 + Y.^2);
6
7  figure;
8  surf(X, Y, sinc(R));
```



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;
- 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