CDS 230
Modeling and Simulation I

Module 7

Matplotlib

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matplotlib

- Capabilities and terminology (axis, figure, plot etc.) are inspired by Matlab's plotting functionality

Two similar ways to use Matplotlib

1) object-oriented way

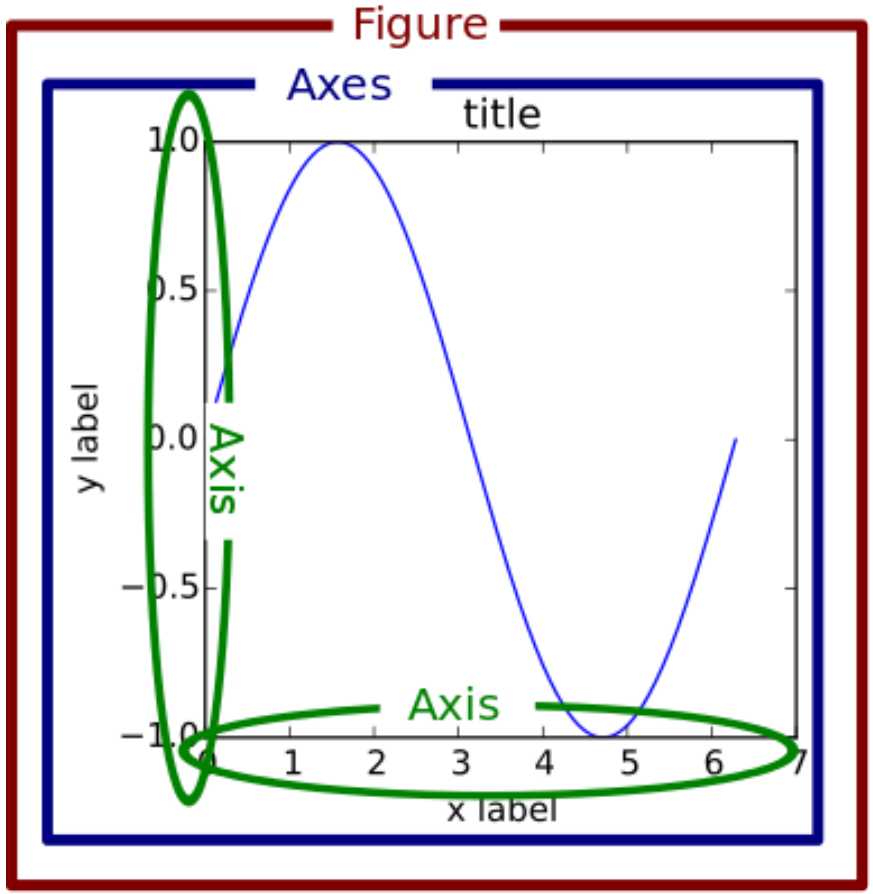
- The user can extend Figure class
- Each state of a figure/axis etc. should be tracked by the user.
- Allows making more customized plots
- Good for production code

2) `pyplot`

- Matlab style plotting
- Keeps the state of current plot without the user saving it
- Ideal for Anaconda Notebooks

```
import matplotlib.pyplot as plt
```

