Introduction to Data Visualization with Matplotlib

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

Data visualization

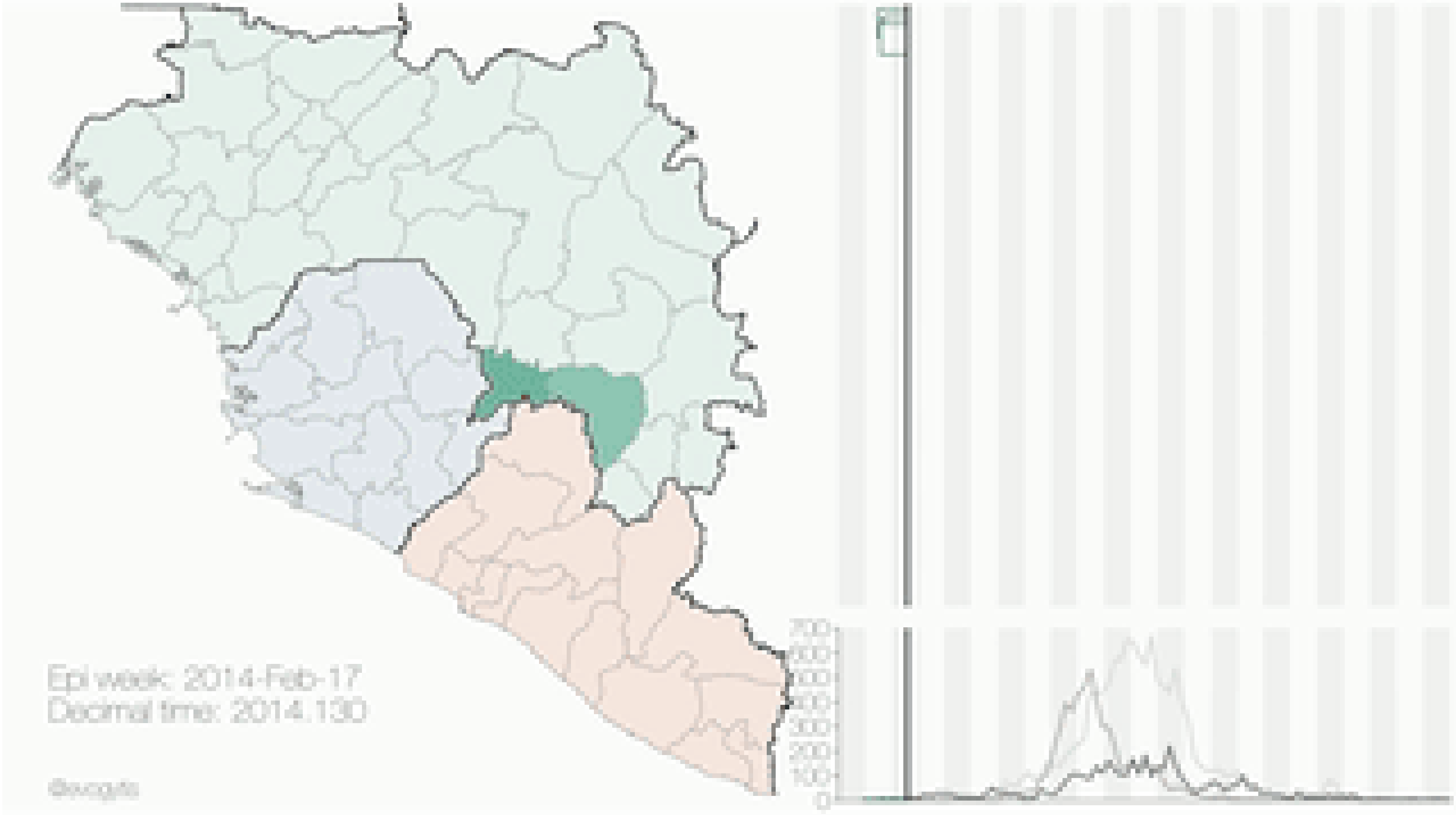
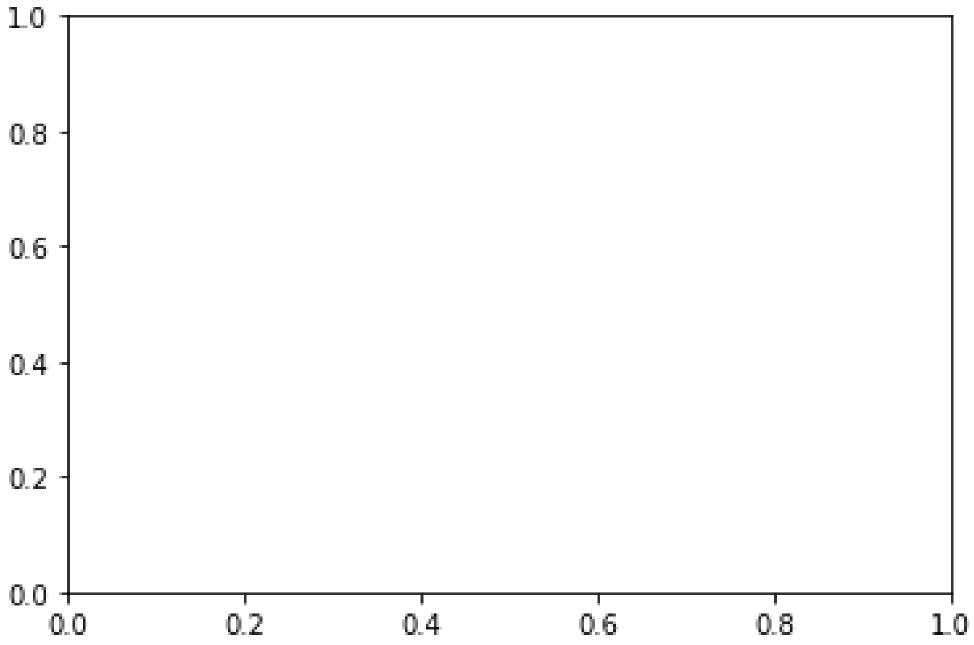


Image credit: Gytis Dudas and Andrew Rambaut

Introducing the pyplot interface

```python
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
plt.show()
```



Adding data to axes

```
seattle_weather["MONTH"]
```

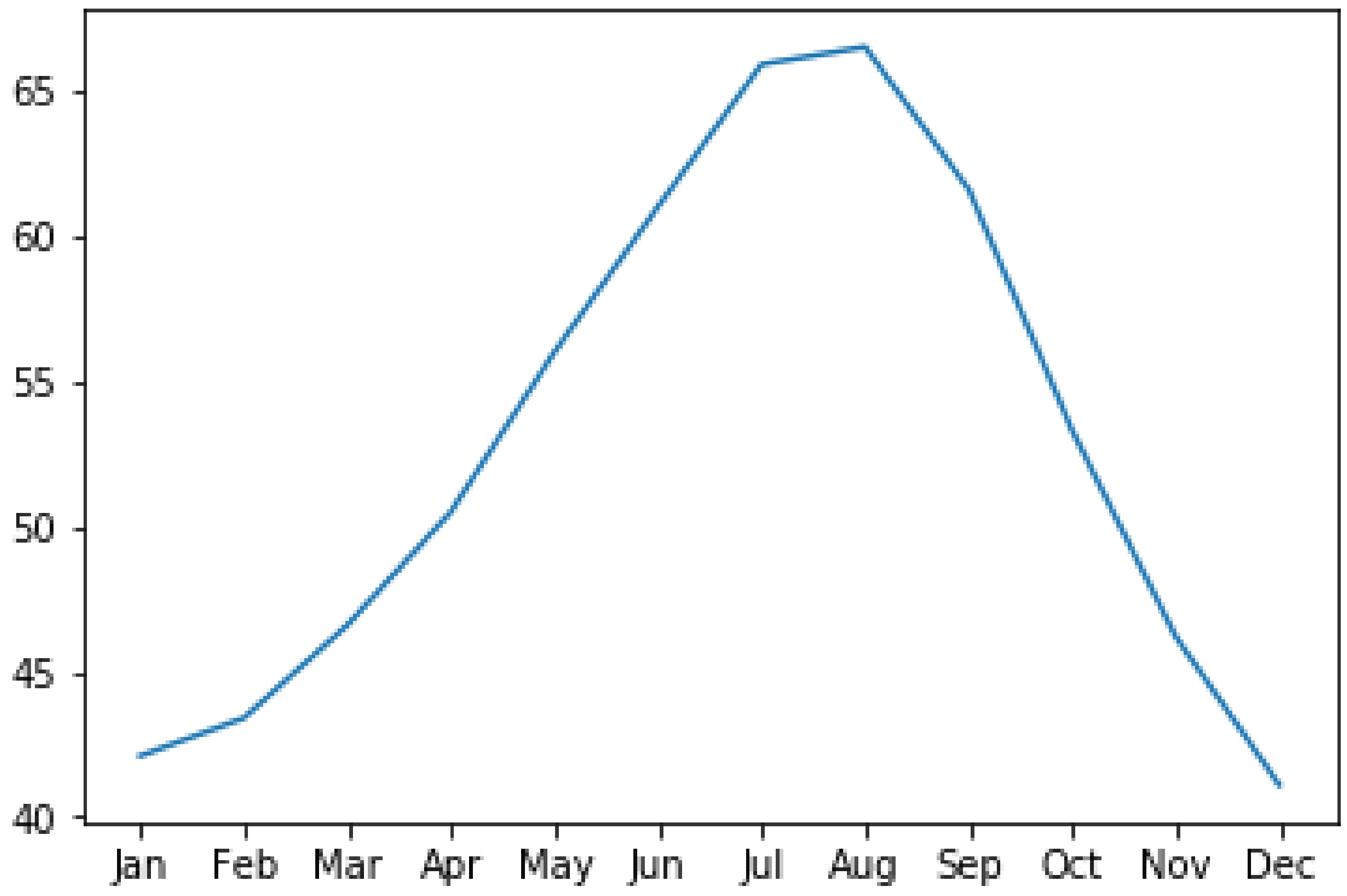
```
DATE
1      Jan
2      Feb
3      Mar
4      Apr
5      May
6      Jun
7      Jul
8      Aug
9      Sep
10     Oct
11     Nov
12     Dec
Name: MONTH, dtype: object
```

```
seattle_weather["MLY-TAVG-NORMAL"]
```

```
1      42.1
2      43.4
3      46.6
4      50.5
5      56.0
6      61.0
7      65.9
8      66.5
9      61.6
10     53.3
11     46.2
12     41.1
Name: MLY-TAVG-NORMAL, dtype: float64
```

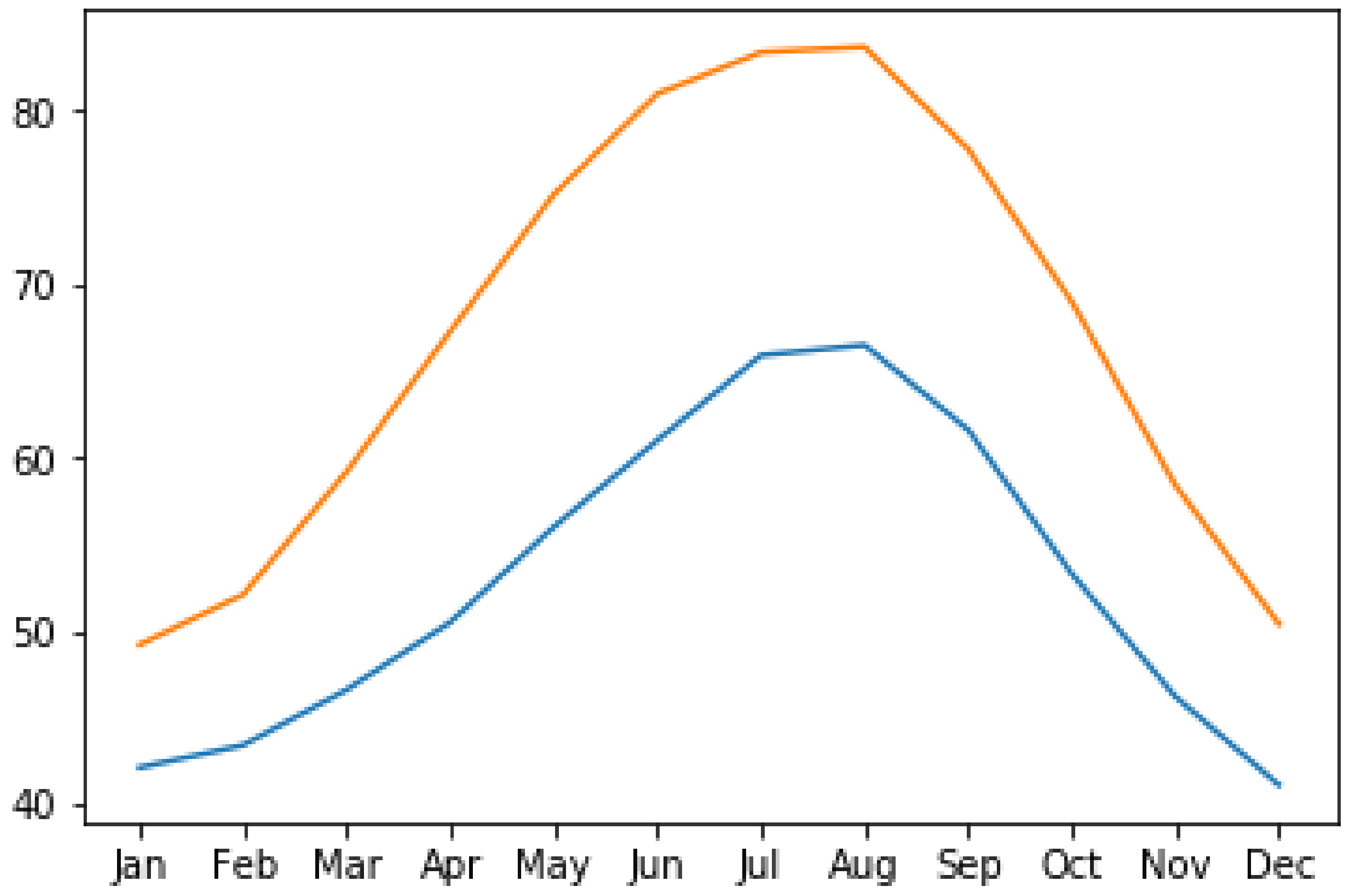
Adding data to axes

```
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
plt.show()
```



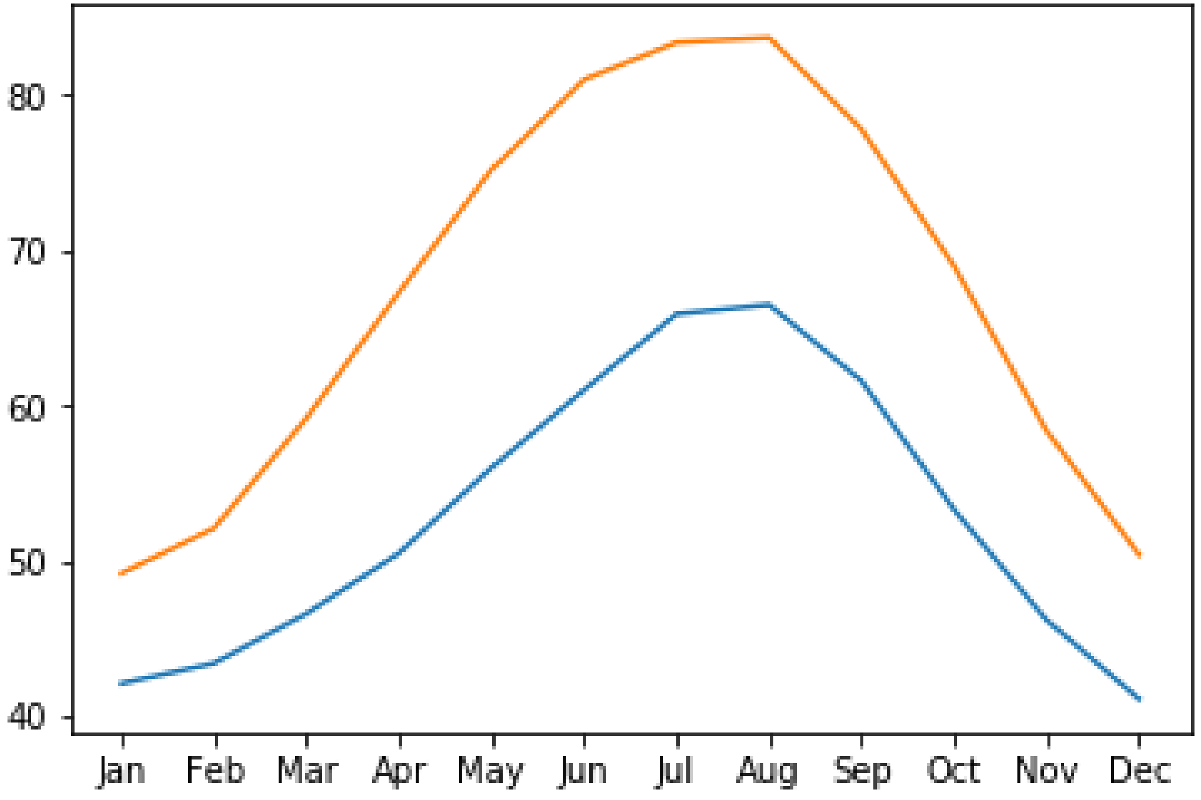
Adding more data

```
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
plt.show()
```



