Data Visualization: Customizing Our Plots

```
$ echo "Data Sciences Institute"
```

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Overview of this slide deck, we will:

- Make more modifications to our plots using Matplotlib, including
    - Legends
    - Annotations (text, shapes, and labels)
    - Axis Labels
    - Styles

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Legends

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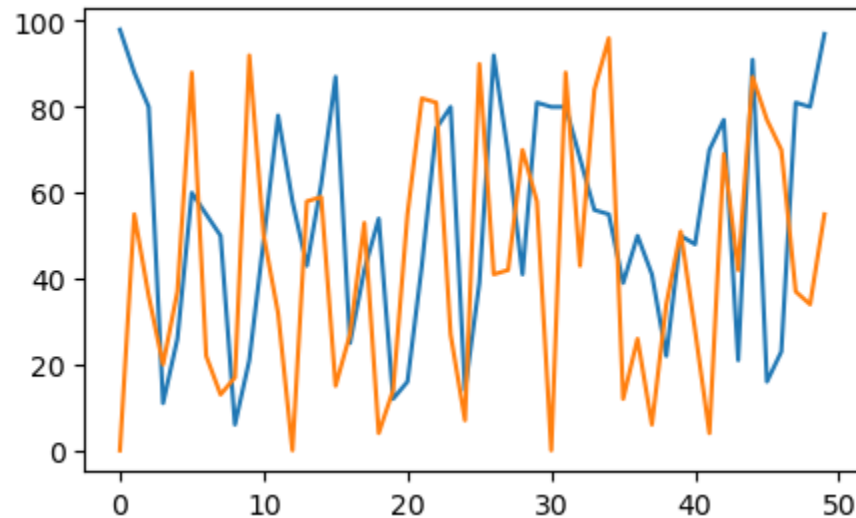
Set up

- Just like before, let's start by loading our libraries and making some sample data

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

np.random.seed(613)
x = np.arange(50)
y1 = np.random.randint(0, 100,50)
y2 = np.random.randint(0, 100,50)
```

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Activity: Recall

- Using what we learned in lesson 1, can you make a line plot with both of our y variables on the same axes?

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Activity: Recall

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```
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y1)
ax.plot(x,y2)
fig.show()
```

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Adding a legend

- To add a legend, we:
  - Add a 'label' argument to each plot object
  - Call 'legend' and specify our legend location

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y1, label = "Person 1" )
ax.plot(x,y2, label = "Person 2" )
ax.legend(loc='lower right')
fig.show()
```

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Modifying our legend

- By adding arguments to our legend object, we can change different elements of our legend

```python
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y1, label = "Person 1")
ax.plot(x,y2, label = "Person 2")
ax.legend(loc='lower right',
          frameon = True, #add frame around the legend
          fontsize = 12, #change font size
          ncol = 2, #specify number of columns
          shadow = True )
fig.show()
```

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Moving the legend outside of the plot area

- We can position the legend outside of our plot by
  - Specifying legend location as before
  - Specifying where we want to anchor that location *on our figure* using **bbox_to_anchor**

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y1, label = "Person 1")
ax.plot(x,y2, label = "Person 2")
ax.legend(loc='upper left',
          bbox_to_anchor =(1, 1))
fig.show()
```

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Text and Annotations

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Annotations with the text() function

- Let's start by putting our data into a scatter plot this time

```python
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y1, label = "Person 1")
ax.scatter(x,y2, label = "Person 2")
ax.legend(loc='lower right')
```

- Then use the text() function to specify coordinates and text

```python
ax.text(10, 95, "This value is important!")
fig.show()
```