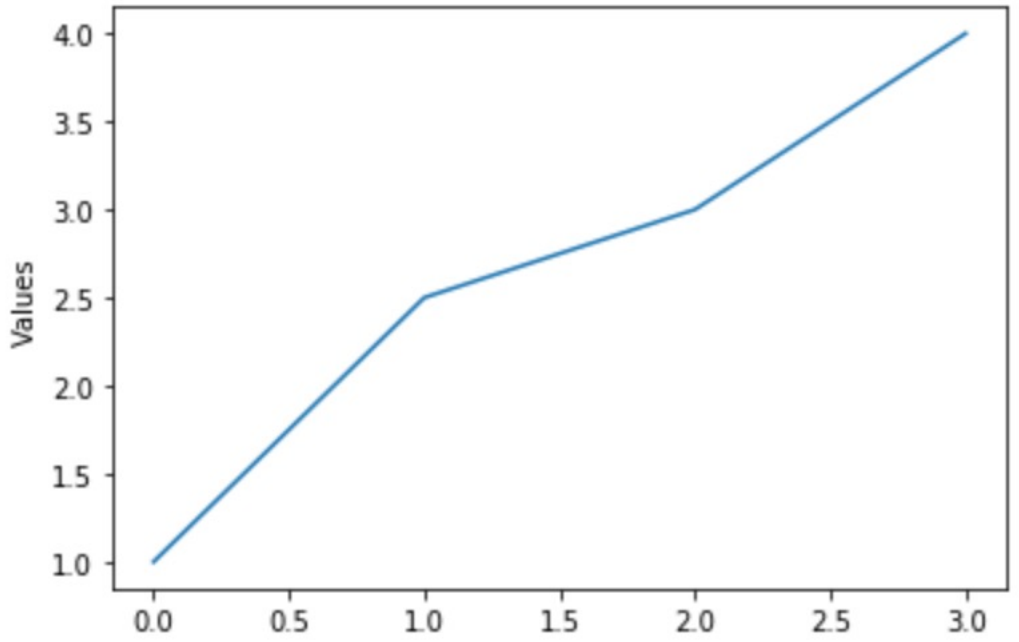
Basic Matplotlib terms



Source: https://realpython.com/python-matplotlib-guide/

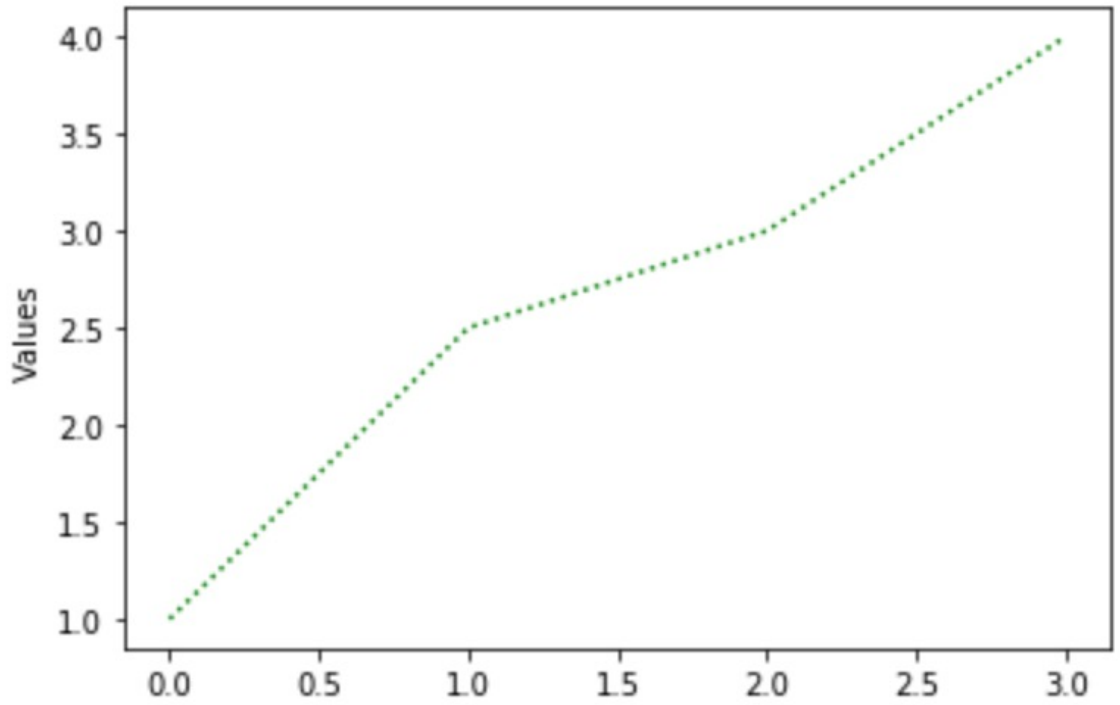
Our first plot

```
import matplotlib.pyplot as plt
plt.plot([1, 2.5, 3, 4])
plt.ylabel('Values')
plt.show()
```