Putting it all together

```
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
plt.show()
```



Practice making a figure!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Customizing your plots

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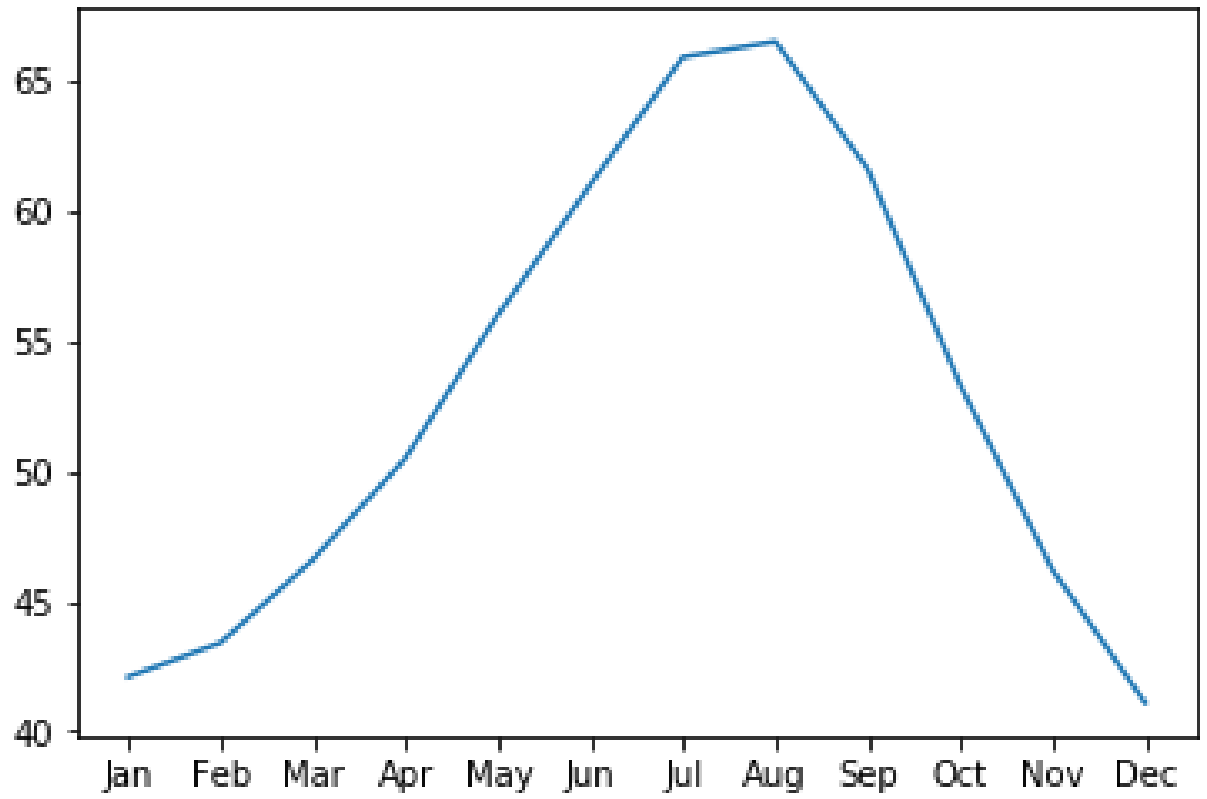
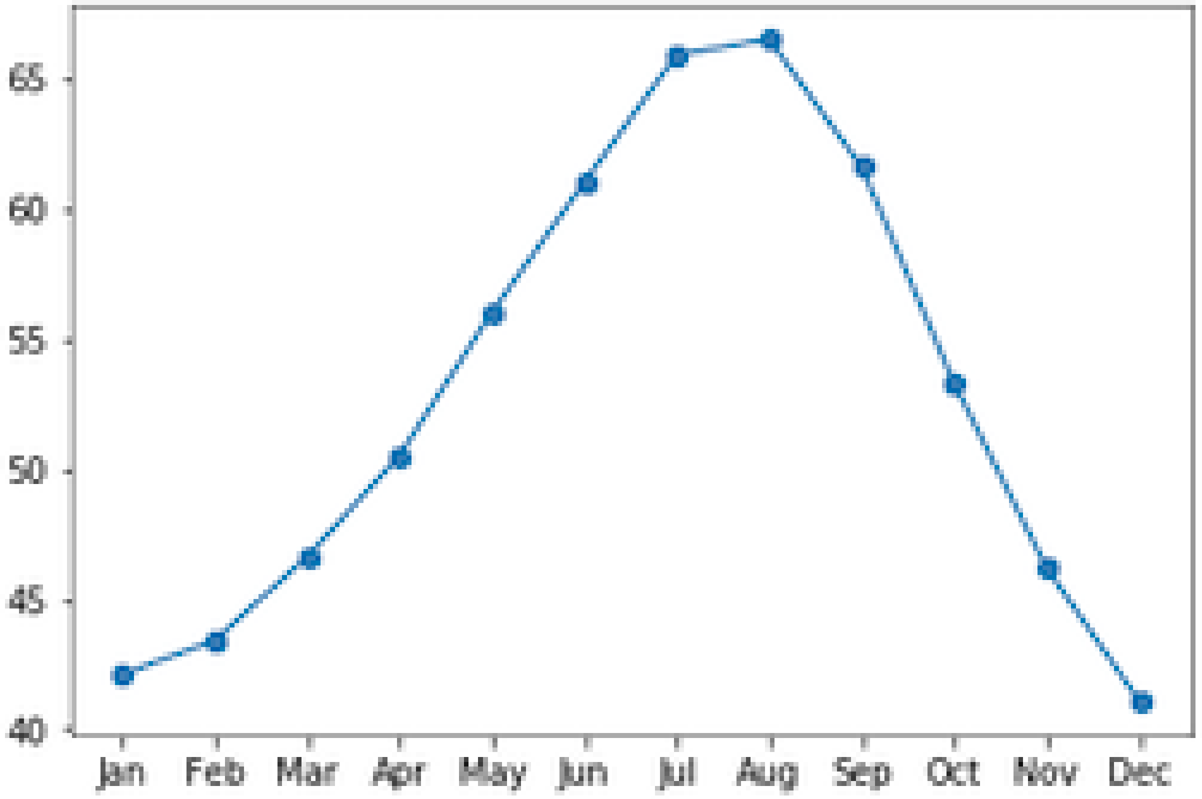
Customizing data appearance

```
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-PRCP-NORMAL"])
plt.show()
```



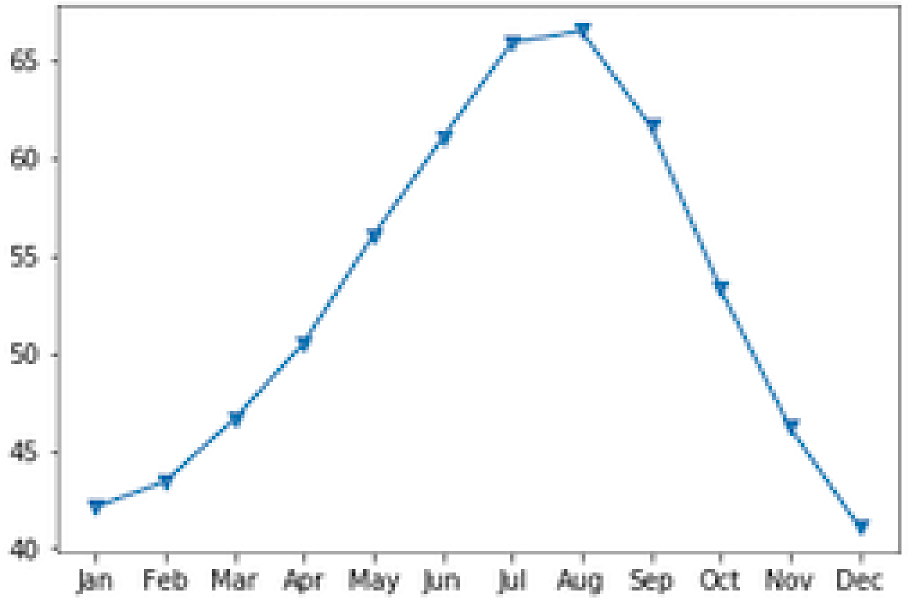
Adding markers

```
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-PRCP-NORMAL"],
        marker="o")
plt.show()
```



Choosing markers

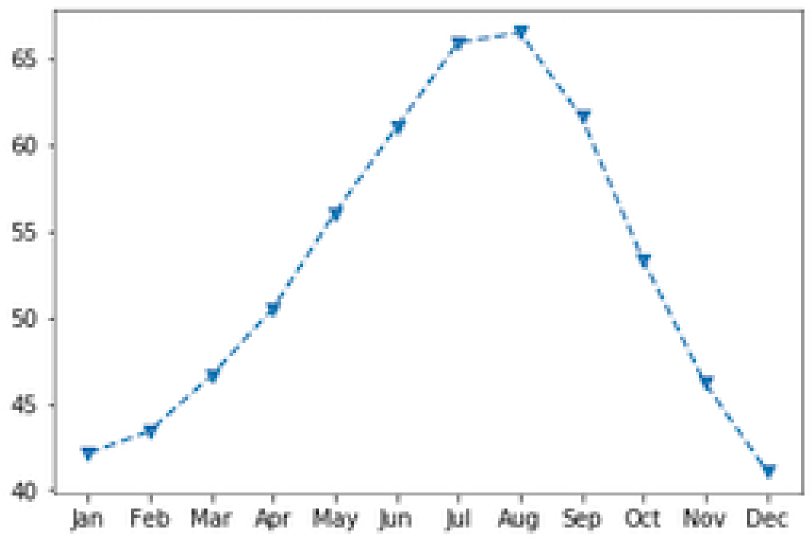
```
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-PRCP-NORMAL"],
        marker="v")
plt.show()
```



https://matplotlib.org/api/markers_api.html

Setting the linestyle

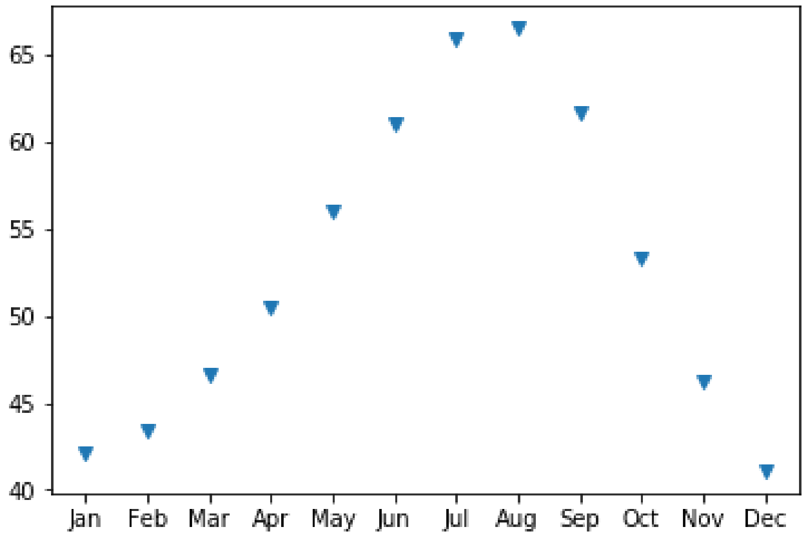
```
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-TAVG-NORMAL"],
        marker="v", linestyle="--")
plt.show()
```



https://matplotlib.org/gallery/lines_bars_and_markers/line_styles_reference.html

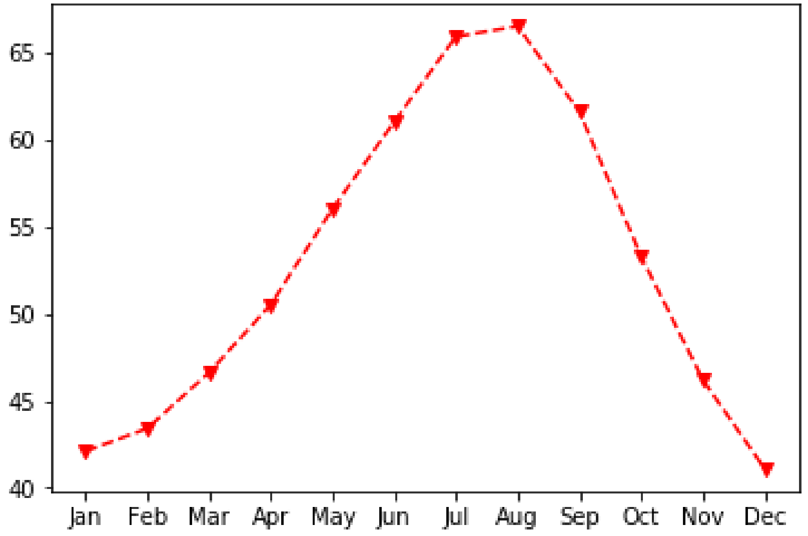
Eliminating lines with linestyle

```
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-TAVG-NORMAL"],
        marker="v", linestyle="None")
plt.show()
```



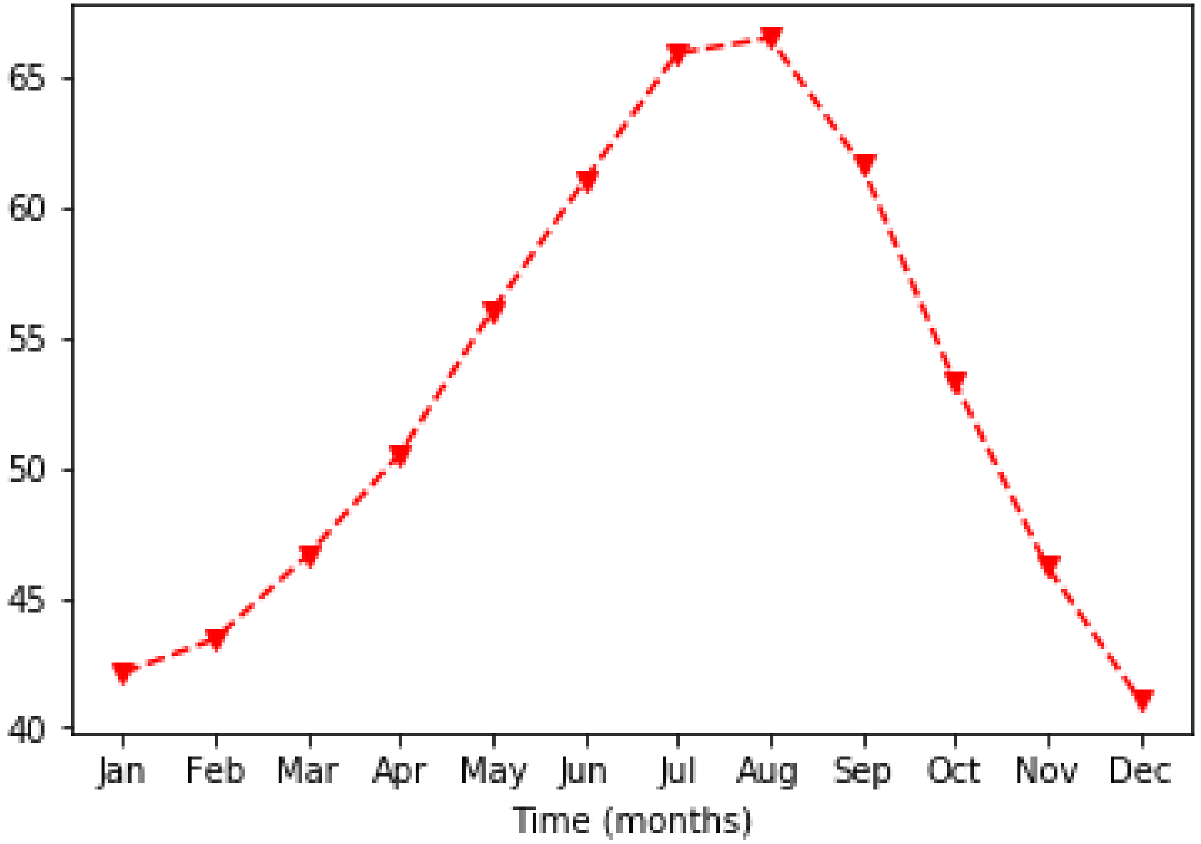
Choosing color

```
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-TAVG-NORMAL"],
        marker="v", linestyle="--", color="r")
plt.show()
```



