Data Visualization: Introduction and Overview

```
$ echo "Data Science Institute"
```

Prerequisites

You have installed the numpy, matplotlib, pandas, scipy, PIL, and requests libraries in Python

Overview of this slide deck, we will:

- Learn about matplotlib
- Produce our first data viz in Python
- Begin to modify elements of our data viz, including
  - Colour
  - Line type
  - Marker size
- Apply our visualization evaluation skills to matplotlib images

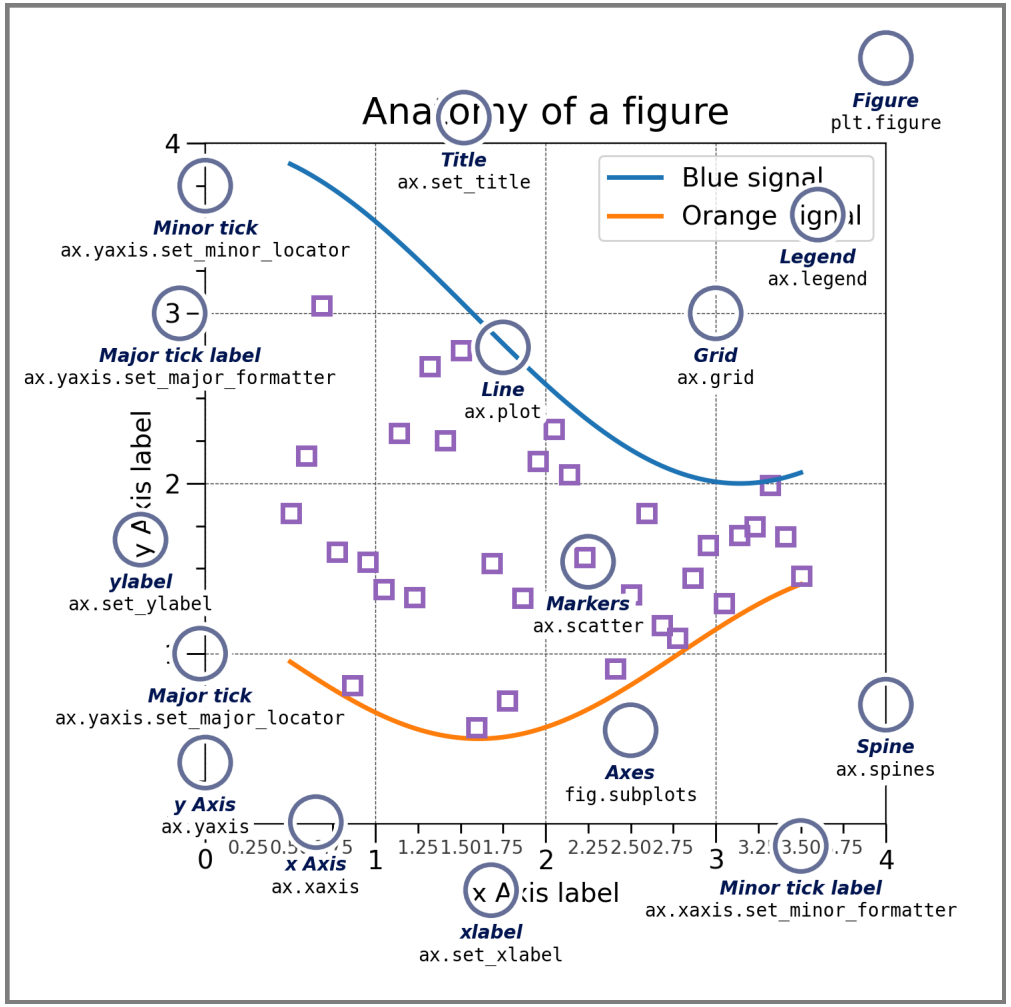
matplotlib

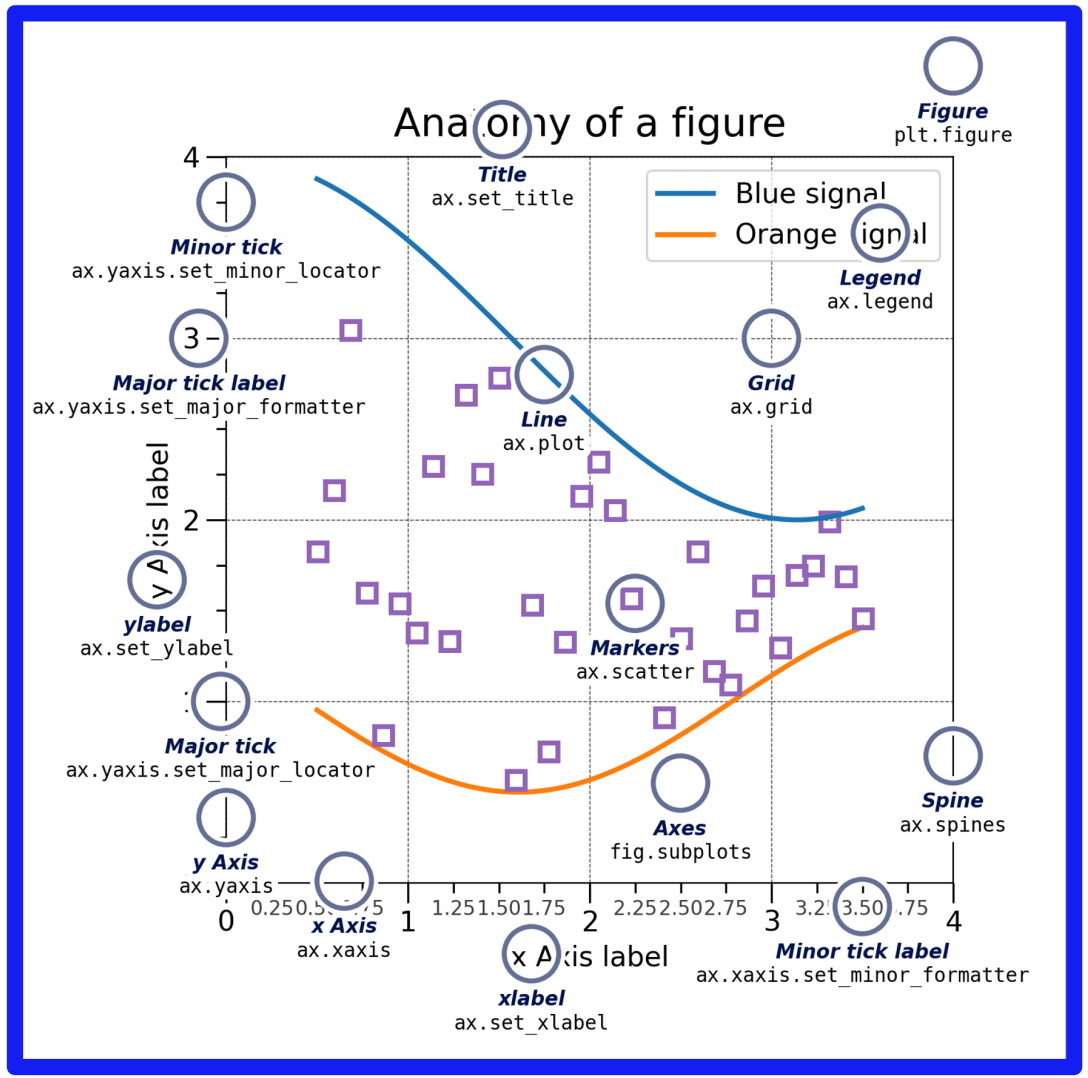
What is matplotlib?

- An open source package for data visualization in Python
- Developed in 2003 to emulate Matlab software
- One package, a LOT of different types of data visualizations

How does matplotlib work?