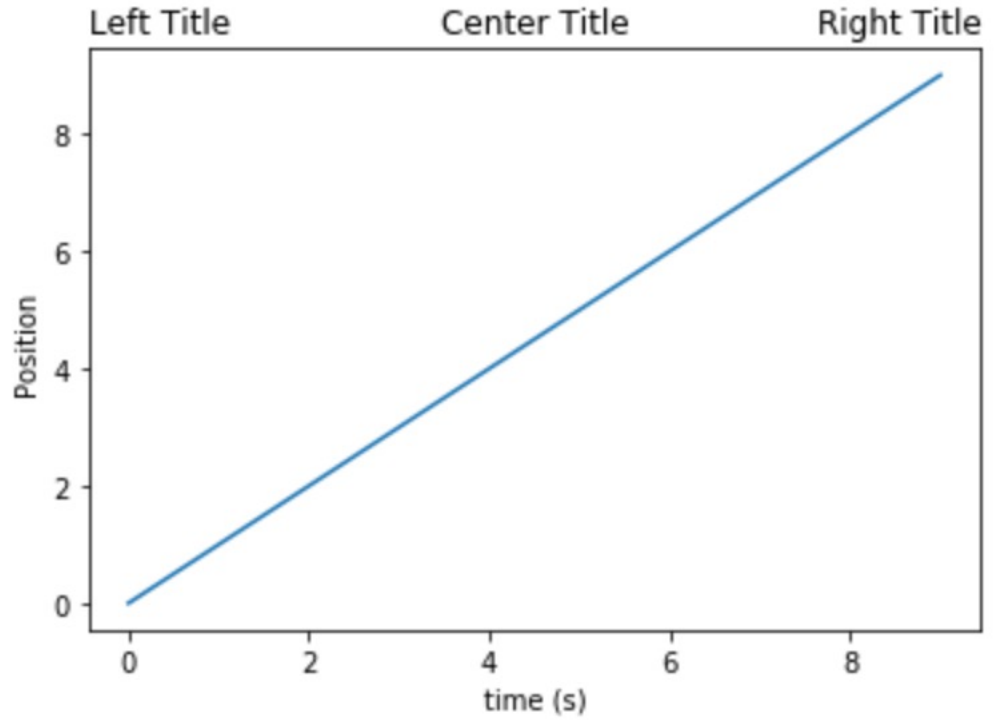
Customization

```
plt.plot([1,2.5,3,4],linestyle='dotted',color='green')
plt.ylabel('Values')
plt.show()
```



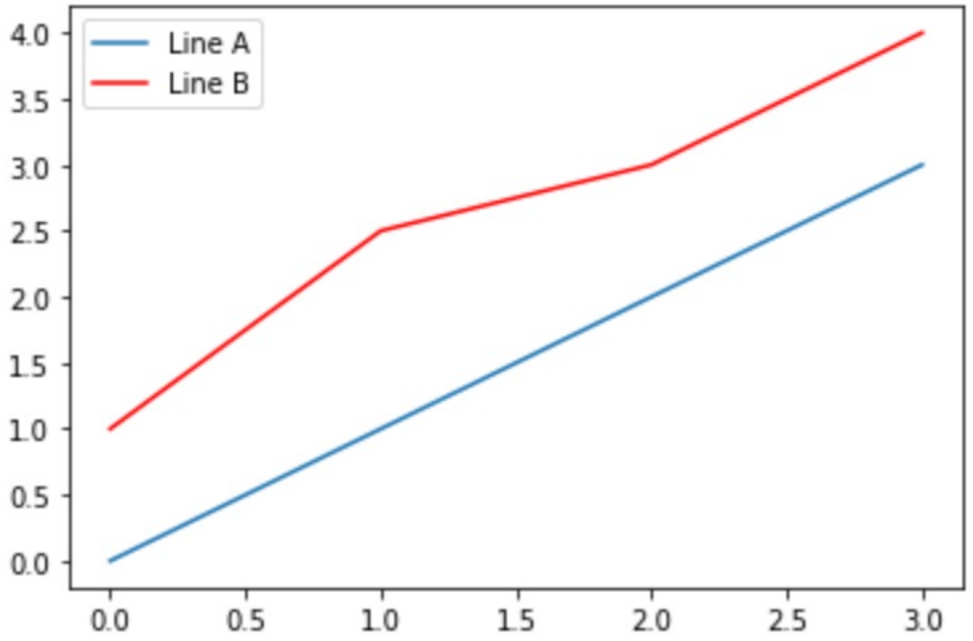
More customization

```
plt.plot(range(10))
plt.title('Center Title')
plt.title('Left Title', loc='left')
plt.title('Right Title', loc='right')
plt.xlabel('time (s)')
plt.ylabel('Position')
plt.show()
```