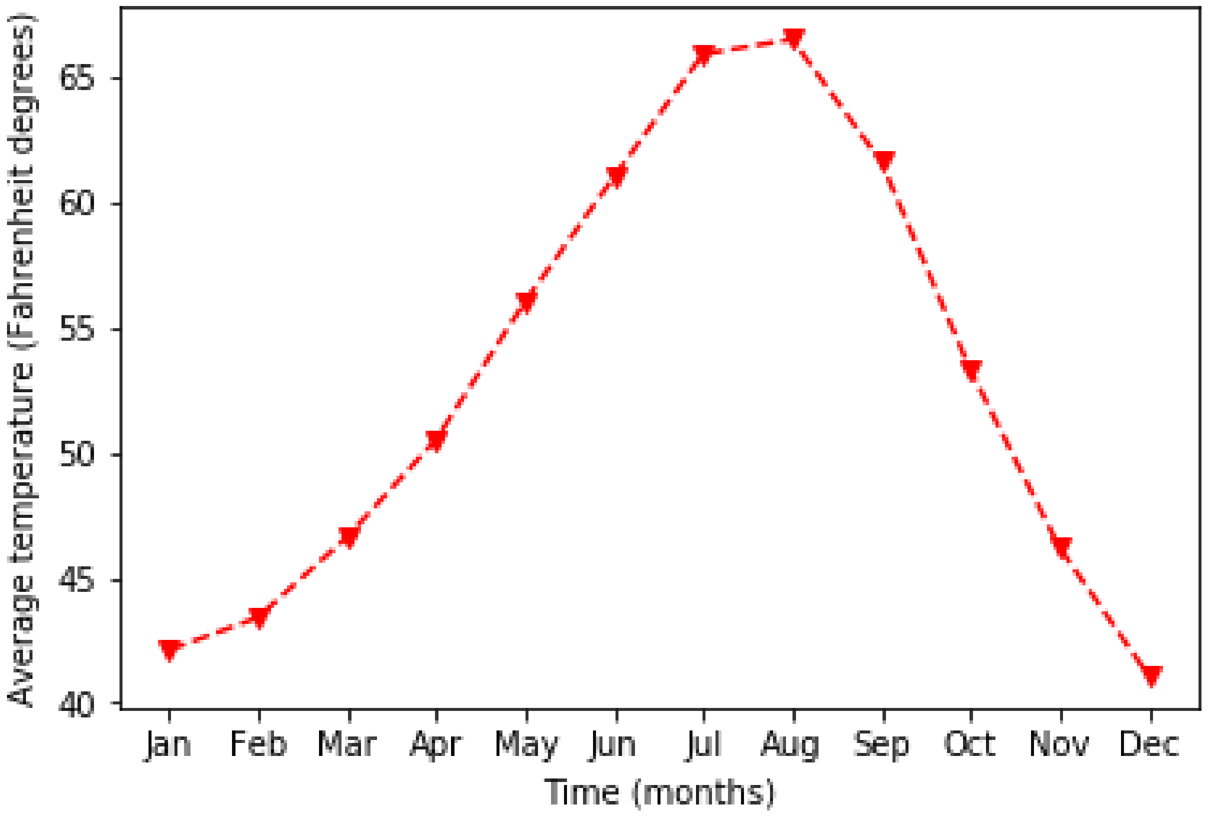
Customizing the axes labels

```
ax.set_xlabel("Time (months)")
plt.show()
```



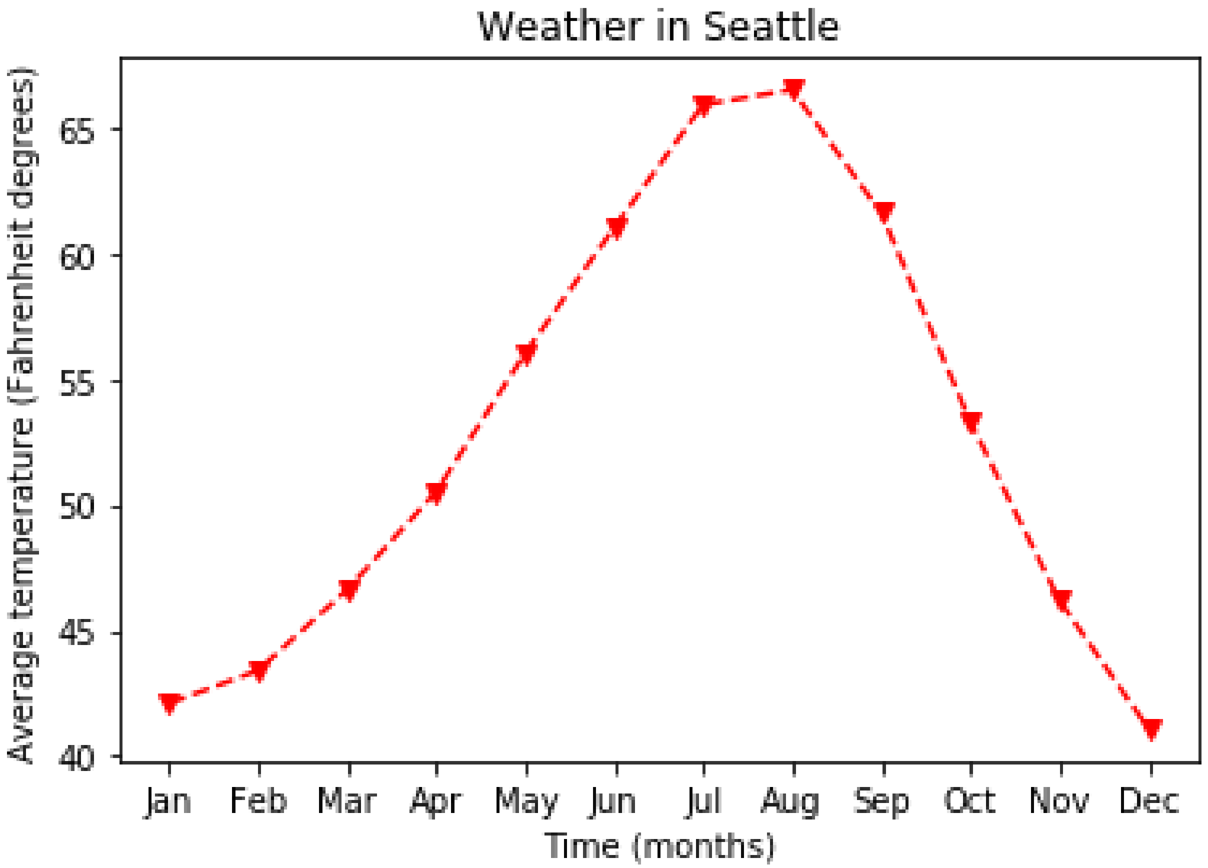
Setting the y axis label

```
ax.set_xlabel("Time (months)")
ax.set_ylabel("Average temperature (Fahrenheit degrees)")
plt.show()
```



Adding a title

```
ax.set_title("Weather in Seattle")
plt.show()
```



Practice customizing your plots!

Small multiples

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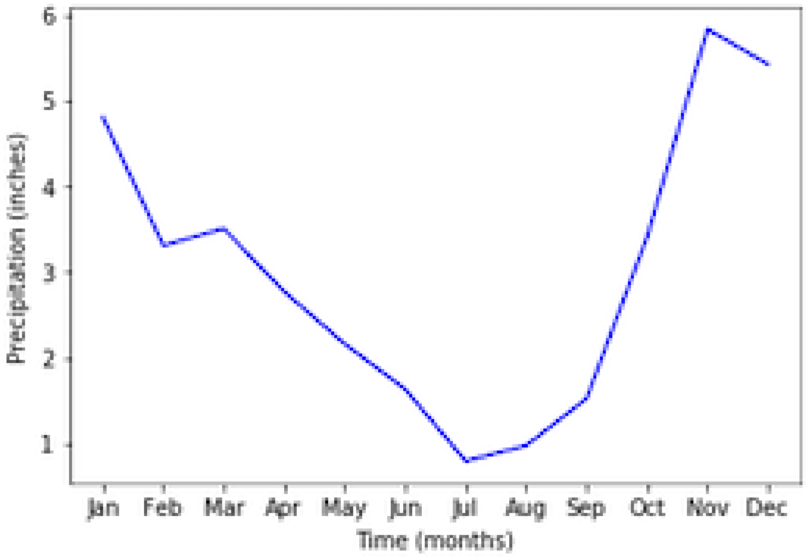
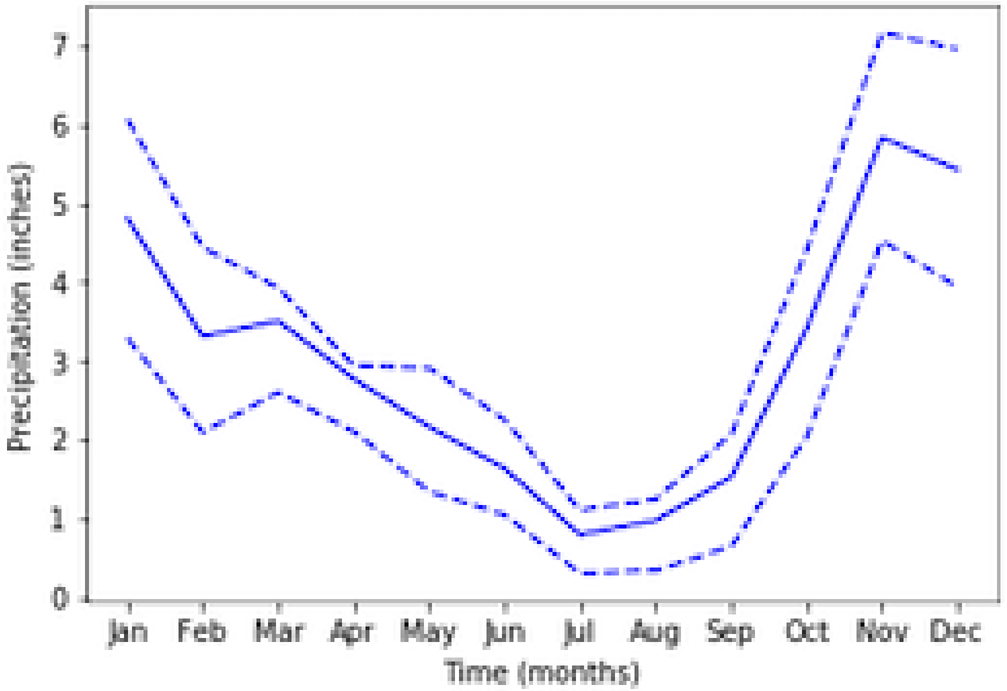
Adding data

```
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-PRCP-NORMAL"],
        color='b')
ax.set_xlabel("Time (months)")
ax.set_ylabel("Precipitation (inches)")
plt.show()
```



Adding more data

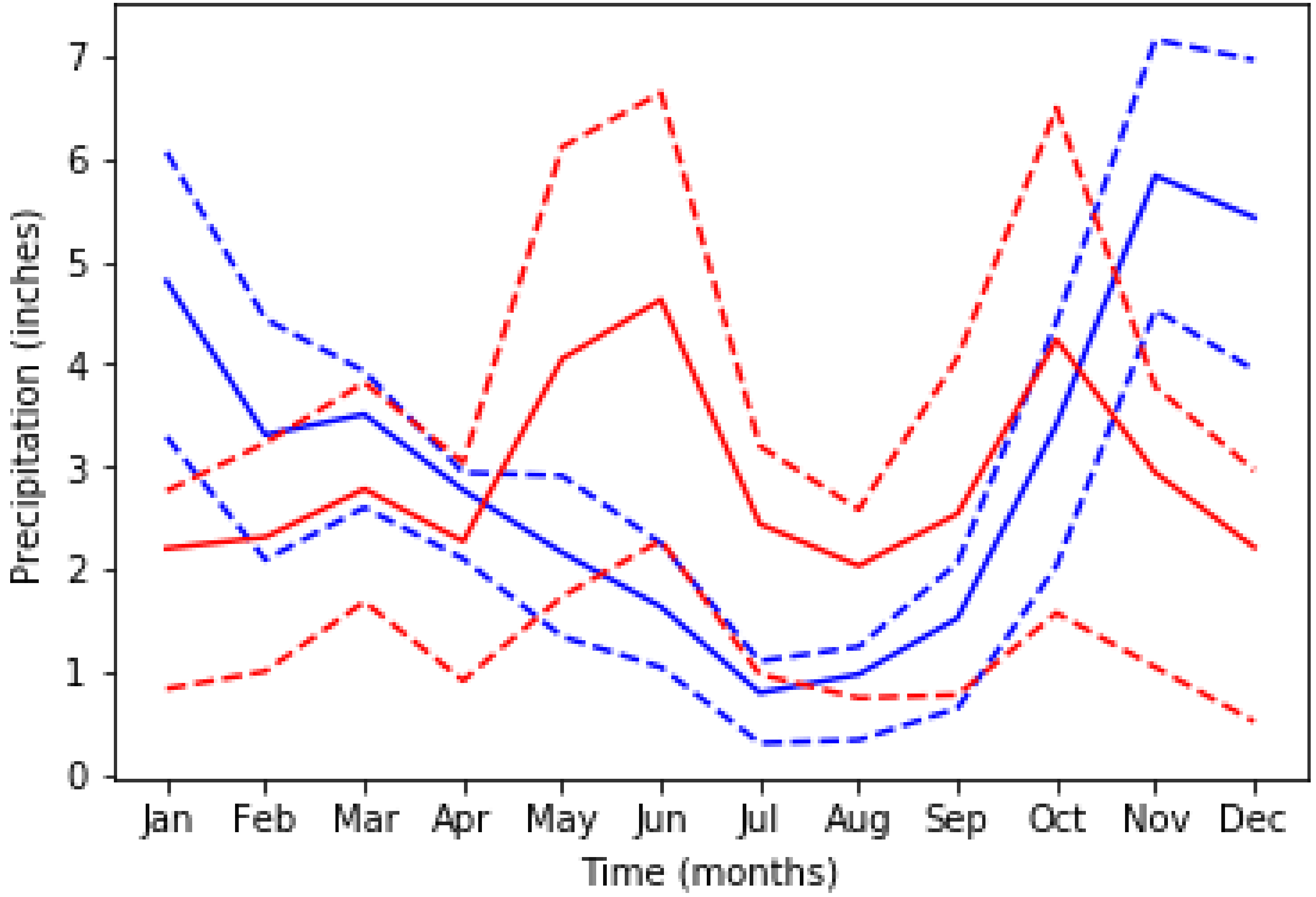
```
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-PRCP-25PCTL"],
        linestyle='--', color='b')
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-PRCP-75PCTL"],
        linestyle='--', color=color)
plt.show()
```



And more data

```
ax.plot(austin_weather["MONTH"], austin_weather["MLY-PRCP-NORMAL"],
        color='r')
ax.plot(austin_weather["MONTH"], austin_weather["MLY-PRCP-25PCTL"],
        linestyle='--', color='r')
ax.plot(austin_weather["MONTH"], austin_weather["MLY-PRCP-75PCTL"],
        linestyle='--', color='r')
plt.show()
```

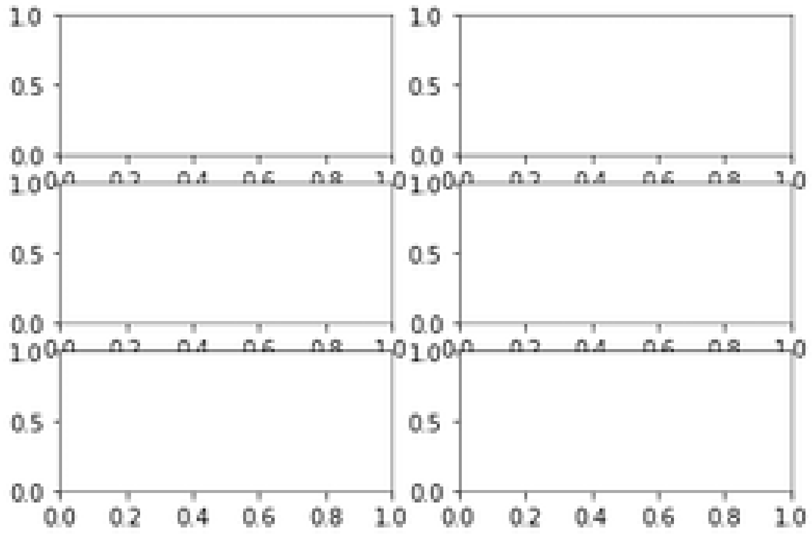
Too much data!