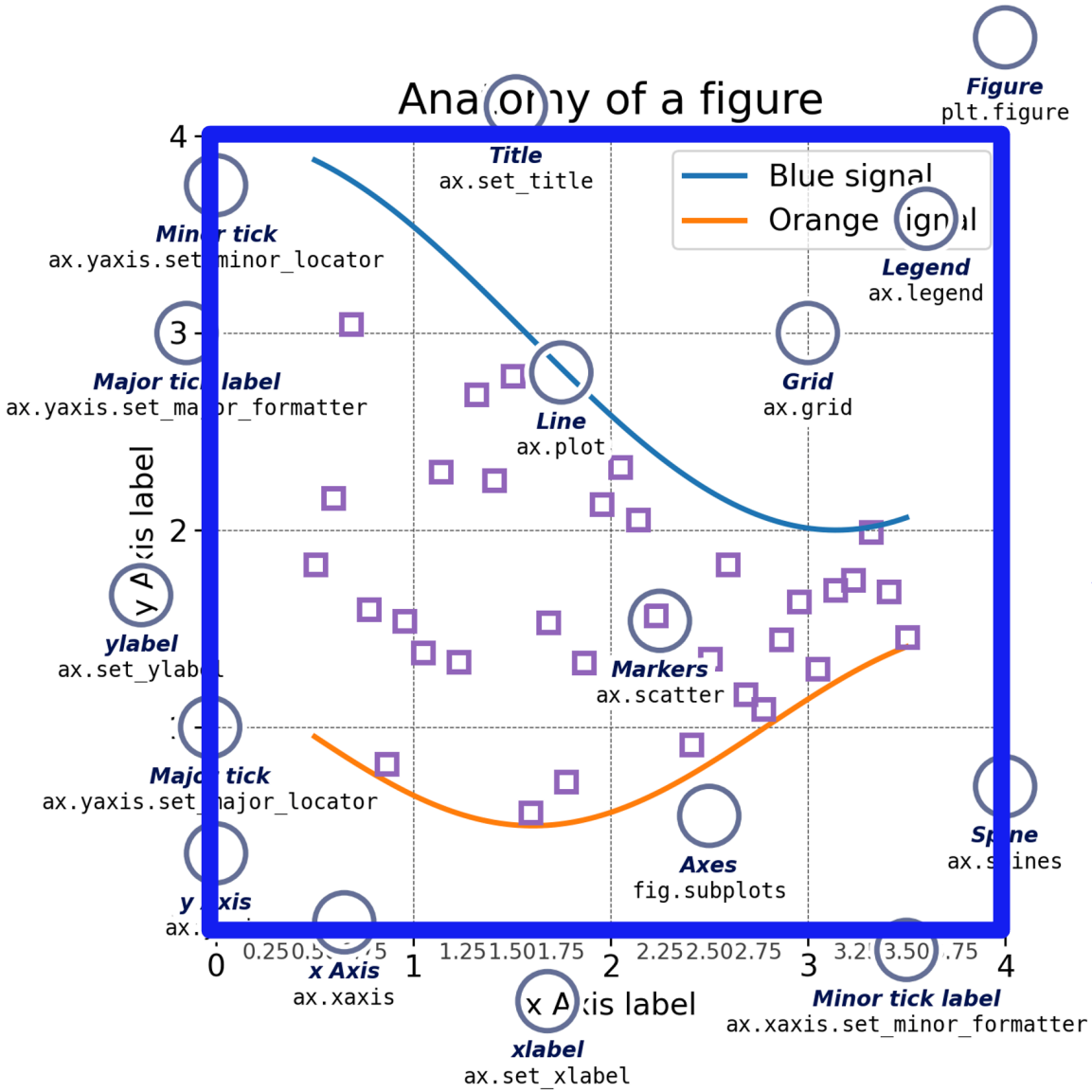
- A **figure** is like a container that holds a set of **axes**
- The axes is our actual plot or graph
- A figure can hold multiple axes (like subplots)
- Every visual element of our plots – colour, legends, axis titles and scales, text – is called an **artist** and belongs to an axes (not to a figure)


Anatomy of a figure
Figure
plt.figure
Title
ax.set_title
Minor tick
ax.yaxis.set_minor_locator
Blue signal
Orange signal
Legend
ax.legend
Major tick label
ax.yaxis.set_major_formatter
Grid
ax.grid
Line
ax.plot
y Axis label
ylabel
ax.set_ylabel
Markers
ax.scatter
Major tick
ax.yaxis.set_major_locator
Axes
fig.subplots
Spine
ax.spines
y Axis
ax.yaxis
x Axis
ax.xaxis
x Axis label
xlabel
ax.set_xlabel
Minor tick label
ax.xaxis.set_minor_formatter
0
1
2
3
4



This entire thing is a figure

source



The plot is called our axes*

***NOT the same thing as the x and y axes on our graph**

Making a figure with matplotlib

Making a basic figure with matplotlib

- First, let's load our libraries

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import scipy
import PIL
import requests
```

Making a basic figure with matplotlib

- Next, make some sample data so that we have something to plot!