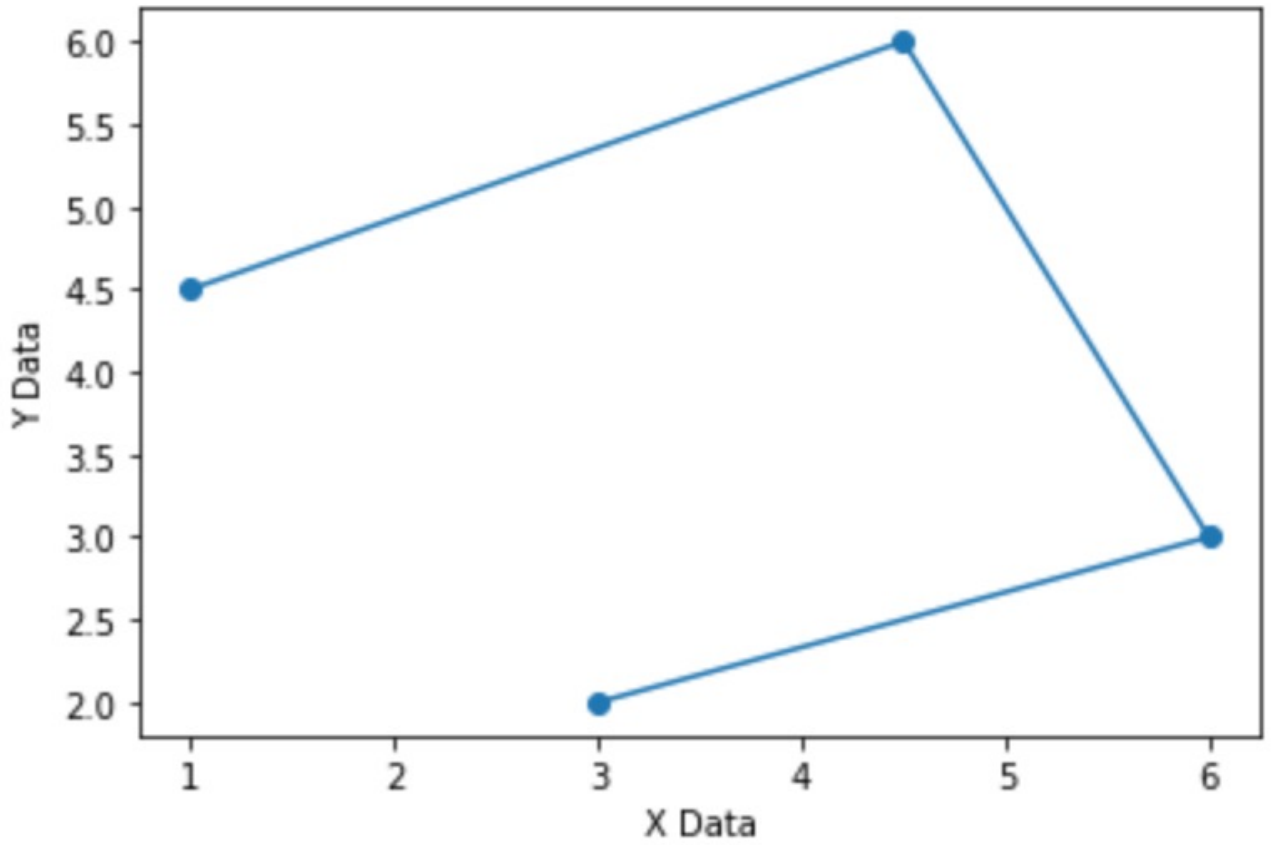
Plotting multiple lines

```
plt.plot(range(4), label="Line A")
plt.plot([1,2.5,3,4], color="red", label="Line B")
plt.legend()
plt.show()
```