Small multiples with plt.subplots

```
fig, ax = plt.subplots()
```

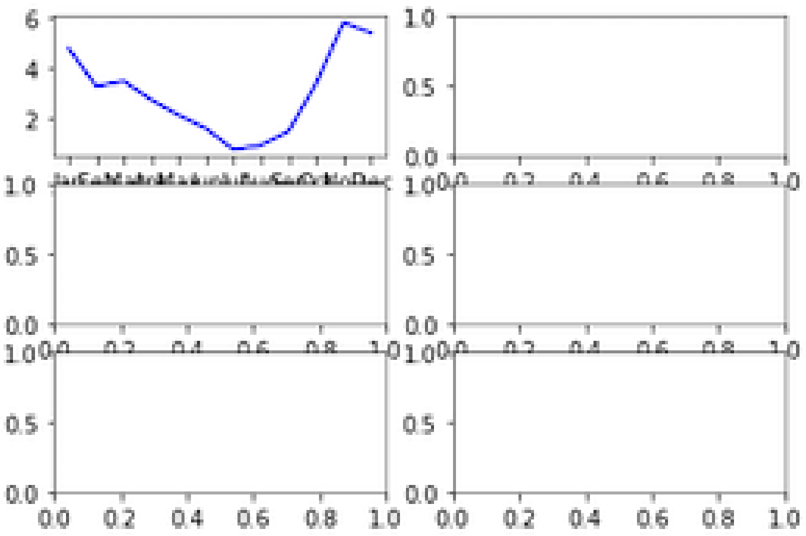
```
fig, ax = plt.subplots(3, 2)
plt.show()
```



Adding data to subplots

```
ax.shape
(3, 2)
```

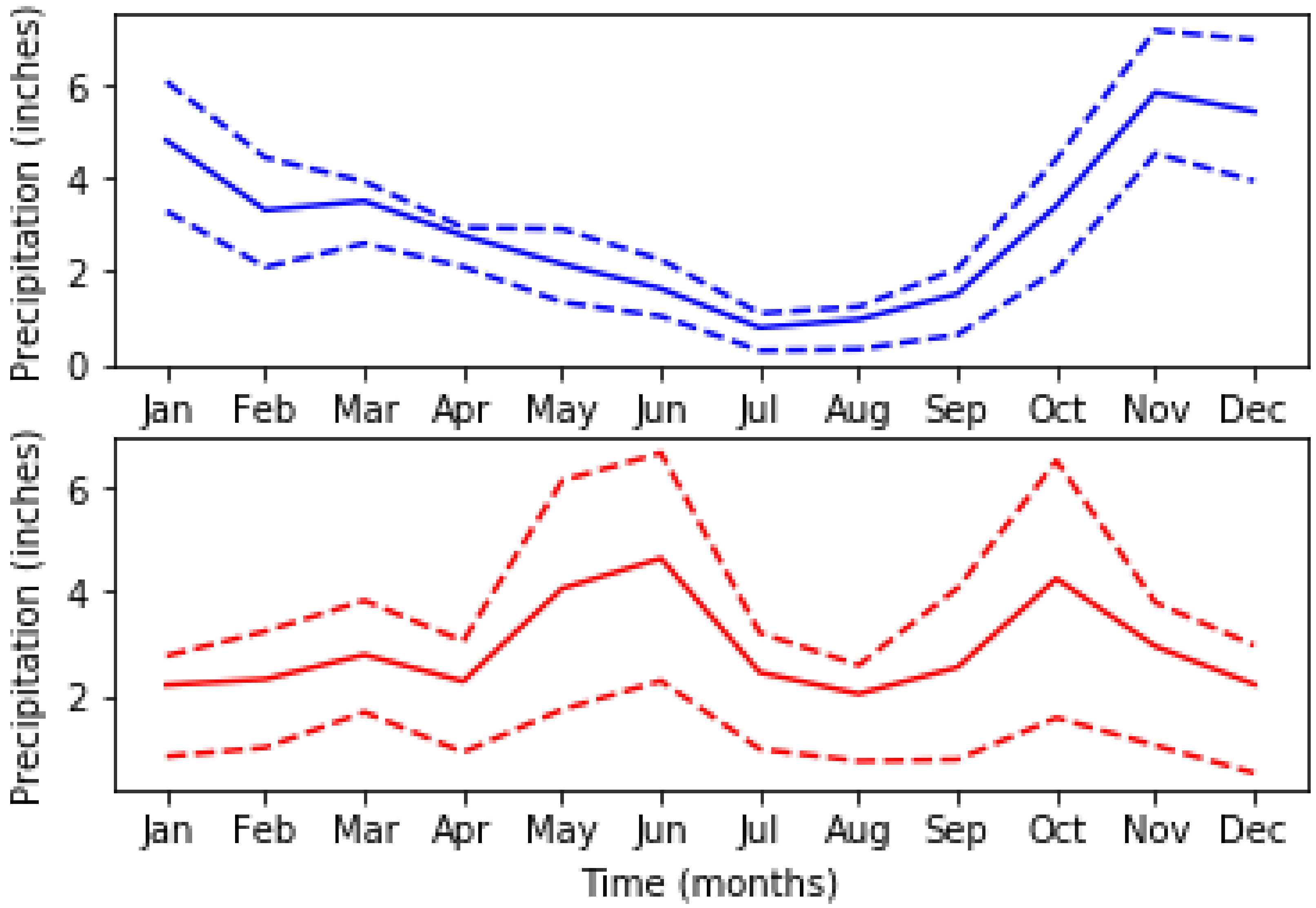
```
ax[0, 0].plot(seattle_weather["MONTH"],
              seattle_weather["MLY-PRCP-NORMAL"],
              color='b')
plt.show()
```



Subplots with data

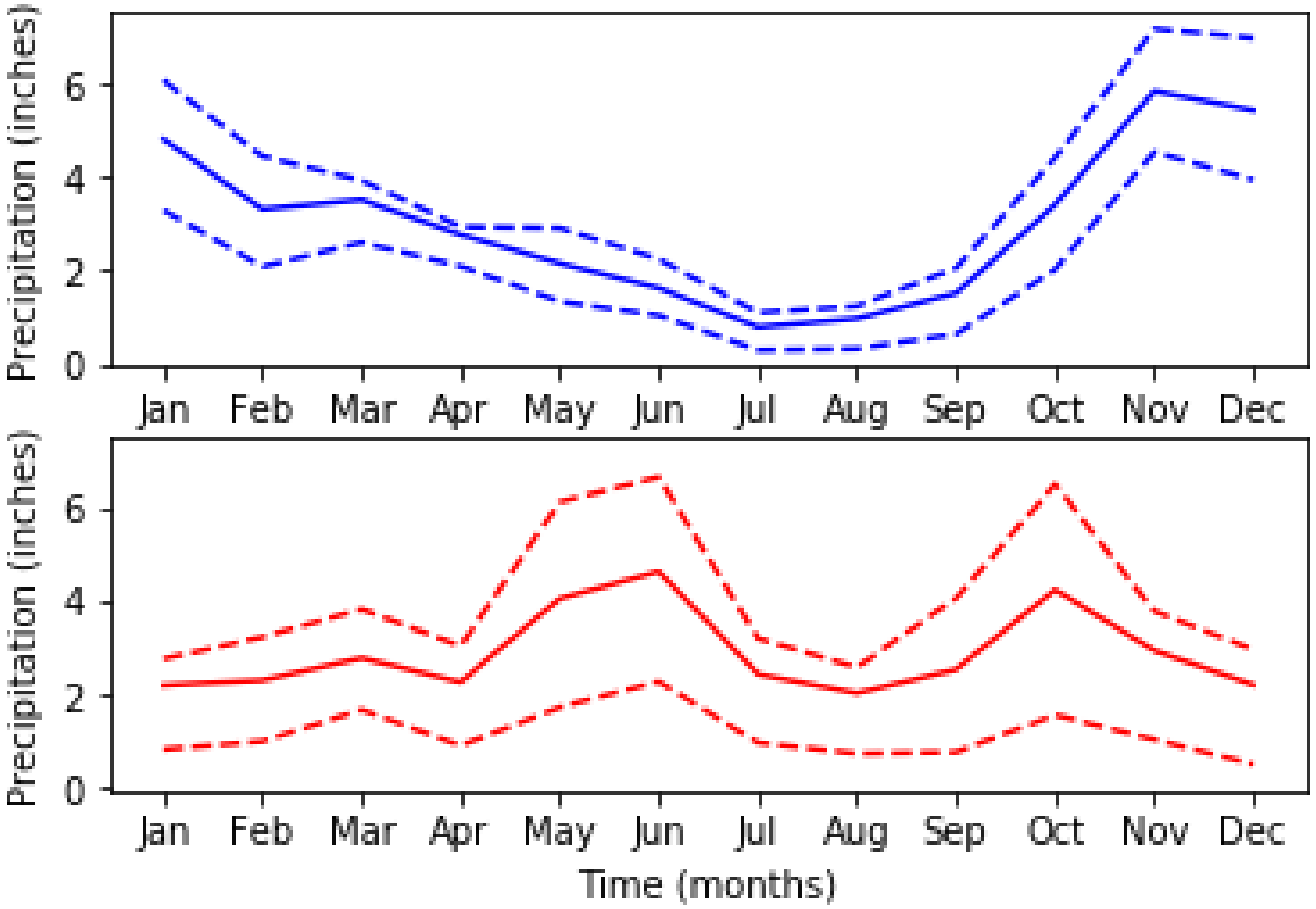
```
fig, ax = plt.subplots(2, 1)
ax[0].plot(seattle_weather["MONTH"], seattle_weather["MLY-PRCP-NORMAL"],
           color='b')
ax[0].plot(seattle_weather["MONTH"], seattle_weather["MLY-PRCP-25PCTL"],
           linestyle='--', color='b')
ax[0].plot(seattle_weather["MONTH"], seattle_weather["MLY-PRCP-75PCTL"],
           linestyle='--', color='b')
ax[1].plot(austin_weather["MONTH"], austin_weather["MLY-PRCP-NORMAL"],
           color='r')
ax[1].plot(austin_weather["MONTH"], austin_weather["MLY-PRCP-25PCTL"],
           linestyle='--', color='r')
ax[1].plot(austin_weather["MONTH"], austin_weather["MLY-PRCP-75PCTL"],
           linestyle='--', color='r')
ax[0].set_ylabel("Precipitation (inches)")
ax[1].set_ylabel("Precipitation (inches)")
ax[1].set_xlabel("Time (months)")
plt.show()
```

Subplots with data



Sharing the y-axis range

```
fig, ax = plt.subplots(2, 1, sharey=True)
```



Practice making subplots!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Plotting time-series data

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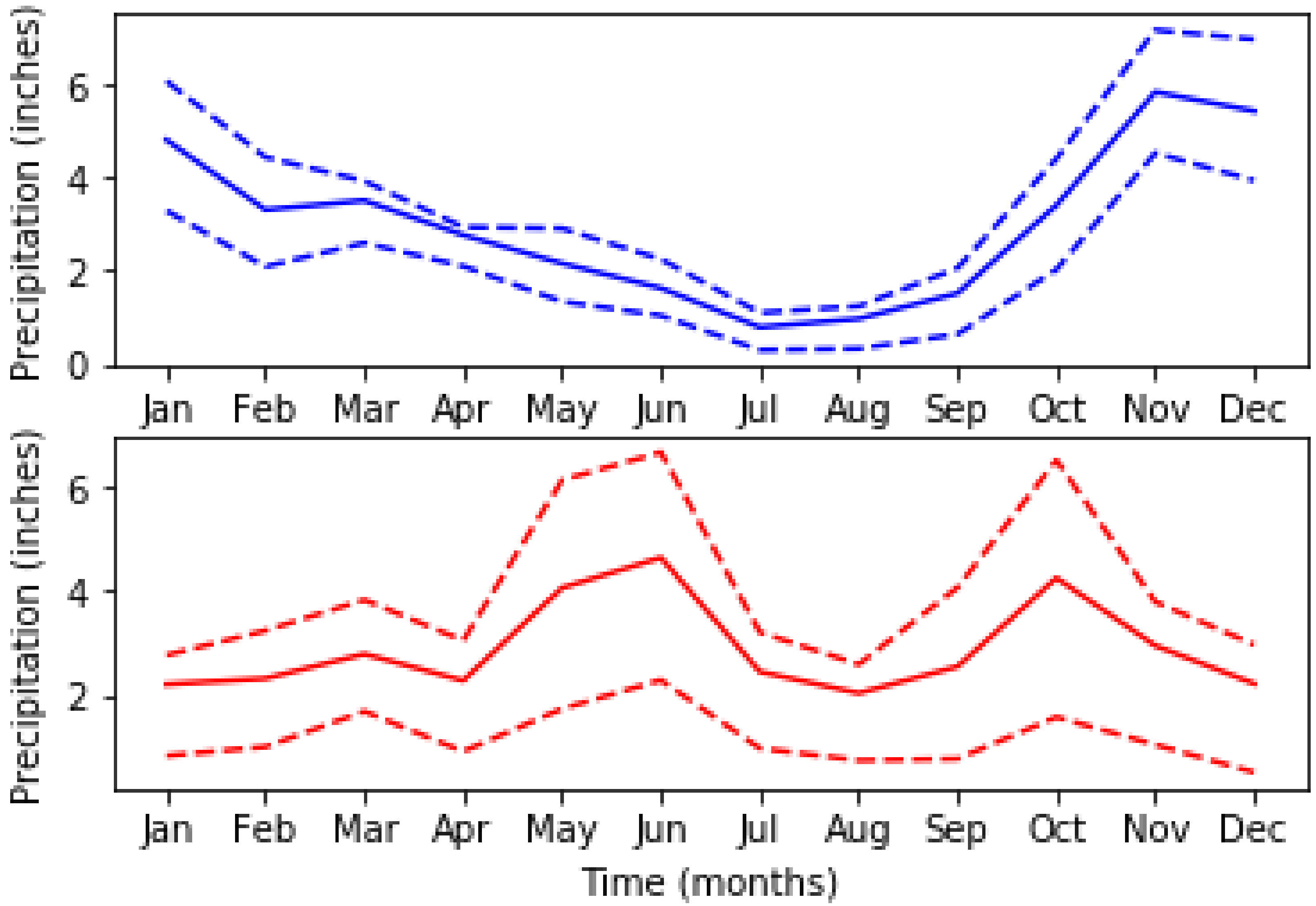
Time-series data



Climate change time-series

```
date,co2,relative_temp
1958-03-06,315.71,0.1
1958-04-06,317.45,0.01
1958-05-06,317.5,0.08
1958-06-06,-99.99,-0.05
1958-07-06,315.86,0.06
1958-08-06,314.93,-0.06
...
2016-08-06,402.27,0.98
2016-09-06,401.05,0.87
2016-10-06,401.59,0.89
2016-11-06,403.55,0.93
2016-12-06,404.45,0.81
```

DateTimeIndex

```
climate_change.index
```

```
DatetimeIndex(['1958-03-06', '1958-04-06', '1958-05-06', '1958-06-06',
               '1958-07-06', '1958-08-06', '1958-09-06', '1958-10-06',
               '1958-11-06', '1958-12-06',
               ...
               '2016-03-06', '2016-04-06', '2016-05-06', '2016-06-06',
               '2016-07-06', '2016-08-06', '2016-09-06', '2016-10-06',
               '2016-11-06', '2016-12-06'],
              dtype='datetime64[ns]', name='date', length=706, freq=None)
```

Time-series data

```
climate_change['relative_temp']
```

```
0       0.10
1       0.01
2       0.08
3      -0.05
4       0.06
5      -0.06
6      -0.03
7       0.04
       ...
701     0.98
702     0.87
703     0.89
704     0.93
705     0.81
Name:co2, Length: 706, dtype: float64
```

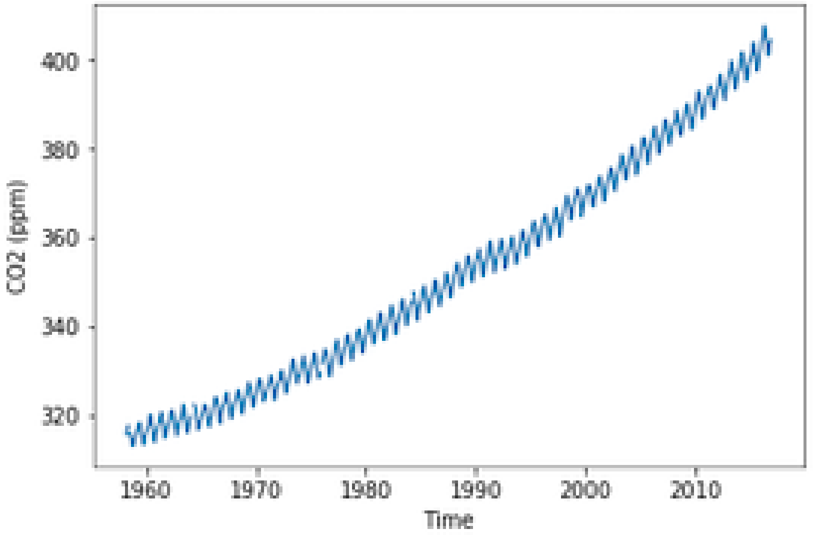
```
climate_change['co2']
```

```
0       315.71
1       317.45
2       317.50
3          NaN
4       315.86
5       314.93
6       313.20
7          NaN
       ...
701     402.27
702     401.05
703     401.59
704     403.55
705     404.45
Name:co2, Length: 706, dtype: float64
```