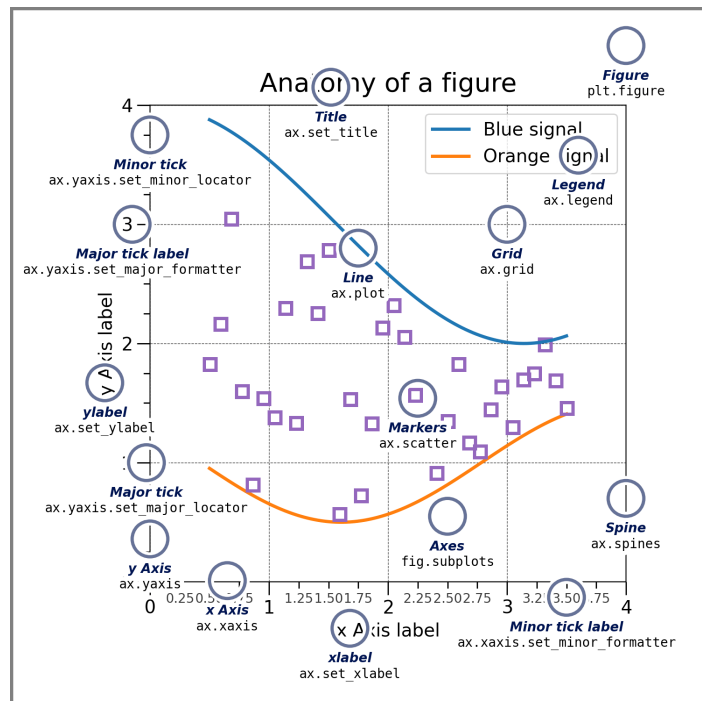UNIVERSITY OF TORONTO | DATA SCIENCES INSTITUTE

Modifying text annotations

- Just like before, we can modify our text annotation by adding arguments

```
ax.text(10, 95, "This value is important!",
    ha='center',    ##alignment of text
    color = 'red',  ##modify font colour
    size = 20)      ##modify font size

fig.show()
```

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Positioning text annotations

- Just now, we located our text annotation using the coordinates of data points

- If we want our annotation linked to a fixed spot, we can locate it at a specific location on our *axes* or the *figure* itself (recall our matplotlib terminology)
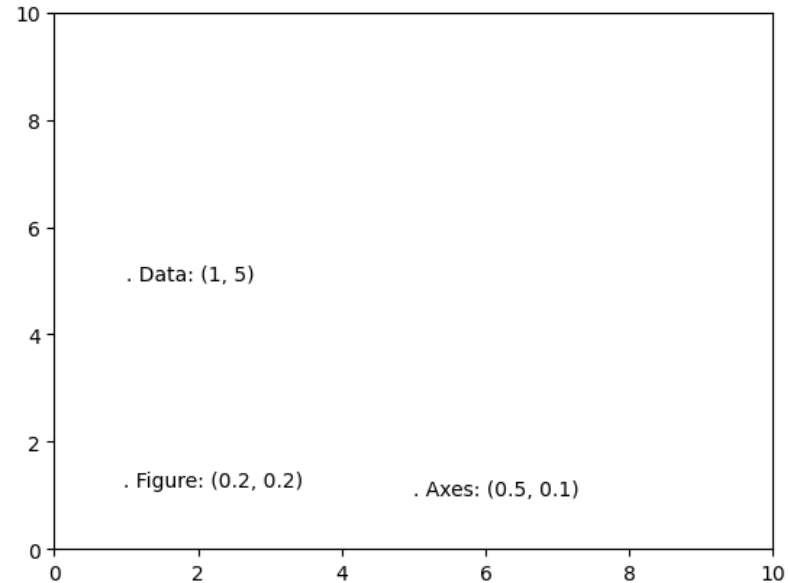
Positioning text annotations

- We can do this using **transforms**

- Start by making a simple, empty set of axes

```
fig, ax = plt.subplots()
ax.axis([0, 10, 0, 10])
```

- Then we can position our annotation with reference to the data (like before), the axes, or the figure (referencing axis/figure dimensions)

```
ax.text(1, 5, ". Data:(1, 5)",            transform=ax.transData   )
ax.text(0.5, 0.1, ". Axes:(0.5, 0.1)",    transform=ax.transAxes   )
ax.text(0.2, 0.2, ". Figure:(0.2, 0.2)",  transform=fig.transFigure )
```

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Positioning text annotations


```
ax.text(1, 5, ". Data: (1, 5)",            transform=ax.transData    )
ax.text(0.5, 0.1, ". Axes: (0.5, 0.1)",   transform=ax.transAxes    )
ax.text(0.2, 0.2, ". Figure: (0.2, 0.2)", transform=fig.transFigure )
```