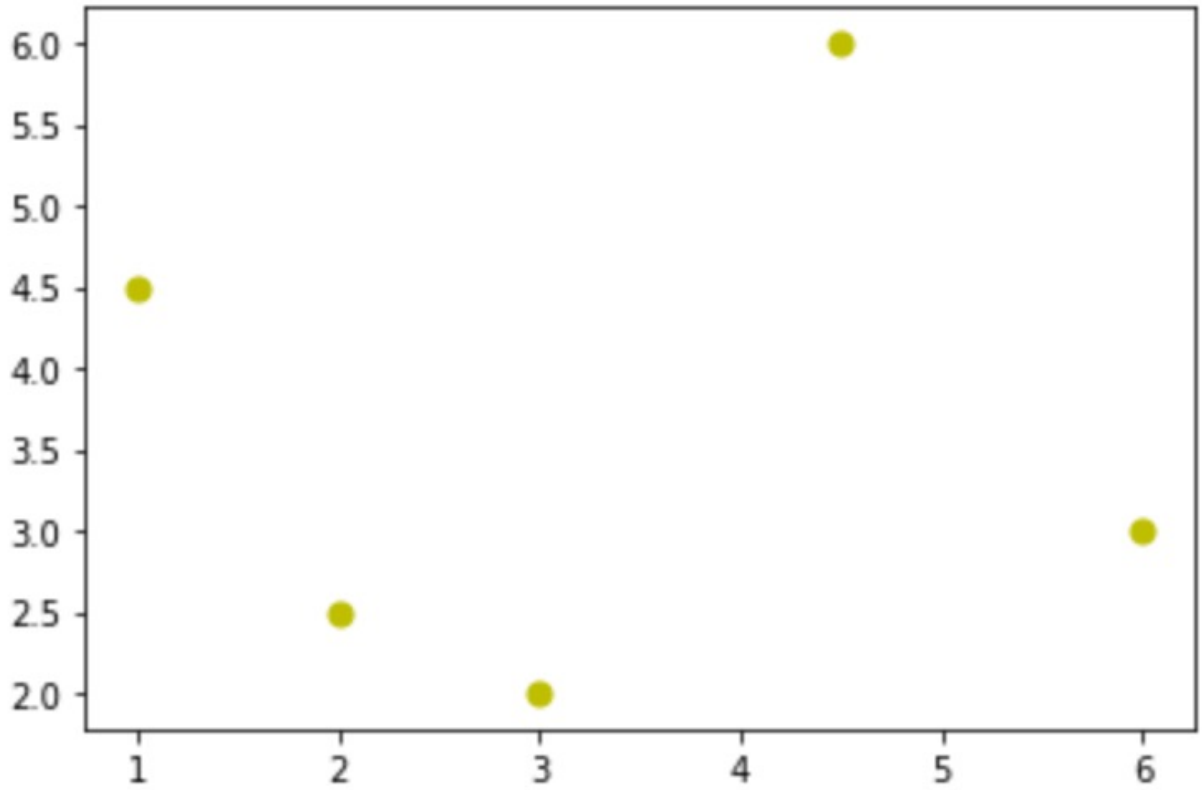
Plotting two dimensional data

```
x  = [1,4.5,6,3]
y  = [4.5,6,3,2]
plt.plot(x,y, marker='o')
plt.xlabel('X Data')
plt.ylabel('Y Data')
plt.show()
```