Plotting time-series data

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
```

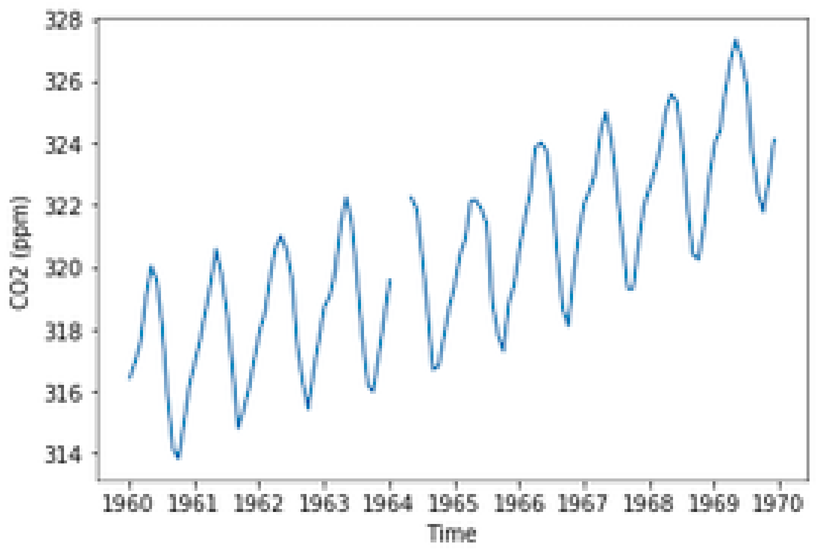
```
ax.plot(climate_change.index, climate_change['co2'])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')
plt.show()
```



Zooming in on a decade

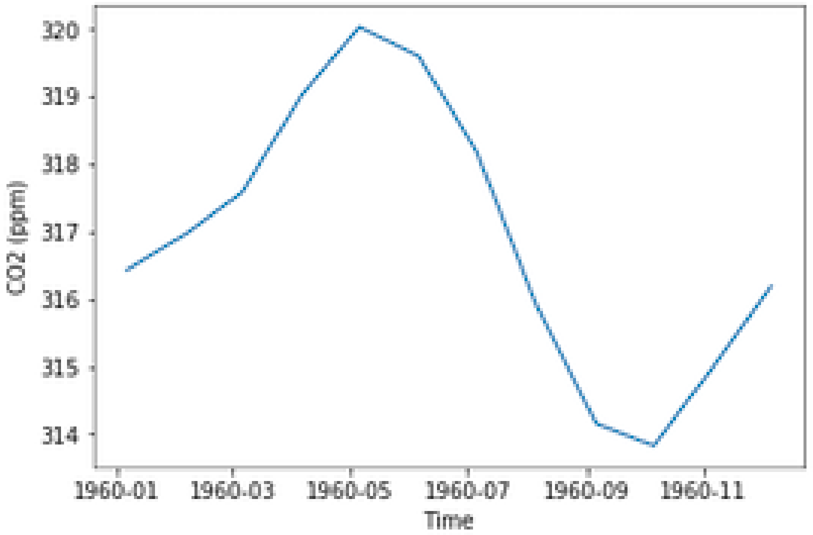
```
sixties = climate_change["1960-01-01":"1969-12-31"]
```

```
fig, ax = plt.subplots()
ax.plot(sixties.index, sixties['co2'])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')
plt.show()
```



Zooming in on one year

```
sixty_nine = climate_change["1969-01-01":"1969-12-31"]
fig, ax = plt.subplots()
ax.plot(sixty_nine.index, sixty_nine['co2'])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')
plt.show()
```



Let's practice time-series plotting!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Plotting time-series with different variables

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

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Data Scientist

Plotting two time-series together

```
import pandas as pd
climate_change = pd.read_csv('climate_change.csv',
                             parse_dates=["date"],
                             index_col="date")
```

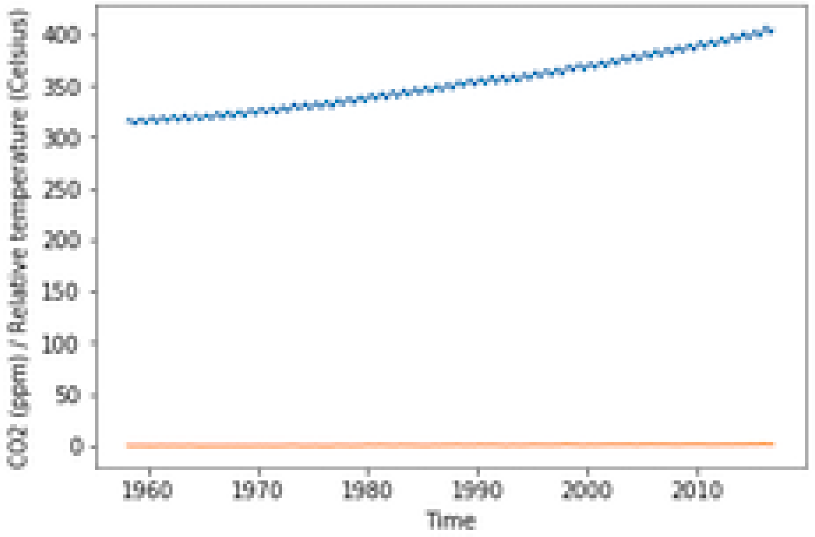
```
climate_change
```

```
              co2  relative_temp
date
1958-03-06  315.71           0.10
1958-04-06  317.45           0.01
1958-07-06  315.86           0.06
...            ...            ...
2016-11-06  403.55           0.93
2016-12-06  404.45           0.81

[706 rows x 2 columns]
```

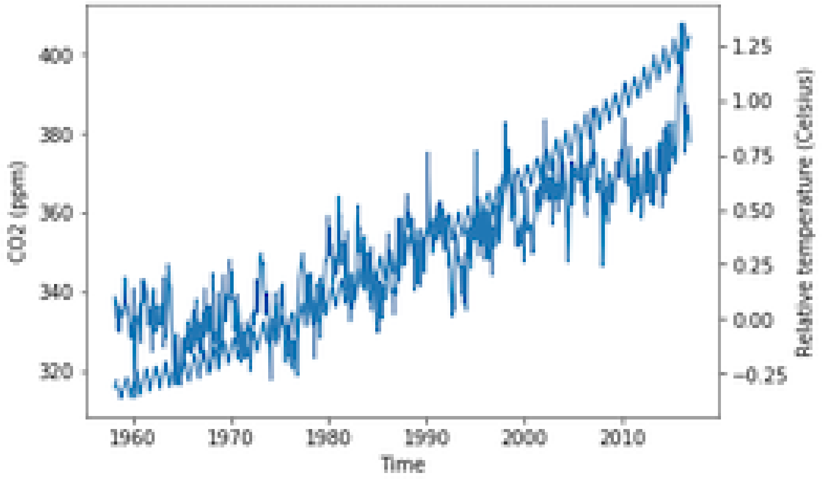
Plotting two time-series together

```python
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"])
ax.plot(climate_change.index, climate_change["relative_temp"])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm) / Relative temperature')
plt.show()
```



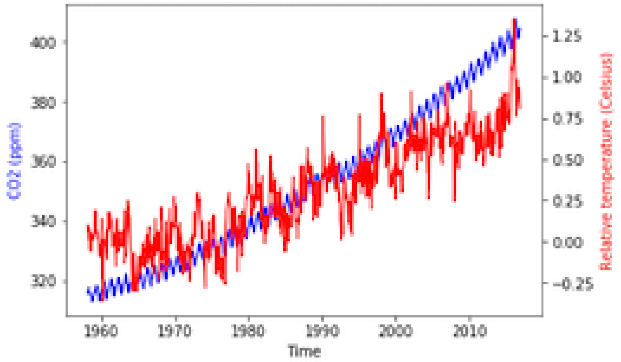
Using twin axes

```
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"])
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)')
ax2 = ax.twinx()
ax2.plot(climate_change.index, climate_change["relative_temp"])
ax2.set_ylabel('Relative temperature (Celsius)')
plt.show()
```



Separating variables by color

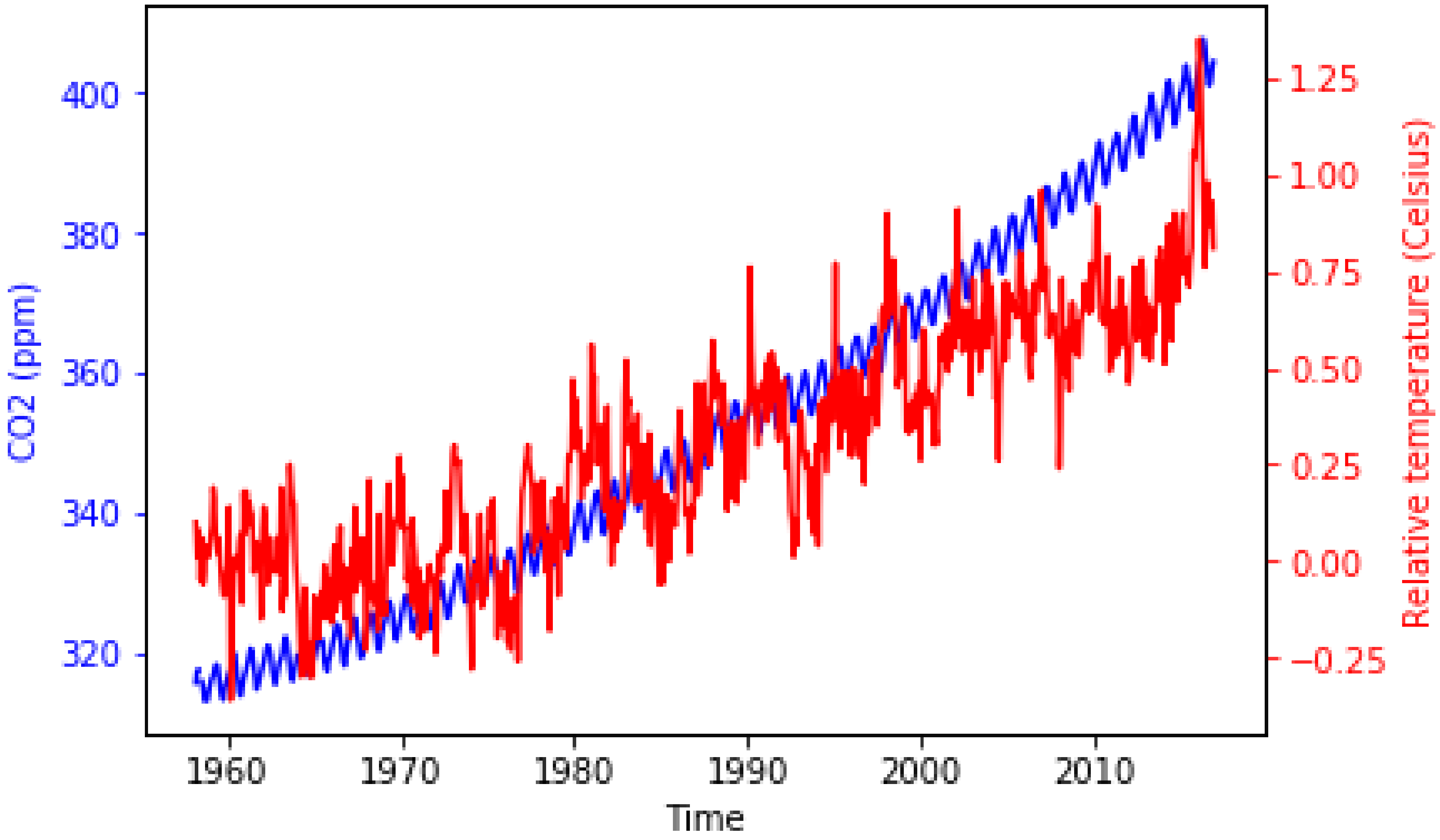
```
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"], color='blue')
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)', color='blue')
ax2 = ax.twinx()
ax2.plot(climate_change.index, climate_change["relative_temp"],
         color='red')
ax2.set_ylabel('Relative temperature (Celsius)', color='red')
plt.show()
```



Coloring the ticks

```
fig, ax = plt.subplots()
ax.plot(climate_change.index, climate_change["co2"],
        color='blue')
ax.set_xlabel('Time')
ax.set_ylabel('CO2 (ppm)', color='blue')
ax.tick_params('y', colors='blue')
ax2 = ax.twinx()
ax2.plot(climate_change.index,
         climate_change["relative_temp"],
         color='red')
ax2.set_ylabel('Relative temperature (Celsius)',
color='red')
ax2.tick_params('y', colors='red')
plt.show()
```

Coloring the ticks

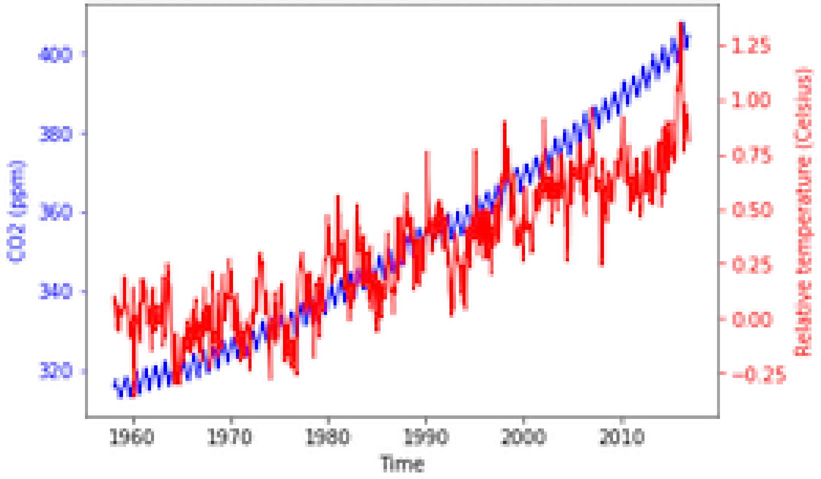


A function that plots time-series

```
def plot_timeseries(axes, x, y, color, xlabel, ylabel):
  axes.plot(x, y, color=color)
  axes.set_xlabel(xlabel)
  axes.set_ylabel(ylabel, color=color)
  axes.tick_params('y', colors=color)
```

Using our function