```
np.random.seed(613)
x = np.arange(50)
y = np.random.randint(0, 100,50)
```

- Then make our basic scatterplot (we'll break it down after!)

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y)
```

Making a basic figure with matplotlib

- Let's try modifying our graph
  - We want to keep our figure and axis definition the same
  - So we only edit our axis object

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.bar(x,y)
```

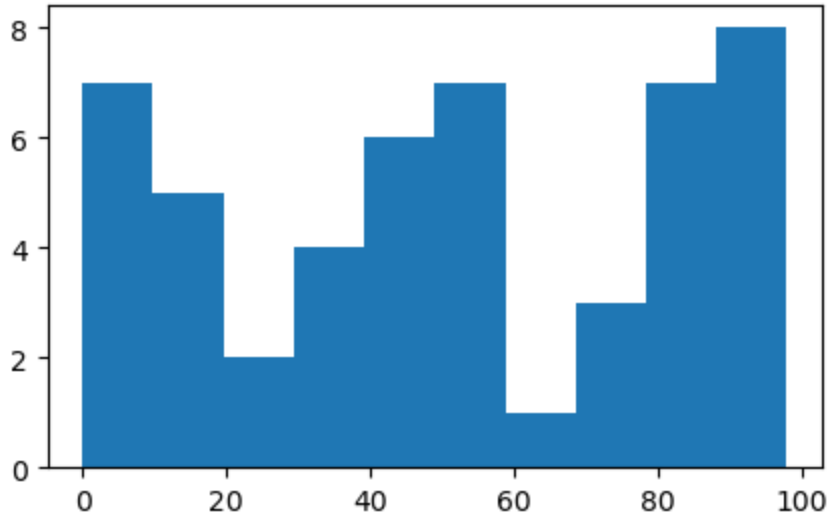
Making a basic figure with matplotlib

- We can also make a line plot

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y)
```

Activity: Try it out

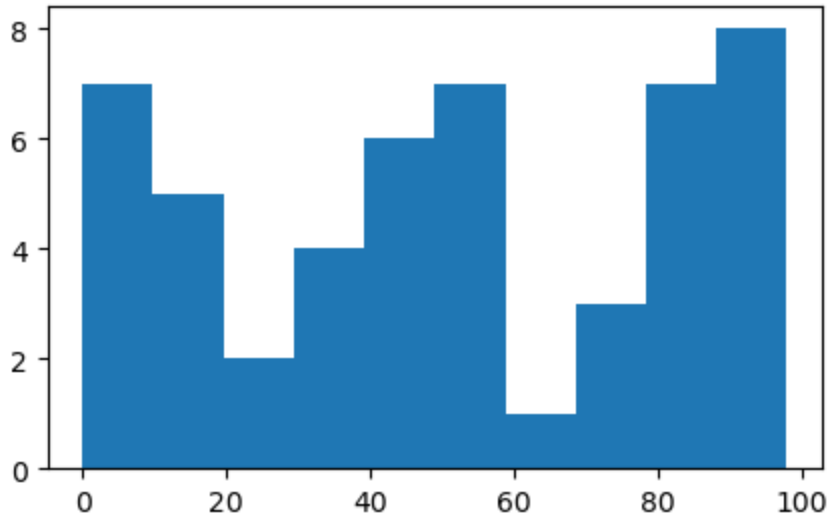
Can you modify our existing code to produce a histogram?