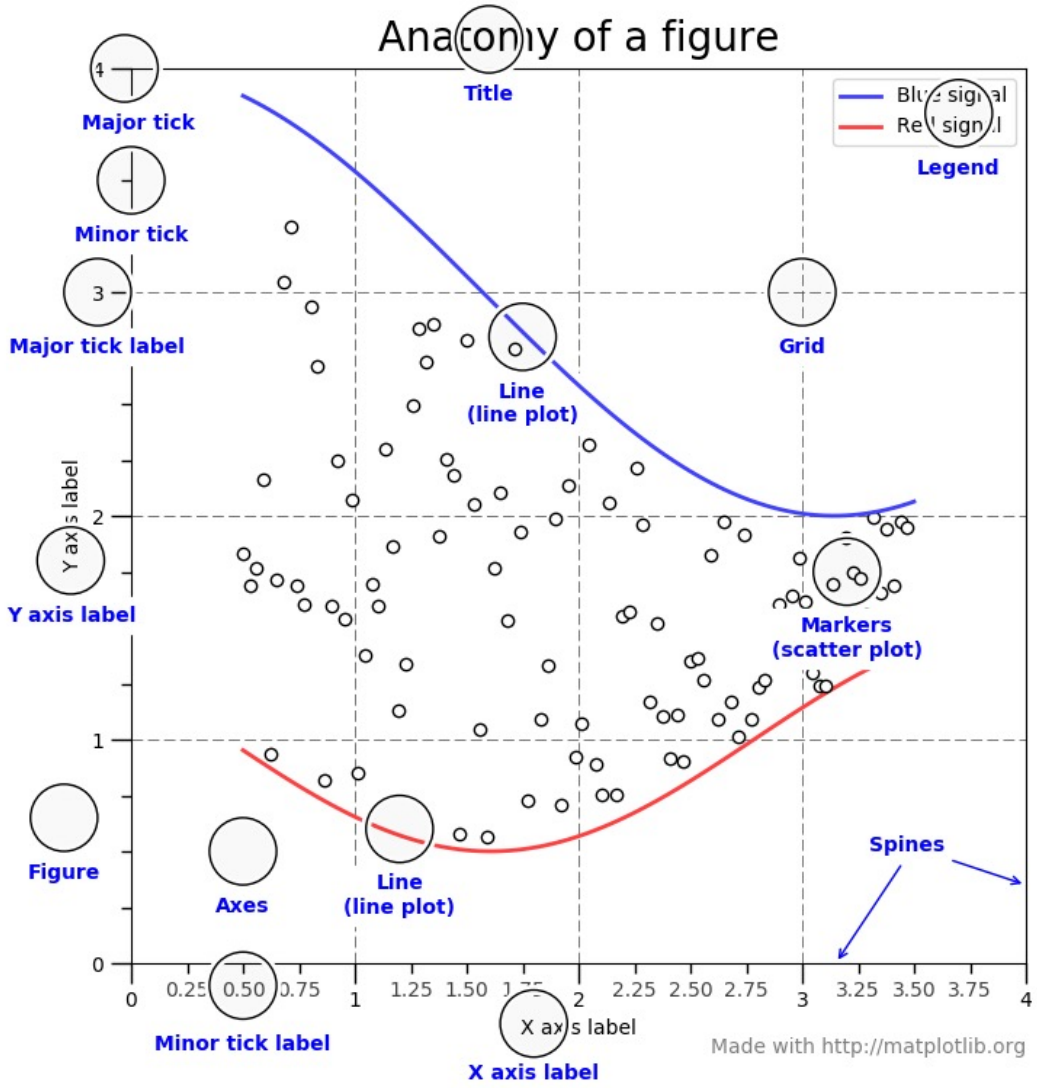


Scatter plot

```
x  = [1,4.5,6,3, 2]
y  = [4.5,6,3,2, 2.5]
plt.scatter(x,y,50,"y")
plt.show()
```