```
fig, ax = plt.subplots()
plot_timeseries(ax, climate_change.index, climate_change['co2'],
               'blue', 'Time', 'CO2 (ppm)')
ax2 = ax.twinx()
plot_timeseries(ax, climate_change.index,
                climate_change['relative_temp'],
               'red', 'Time', 'Relative temperature (Celsius)')
plt.show()
```



Create your own function!

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Annotating time-series data

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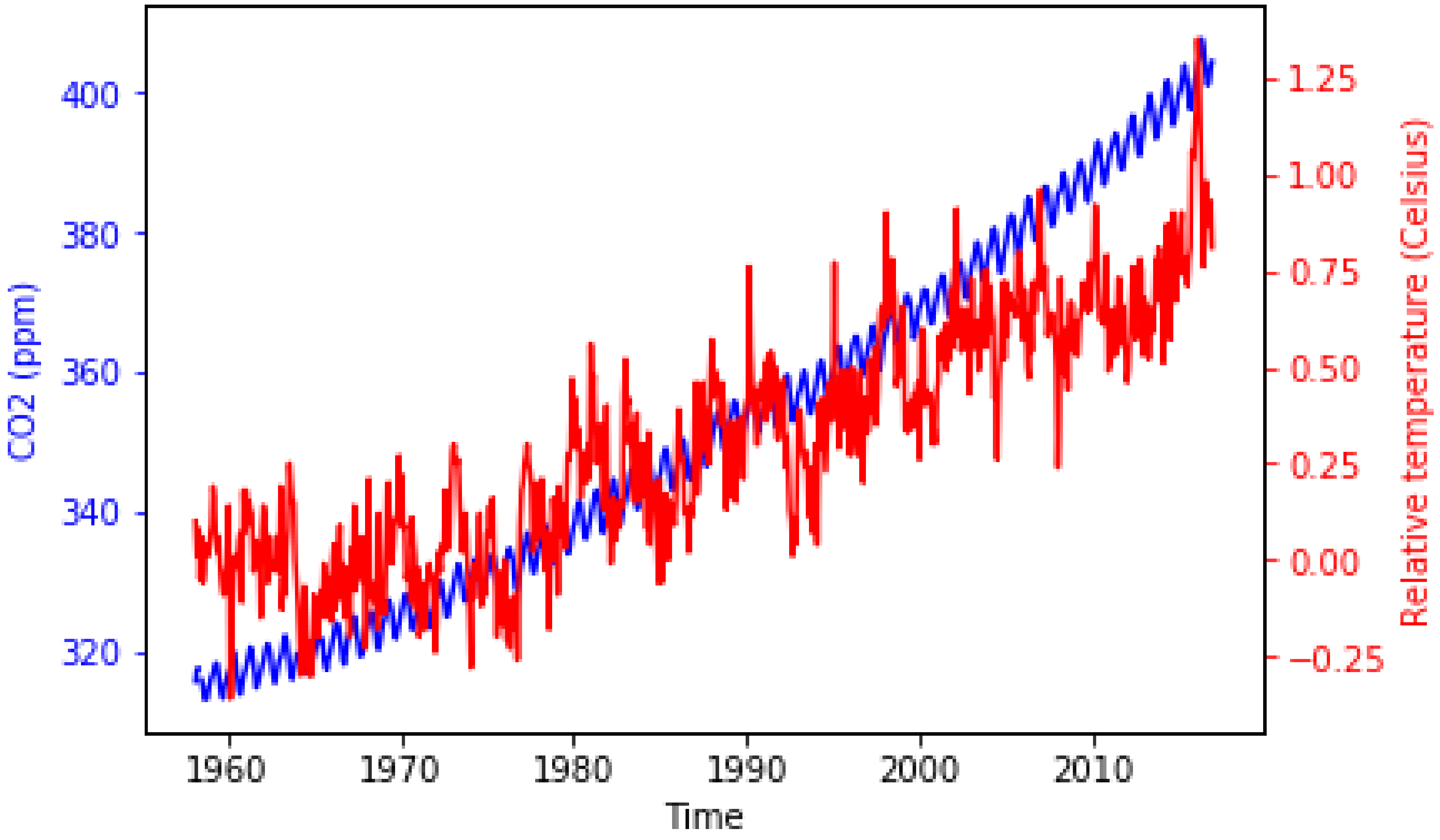
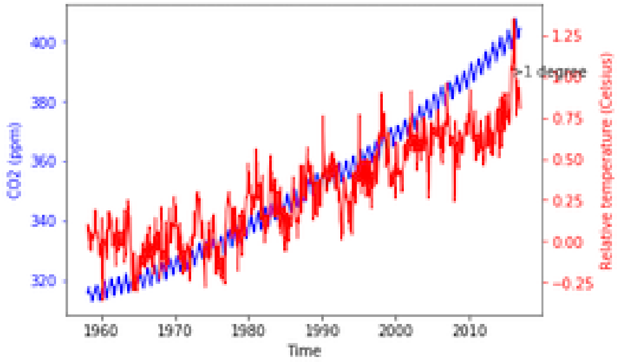
Time-series data



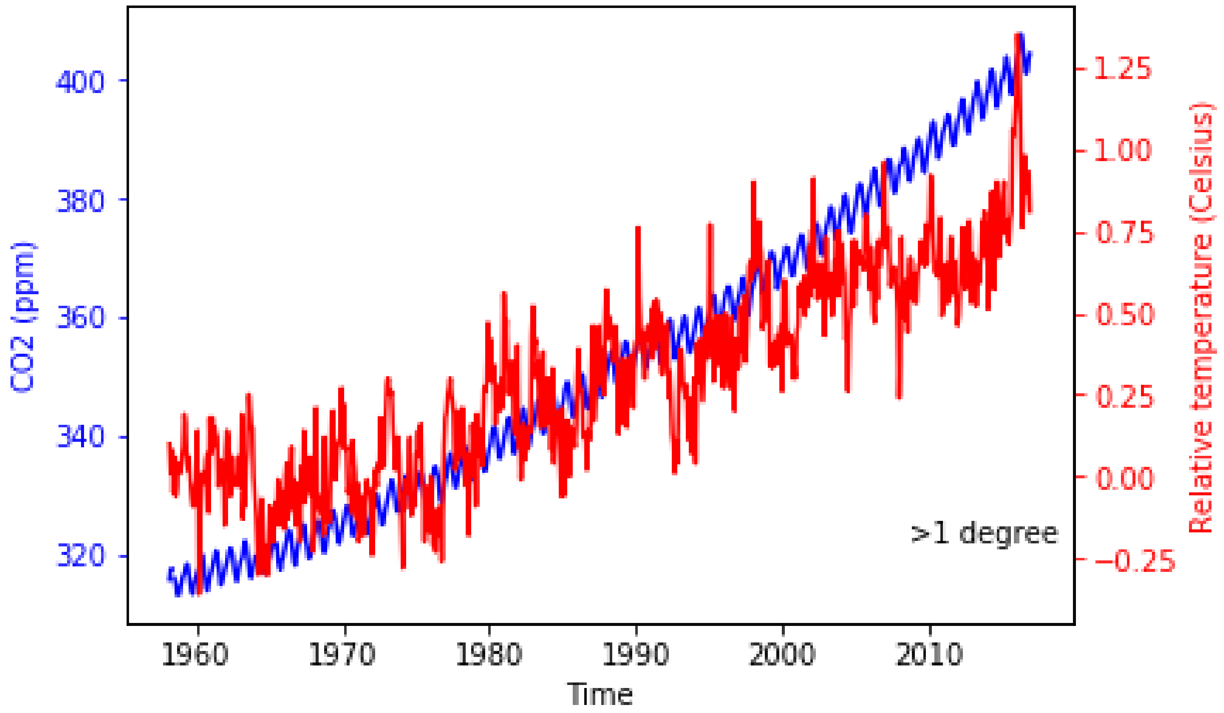
Annotation

```
fig, ax = plt.subplots()
plot_timeseries(ax, climate_change.index, climate_change['co2'],
               'blue', 'Time', 'CO2 (ppm)')
ax2 = ax.twinx()
plot_timeseries(ax2, climate_change.index,
                climate_change['relative_temp'],
               'red', 'Time', 'Relative temperature (Celsius)')
ax2.annotate(">1 degree",  xy=[pd.TimeStamp("2015-10-06"), 1])
plt.show()
```



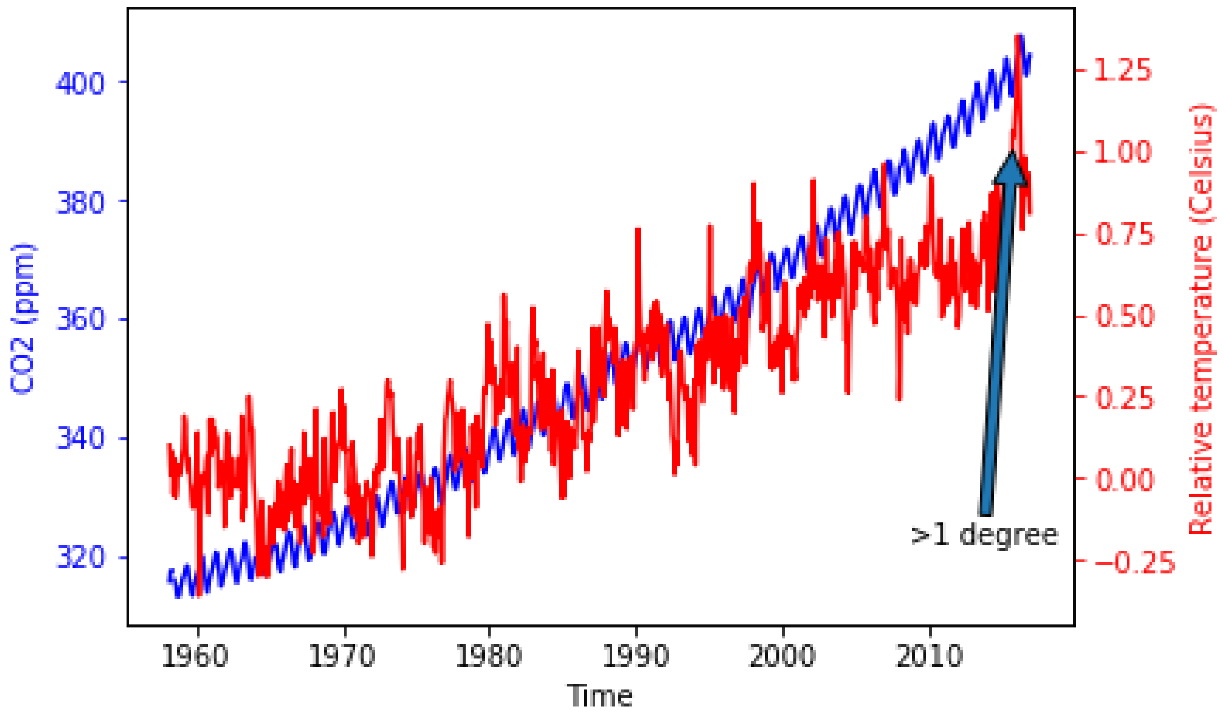
Positioning the text

```
ax2.annotate(">1 degree",
             xy=(pd.Timestamp('2015-10-06'), 1),
             xytext=(pd.Timestamp('2008-10-06'), -0.2))
```



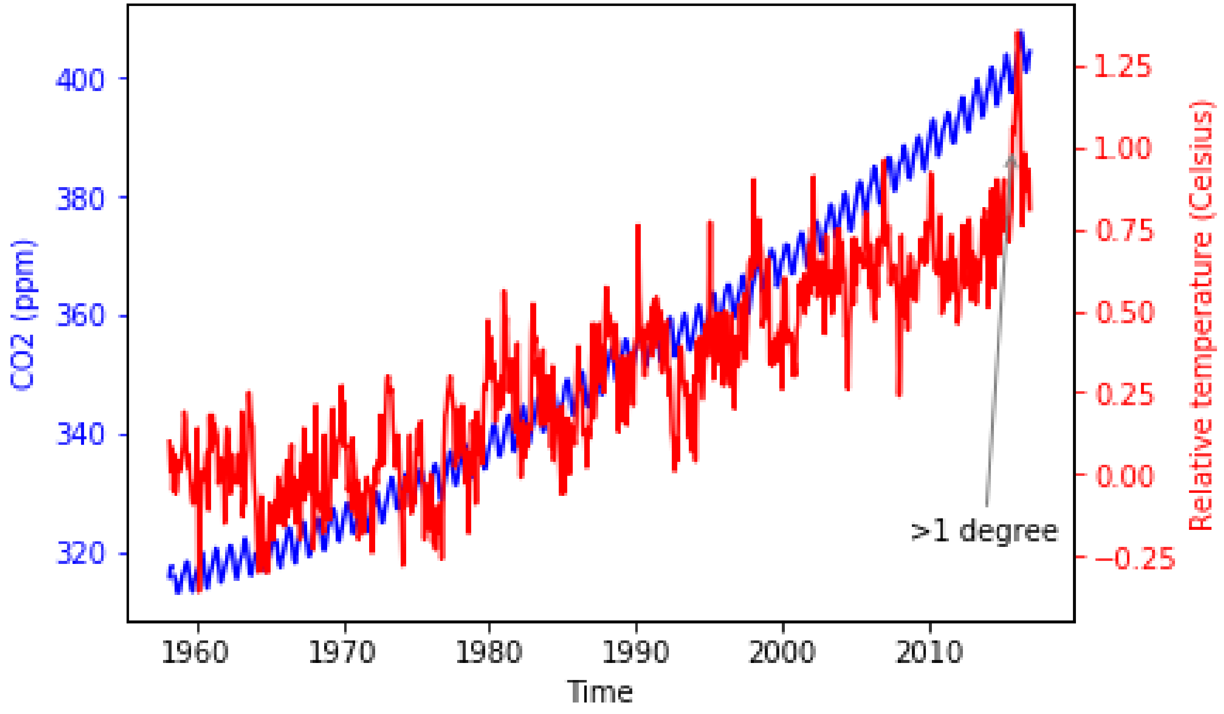
Adding arrows to annotation

```
ax2.annotate(">1 degree",
             xy=(pd.Timestamp('2015-10-06'), 1),
             xytext=(pd.Timestamp('2008-10-06'), -0.2),
             arrowprops={})
```



Customizing arrow properties

```
ax2.annotate(">1 degree",
             xy=(pd.Timestamp('2015-10-06'), 1),
             xytext=(pd.Timestamp('2008-10-06'), -0.2),
             arrowprops={"arrowstyle":"->", "color":"gray"})
```



Customizing annotations

https://matplotlib.org/users/annotations.html

Practice annotating plots!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Quantitative comparisons: bar-charts

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

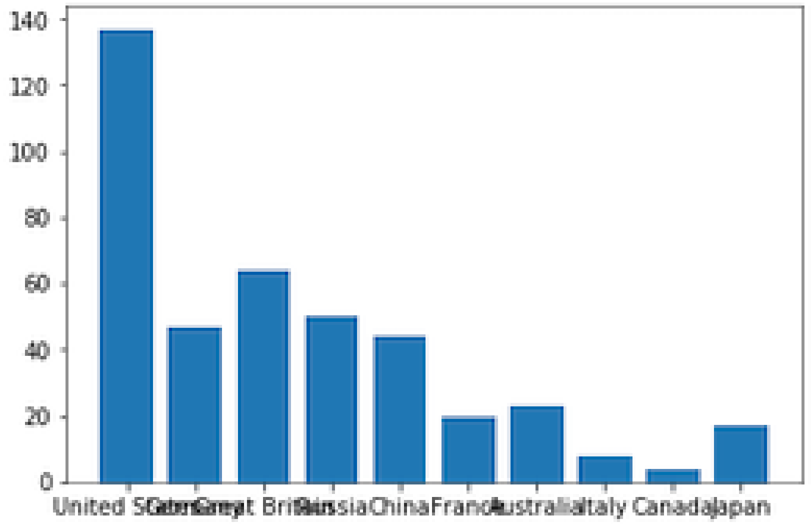
Ariel Rokem
Data Scientist

Olympic medals

```
,Gold, Silver, Bronze
United States, 137, 52, 67
Germany, 47, 43, 67
Great Britain, 64, 55, 26
Russia, 50, 28, 35
China, 44, 30, 35
France, 20, 55, 21
Australia, 23, 34, 25
Italy, 8, 38, 24
Canada, 4, 4, 61
Japan, 17, 13, 34
```

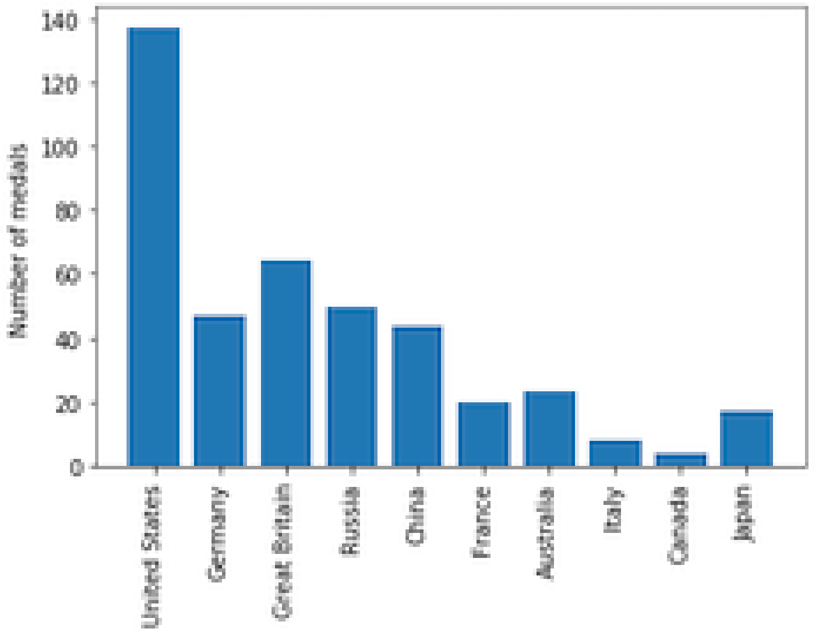
Olympic medals: visualizing the data

```
medals = pd.read_csv('medals_by_country_2016.csv', index_col=0)
fig, ax = plt.subplots()
ax.bar(medals.index, medals["Gold"])
plt.show()
```



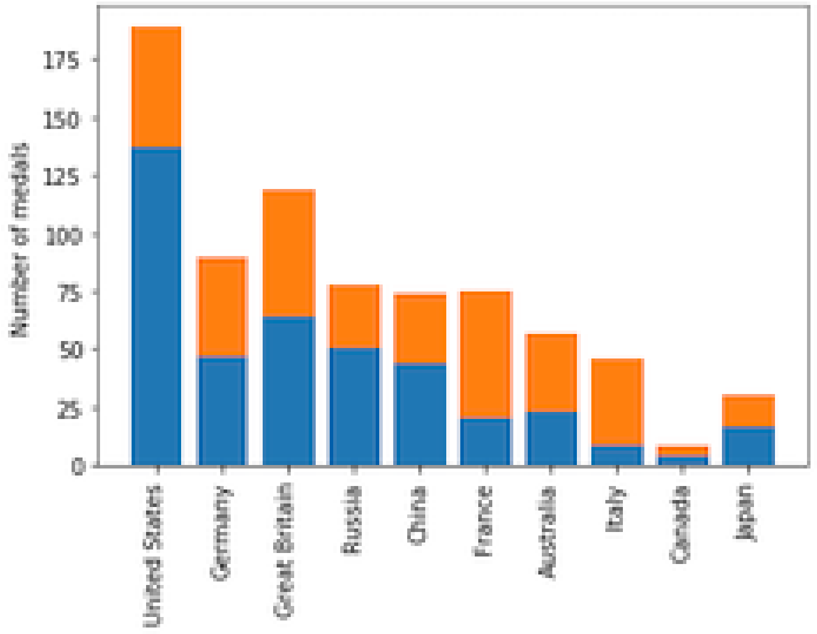
Interlude: rotate the tick labels