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Annotating with arrows

- We can use the **annotate()** function to annotate with arrows and text (e.g. to focus at a specific point)
    - We have to specify the location to point at **and** the location where we want our text

```python
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y1, label = "Person 1")
ax.scatter(x,y2, label = "Person 2")
ax.legend(loc='lower right')

ax.annotate('This is important!', xy=(10, 95), xytext=(20, 94),
            arrowprops=dict(facecolor='black'))

fig.show()
```

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Modifying arrows

- Use the **arrowprops** argument to adjust our arrow style and colour
  - Matplotlib documentation describes possible arrow styles (https://matplotlib.org/3.1.1/api/_as_gen/matplotlib.pyplot.annotate.html)
  - Try "->", "<->", "-[", "fancy"

```
ax.annotate('This is important!',
        xy=(10, 95), xytext=(20, 94),
        arrowprops = dict(arrowstyle = "wedge",
                          color = " hotpink "))

fig.show()
```

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Axis Labels

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Removing tick marks and labels

- We can remove tick marks or labels from our axis like so:

    - Use **locator** to remove ticks and labels

    - Use **formatter** to remove only labels

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y1, label = "Person 1")
ax.scatter(x,y2, label = "Person 2")
ax.legend(loc='lower right')

ax.yaxis.set_major_locator(plt.NullLocator())
ax.xaxis.set_major_formatter(plt.NullFormatter())
```

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Limiting tick marks

- We can also define a maximum number of ticks we want on our axis

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y1, label = "Person 1")
ax.scatter(x,y2, label = "Person 2")
ax.legend(loc='lower right')
ax.xaxis.set_major_locator(plt.MaxNLocator(3))
```

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Tick mark intervals

- We can set tick marks at a particular interval (in this case, 5) using MultipleLocator

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y1, label = "Person 1")
ax.scatter(x,y2, label = "Person 2")
ax.legend(loc='lower right')
ax.xaxis.set_major_locator(plt.MultipleLocator(5))
```

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Rotating axis labels

- To rotate axis labels and horizontal alignment, use **xticks()**

```
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y1, label = "Person 1")
ax.scatter(x,y2, label = "Person 2")
ax.legend(loc='lower right')

plt.xticks(rotation=45, ha='right')
```

- **Try modifying fontsize and font as well**

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Activity: Modifying axis title fonts

- Can you use what we did in a previous lesson to modify our x axis title?
  - We want a serif font with indigo colour, and for the axis title to be "Shiny New X Axis!"
  - Use plt.xlabel()
  - **HINT**: Recall fontdict

Activity: Modifying axis title fonts

- Can you use what we did in a previous lesson to modify our x axis title?
    - We want a serif font with indigo colour, and for the axis title to be "Shiny New X Axis!"
    - Use plt.xlabel()
    - **HINT**: Recall fontdict

```
font1 = {' family':'serif','color':'indigo'}
fig, ax = plt.subplots(figsize=(5, 3))
ax.scatter(x,y1, label = "Person 1")
ax.scatter(x,y2, label = "Person 2")
ax.legend(loc='lower right')
plt.xlabel('Shiny New X Axis!', fontsize = 18, fontdict = font1)
```

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Styles

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What are styles

- Styles are a convenient way to change many aesthetic dimensions of our plots at the same time

- To view available pre-made styles, use:
  ```
  plt.style.available
  ```

- To use a style, just type the following before you make your figure:
  ```
  plt.style.use('fivethirtyeight')
  ```

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What are styles

```
plt.style.use('fivethirtyeight')

np.random.seed(613)
x = np.arange(50)
y1 = np.random.randint(0, 100,50)
y2 = np.random.randint(0, 100,50)
fig, ax = plt.subplots(figsize=(5, 3))
ax.plot(x,y1)
ax.plot(x,y2)
fig.show()
```

- **Try using different styles and see how they change your plot!**

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Next session:

- Subplots, multiple axes, and combining elements in matplotlib

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