Anatomy of Matplotlib figures



Source: https://matplotlib.org/examples/showcase/anatomy.html

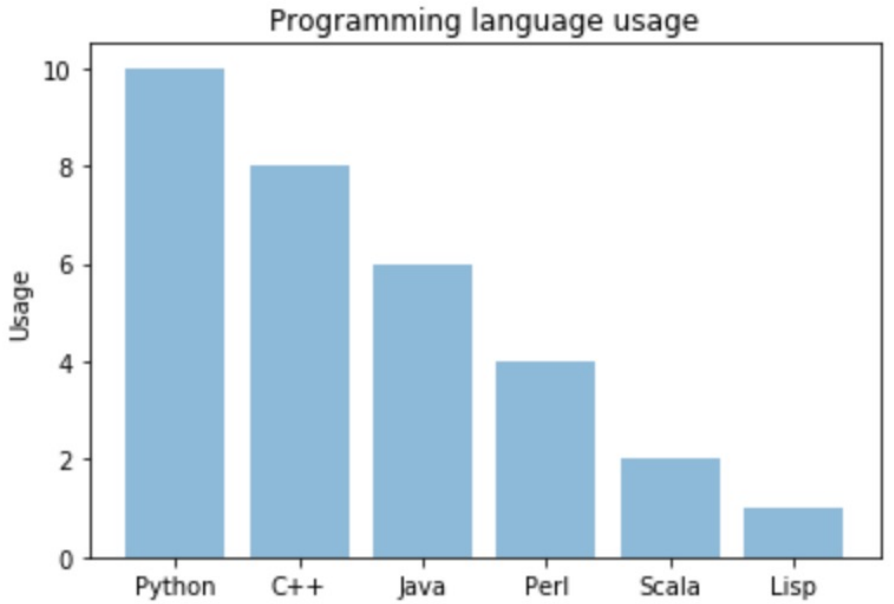
Matplotlib bar chart

```
import matplotlib.pyplot as plt
```

```
objects = ('Python', 'C++', 'Java', 'Perl', 'Scala', 'Lisp')
x_pos = np.arange(len(objects))
performance = [10,8,6,4,2,1]

plt.bar(x_pos, performance, align='center', alpha=0.5)
plt.xticks(x_pos, objects)
plt.ylabel('Usage')
plt.title('Programming language usage')

plt.show()
```

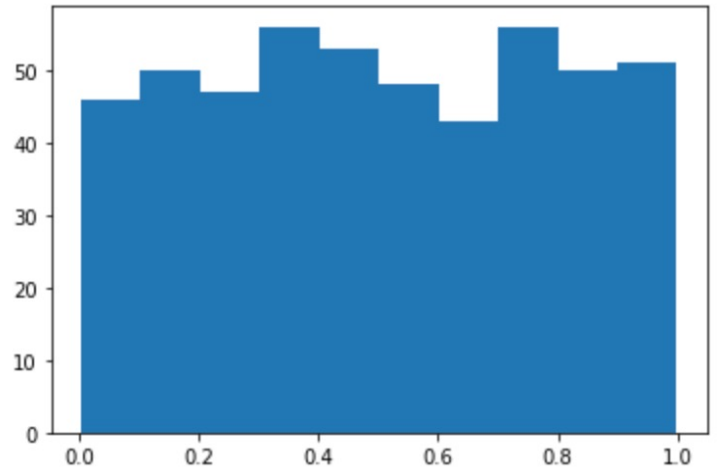


Source: https://pythonspot.com/matplotlib-bar-chart/

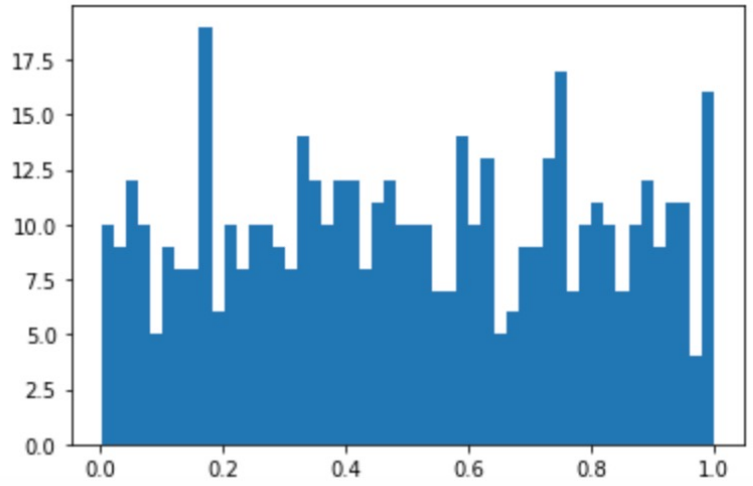
Histogram

```
vals = np.random.random(500)
```

```
plt.hist(vals)
plt.show()
```




```
plt.hist(vals,bins=50)
plt.show()
```



Other plotting options?

- Visit Matplotlib Gallery https://matplotlib.org/stable/gallery/index.html
- Other great packages
  - Seaborn
  - ggplot
  - Bokeh
  - Plotly
  - geoplotlib