```
fig, ax = plt.subplots()
ax.bar(medals.index, medals["Gold"])
ax.set_xticklabels(medals.index, rotation=90)
ax.set_ylabel("Number of medals")
plt.show()
```



Olympic medals: visualizing the other medals

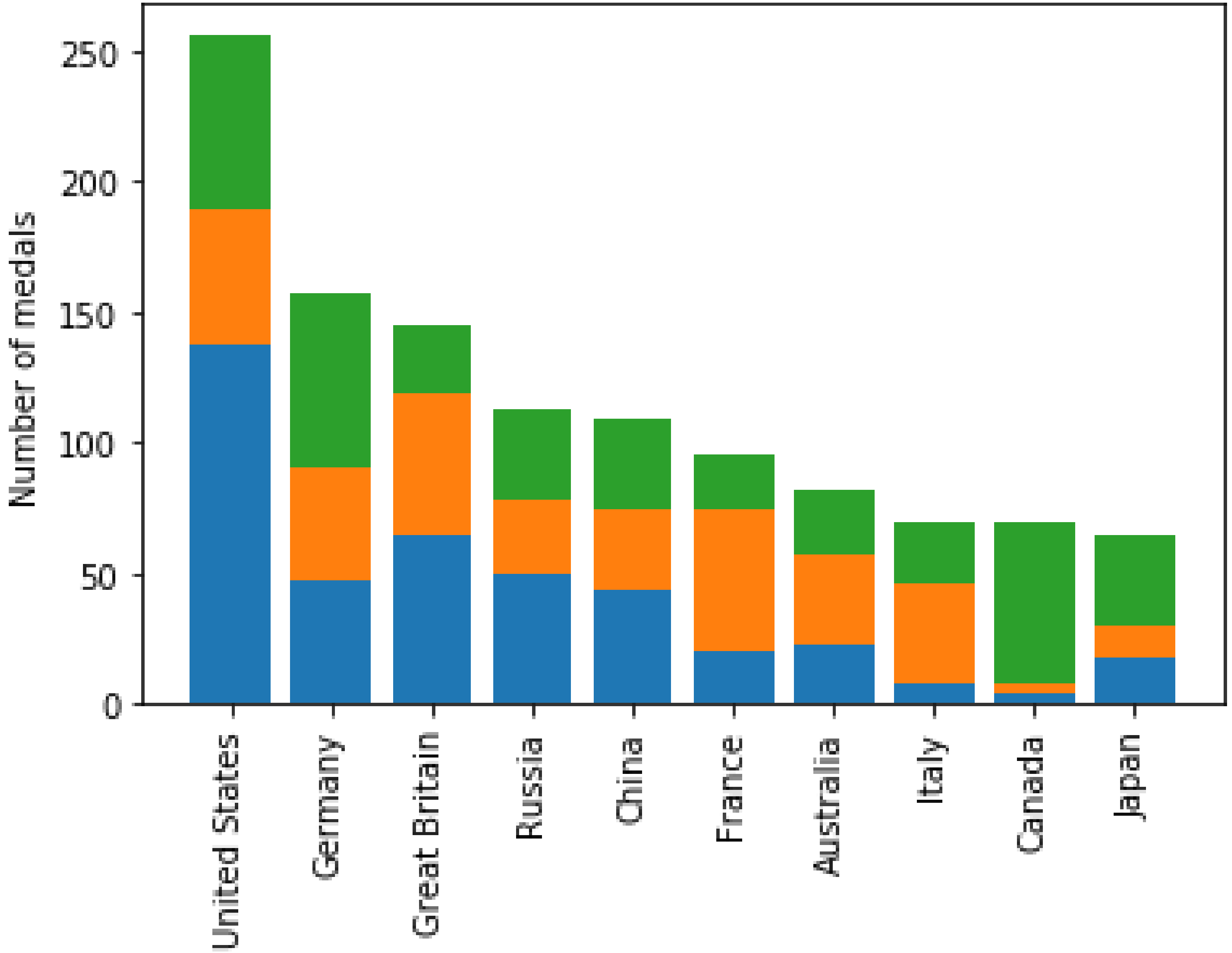
```
fig, ax = plt.subplots
ax.bar(medals.index, medals["Gold"])
ax.bar(medals.index, medals["Silver"], bottom=medals["Gold"])
ax.set_xticklabels(medals.index, rotation=90)
ax.set_ylabel("Number of medals")
plt.show()
```



Olympic medals: visualizing all three

```
fig, ax = plt.subplots
ax.bar(medals.index, medals["Gold"])

ax.bar(medals.index, medals["Silver"], bottom=medals["Gold"])
ax.bar(medals.index, medals["Bronze"],
       bottom=medals["Gold"] + medals["Silver"])
ax.set_xticklabels(medals.index, rotation=90)
ax.set_ylabel("Number of medals")
plt.show()
```

Stacked bar chart



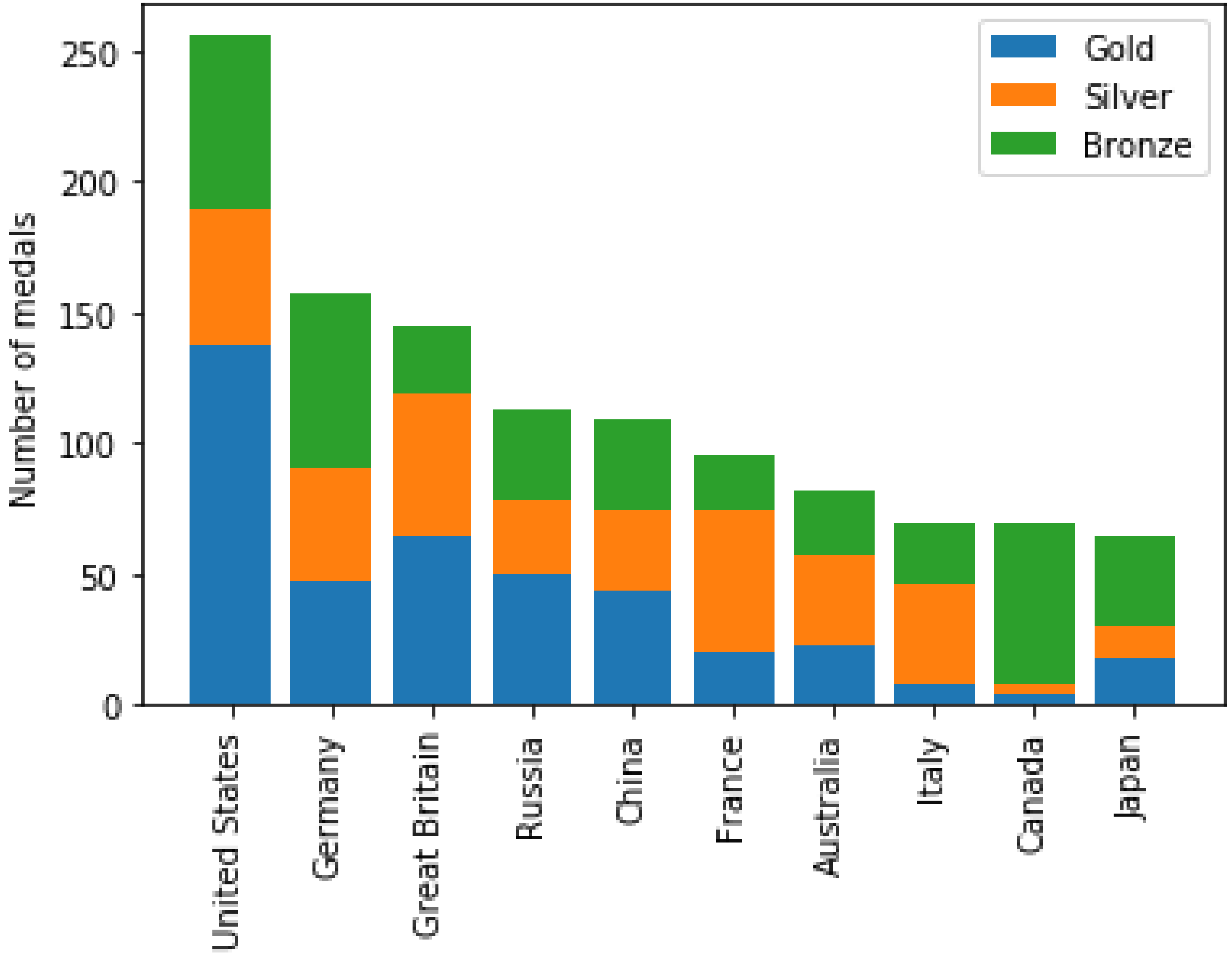
Adding a legend

```
fig, ax = plt.subplots
ax.bar(medals.index, medals["Gold"])
ax.bar(medals.index, medals["Silver"], bottom=medals["Gold"])
ax.bar(medals.index, medals["Bronze"],
       bottom=medals["Gold"] + medals["Silver"])

ax.set_xticklabels(medals.index, rotation=90)
ax.set_ylabel("Number of medals")
```

Adding a legend

```
fig, ax = plt.subplots
ax.bar(medals.index, medals["Gold"], label="Gold")
ax.bar(medals.index, medals["Silver"], bottom=medals["Gold"],
       label="Silver")
ax.bar(medals.index, medals["Bronze"],
       bottom=medals["Gold"] + medals["Silver"],
       label="Bronze")

ax.set_xticklabels(medals.index, rotation=90)
ax.set_ylabel("Number of medals")
ax.legend()
plt.show()
```

Stacked bar chart with legend



Create a bar chart!

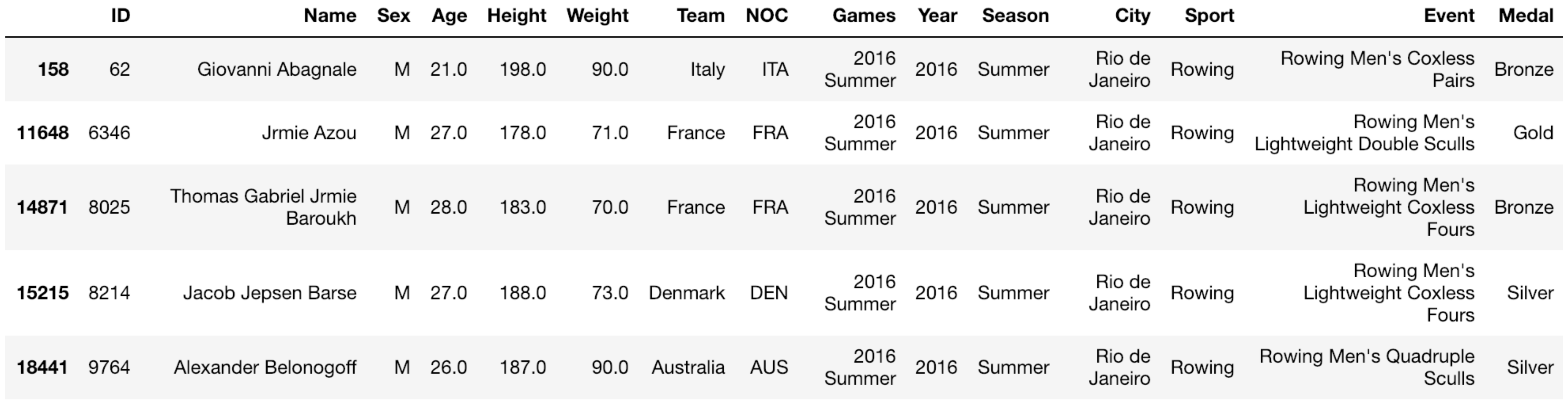
INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Quantitative comparisons: histograms

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

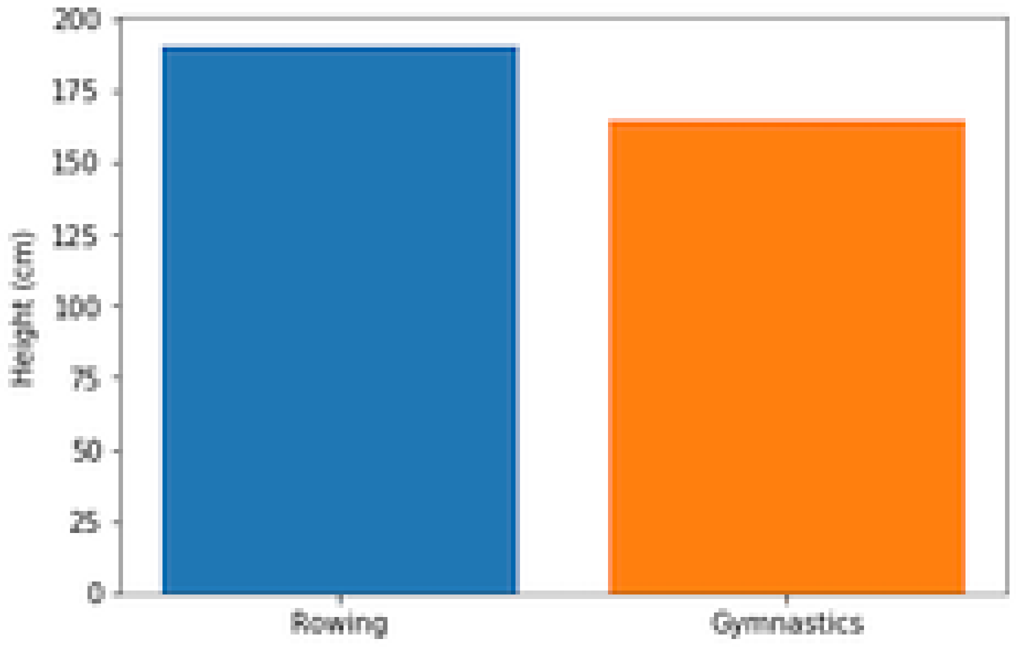
Histograms



	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal
158	62	Giovanni Abagnale	M	21.0	198.0	90.0	Italy	ITA	2016 Summer	2016	Summer	Rio de Janeiro	Rowing	Rowing Men's Coxless Pairs	Bronze
11648	6346	Jrmie Azou	M	27.0	178.0	71.0	France	FRA	2016 Summer	2016	Summer	Rio de Janeiro	Rowing	Rowing Men's Lightweight Double Sculls	Gold
14871	8025	Thomas Gabriel Jrmie Baroukh	M	28.0	183.0	70.0	France	FRA	2016 Summer	2016	Summer	Rio de Janeiro	Rowing	Rowing Men's Lightweight Coxless Fours	Bronze
15215	8214	Jacob Jepsen Barse	M	27.0	188.0	73.0	Denmark	DEN	2016 Summer	2016	Summer	Rio de Janeiro	Rowing	Rowing Men's Lightweight Coxless Fours	Silver
18441	9764	Alexander Belonogoff	M	26.0	187.0	90.0	Australia	AUS	2016 Summer	2016	Summer	Rio de Janeiro	Rowing	Rowing Men's Quadruple Sculls	Silver

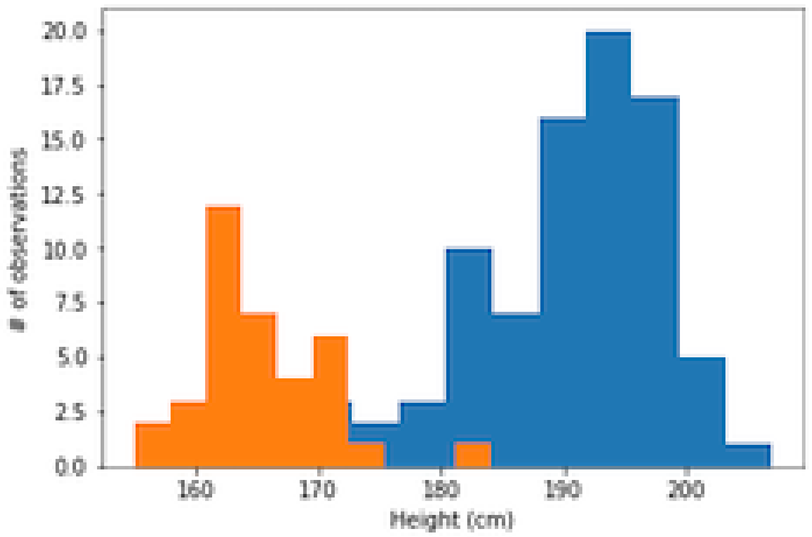
A bar chart again