Hint: try ‘hist’ for our axis type

Activity: Try it out

Let's try modifying our graph




```
fig, ax = plt.subplots(figsize=(5, 3))
ax.hist(y)
```

Plot Labels

Adding axis labels and titles

- Let's add to the last plot we made

```
ax.set_title('Total growth over time')
ax.set_ylabel('Total growth')
ax.set_xlabel('Years since start')
fig.tight_layout()
```

Modifying labels and titles

- We can modify our labels and titles' appearance by using font dictionaries ('fontdict')
- First, make a dictionary with the properties we want for our labels

```
font1 = {'family':'sans-serif','color':'blue','size':20}
font2 = {'family':'monospace','color':'green','size':14}
```

Modifying labels and titles

- Then we'll add fontdict arguments to our previous lineplot

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y)
ax.set_title('Total growth over time', fontdict = font1)
ax.set_ylabel('Total growth', fontdict = font2)
ax.set_xlabel('Years since start', fontdict = font2)
fig.tight_layout()
```

Moving labels and titles

- We can move our lables with the loc argument

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y)
ax.set_title('Total growth over time', fontdict = font1, loc = 'left')
ax.set_ylabel('Total growth', fontdict = font2)
ax.set_xlabel('Years since start', fontdict = font2)
fig.tight_layout()
```

Customizing plot appearance

Modifying data points

- Remake our basic scatterplot, but this time add color and marker arguments (NOTE: American spelling)

```
fig, ax = plt.subplots(figsize=(5, 3))

ax.scatter( x,
           y,
           marker='*',          # NEW ADDITIONS
           color = "indigo")    # NEW ADDITIONS

fig.show()
```

Modifying data points

We can also adjust the style and width of the line connecting our points

```
fig, ax = plt.subplots(figsize=(5, 3))

ax.plot(x,
        y,
        marker='*',
        color = 'indigo',
        linestyle = '--',   # NEW ADDITIONS
        linewidth = 2)      # NEW ADDITIONS
fig.show()
```

Modifying data points: Colour

- We can modify colour using named colors
  - https://matplotlib.org/stable/gallery/color/named_colors.html#sphx-glr-gallery-color-named-colors-py
- Or we can use hex codes

```
fig, ax = plt.subplots(figsize=(5, 3))

# color being the new addition
ax.plot(x,y,marker='*', color = '#7425b9’, linestyle = '--', linewidth = 2)
fig.show()
```

Modifying data points

Let's customize our plot further

```
ax.plot(x,y,marker='*',
        markersize = 12,                # NEW ADDITIONS
        color = '#7425b9',
        linestyle = '--',
        linewidth = 2,
        markeredgecolor = '#fa9359',  # NEW ADDITIONS
        markerfacecolor = '#fa9359' ) # NEW ADDITIONS
```

Grid lines

- We can add grid lines to our axis object using **.grid()**

```
ax.grid(axis = 'y')
```

- Activity: Can you modify the appearance (colour, width, linestyle) of our grid lines using what we learned before?

Grid lines

- We can add grid lines to our axis object using **.grid()**

```
ax.grid(axis = 'y')
```

- Activity: Can you modify the appearance (colour, width, linestyle) of our grid lines using what we learned before?

```
ax.grid(axis = 'y')

ax.grid(axis = ‘y’, color = "blue", linewidth = 2, linestyle = '-.')
```

Resources: Matplotlib Cheatsheets

- https://s3.amazonaws.com/assets.datacamp.com/blog_assets/Python_Matplotlib_Cheat_Sheet.pdf
- https://github.com/matplotlib/cheatsheets (with beginner, intermediate, and general tips versions)

We haven't covered most of what's on the cheatsheets yet, but keep them for your reference!

Activity: Exploring matplotlib

Activity

- Visit the Python Graph Gallery at https://python-graph-gallery.com/all-charts/
- Select one of the visualization types that you find most interesting
- For your visualization of choice:
    i. Copy the provided code and attempt to replicate the output in Python. NOTE: You may have to install packages.
    ii. Recall the **aesthetic** , **substantive** , and **perceptual** qualities of data visualizations. Does your visualization of choice succeed in each area?

Feedback!

In the next session, we'll continue with...

- The responses from the polls
- What is reproducible data visualization?
- How can we incorporate ideas about reproducibility into our data visualization practices? (Ethics)
- More matplotlib!