```
fig, ax = plt.subplots()
ax.bar("Rowing", mens_rowing["Height"].mean())
ax.bar("Gymnastics", mens_gymnastics["Height"].mean())
ax.set_ylabel("Height (cm)")
plt.show()
```



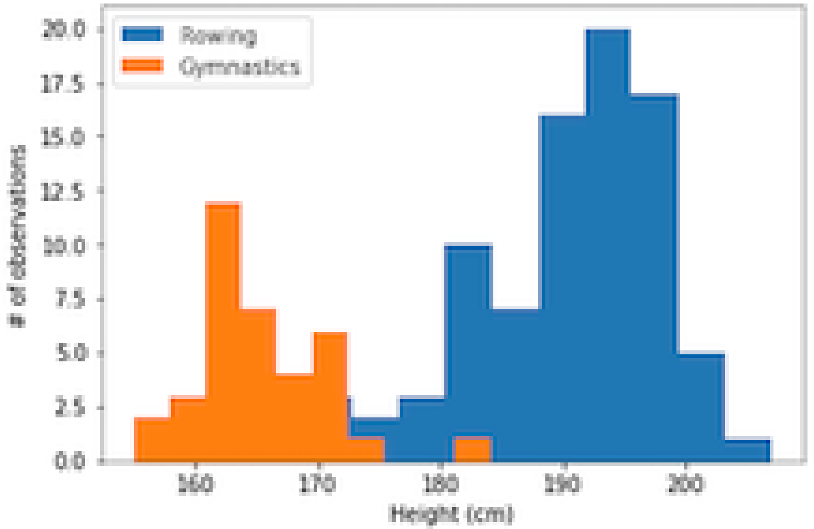
Introducing histograms

```
fig, ax = plt.subplots()
ax.hist(mens_rowing["Height"])
ax.hist(mens_gymnastic["Height"])
ax.set_xlabel("Height (cm)")
ax.set_ylabel("# of observations")
plt.show()
```



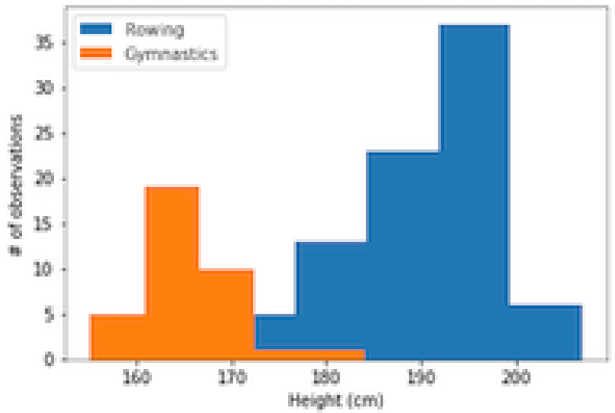
Labels are needed

```
ax.hist(mens_rowing["Height"], label="Rowing")
ax.hist(mens_gymnastic["Height"], label="Gymnastics")
ax.set_xlabel("Height (cm)")
ax.set_ylabel("# of observations")
ax.legend()
plt.show()
```



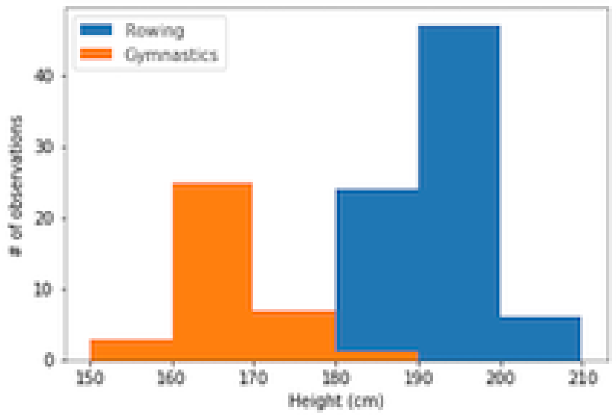
Customizing histograms: setting the number of bins

```
ax.hist(mens_rowing["Height"], label="Rowing", bins=5)
ax.hist(mens_gymnastic["Height"], label="Gymnastics", bins=5)
ax.set_xlabel("Height (cm)")
ax.set_ylabel("# of observations")
ax.legend()
plt.show()
```



Customizing histograms: setting bin boundaries

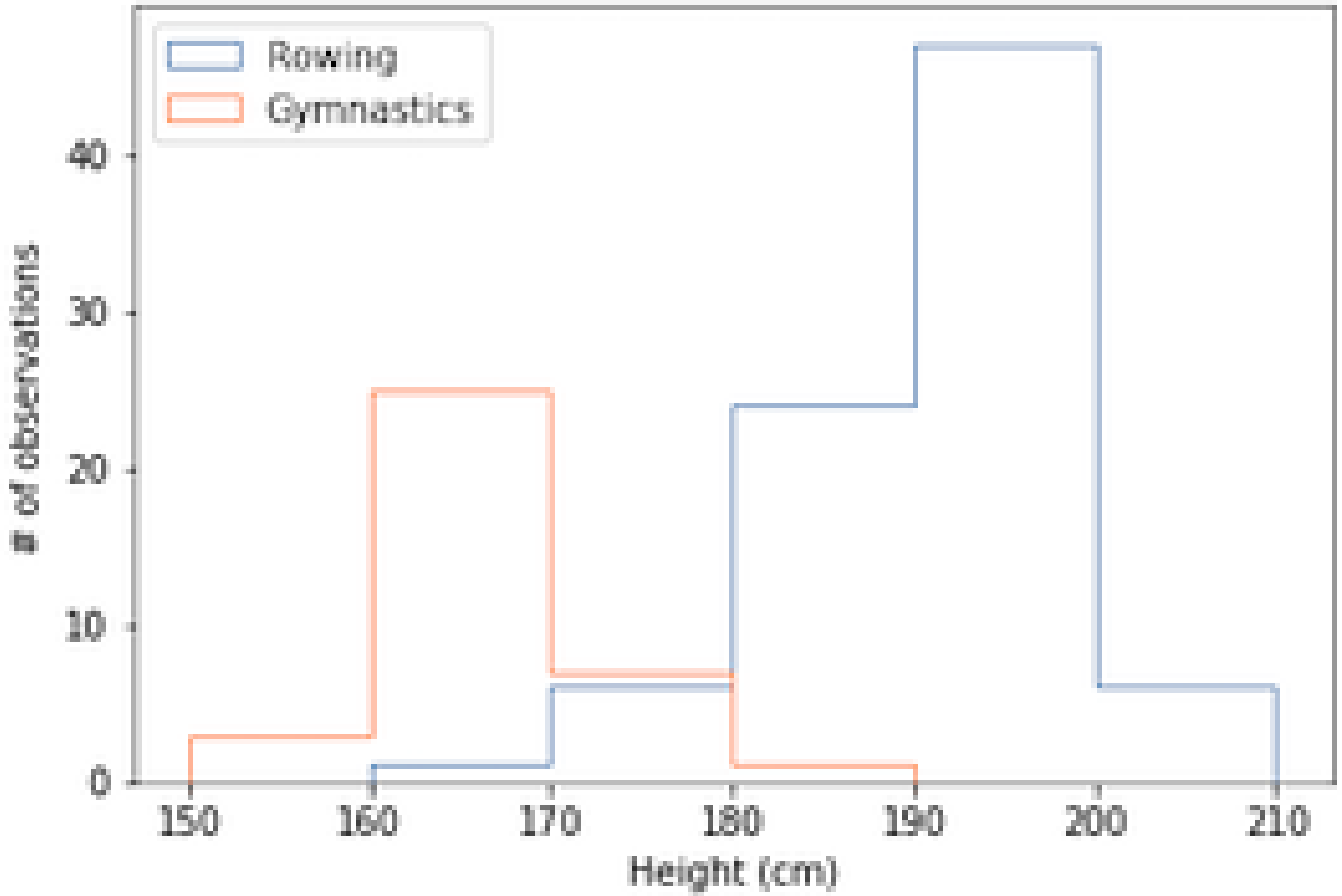
```
ax.hist(mens_rowing["Height"], label="Rowing",
        bins=[150, 160, 170, 180, 190, 200, 210])

ax.hist(mens_gymnastic["Height"], label="Gymnastics",
        bins=[150, 160, 170, 180, 190, 200, 210])

ax.set_xlabel("Height (cm)")
ax.set_ylabel("# of observations")
ax.legend()
plt.show()
```



Customizing histograms: transparency

```python
ax.hist(mens_rowing["Height"], label="Rowing",
        bins=[150, 160, 170, 180, 190, 200, 210],
        histtype="step")

ax.hist(mens_gymnastic["Height"], label="Gymnastics",
        bins=[150, 160, 170, 180, 190, 200, 210],
        histtype="step")

ax.set_xlabel("Height (cm)")
ax.set_ylabel("# of observations")
ax.legend()
plt.show()
```

Histogram with a histtype of step



Create your own histogram!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Statistical plotting

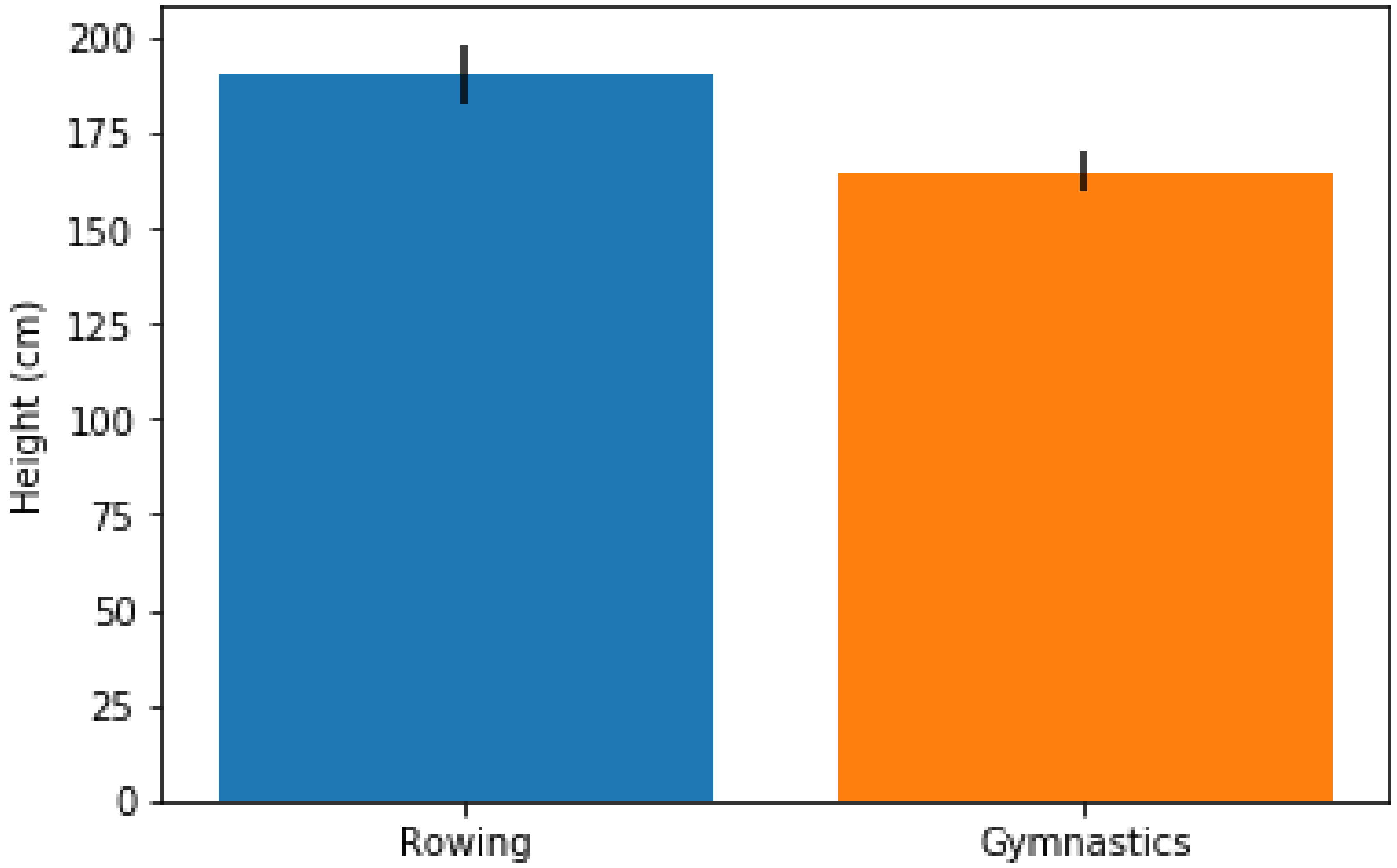
INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

Adding error bars to bar charts

```
fig, ax = plt.subplots()

ax.bar("Rowing",
       mens_rowing["Height"].mean(),
       yerr=mens_rowing["Height"].std())

ax.bar("Gymnastics",
       mens_gymnastics["Height"].mean(),
       yerr=mens_gymnastics["Height"].std())

ax.set_ylabel("Height (cm)")

plt.show()
```

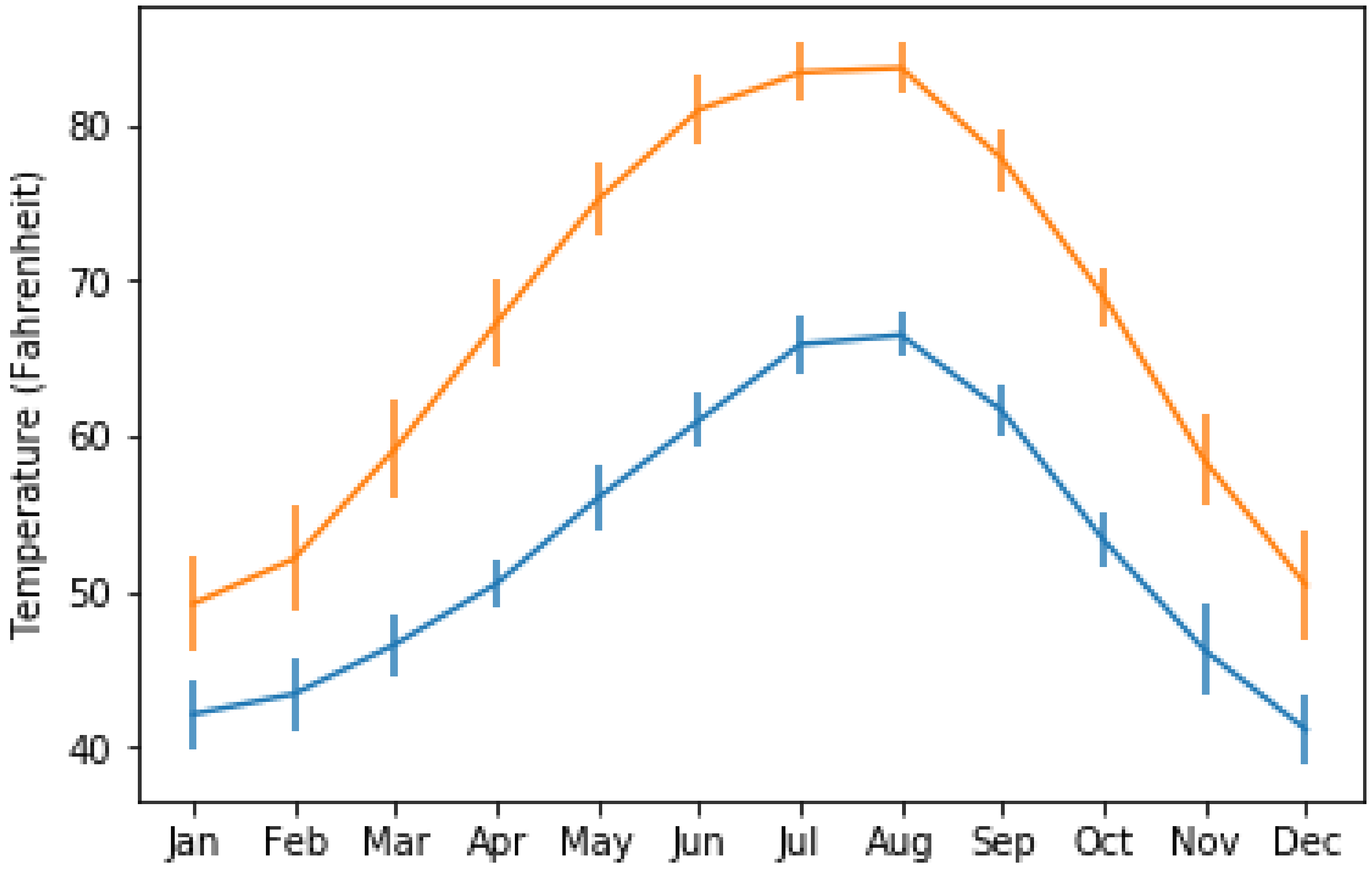
Error bars in a bar chart



Adding error bars to plots

```
fig, ax = plt.subplots()

ax.errorbar(seattle_weather["MONTH"],
            seattle_weather["MLY-TAVG-NORMAL"],
            yerr=seattle_weather["MLY-TAVG-STDDEV"])

ax.errorbar(austin_weather["MONTH"],
            austin_weather["MLY-TAVG-NORMAL"],
            yerr=austin_weather["MLY-TAVG-STDDEV"])

ax.set_ylabel("Temperature (Fahrenheit)")

plt.show()
```

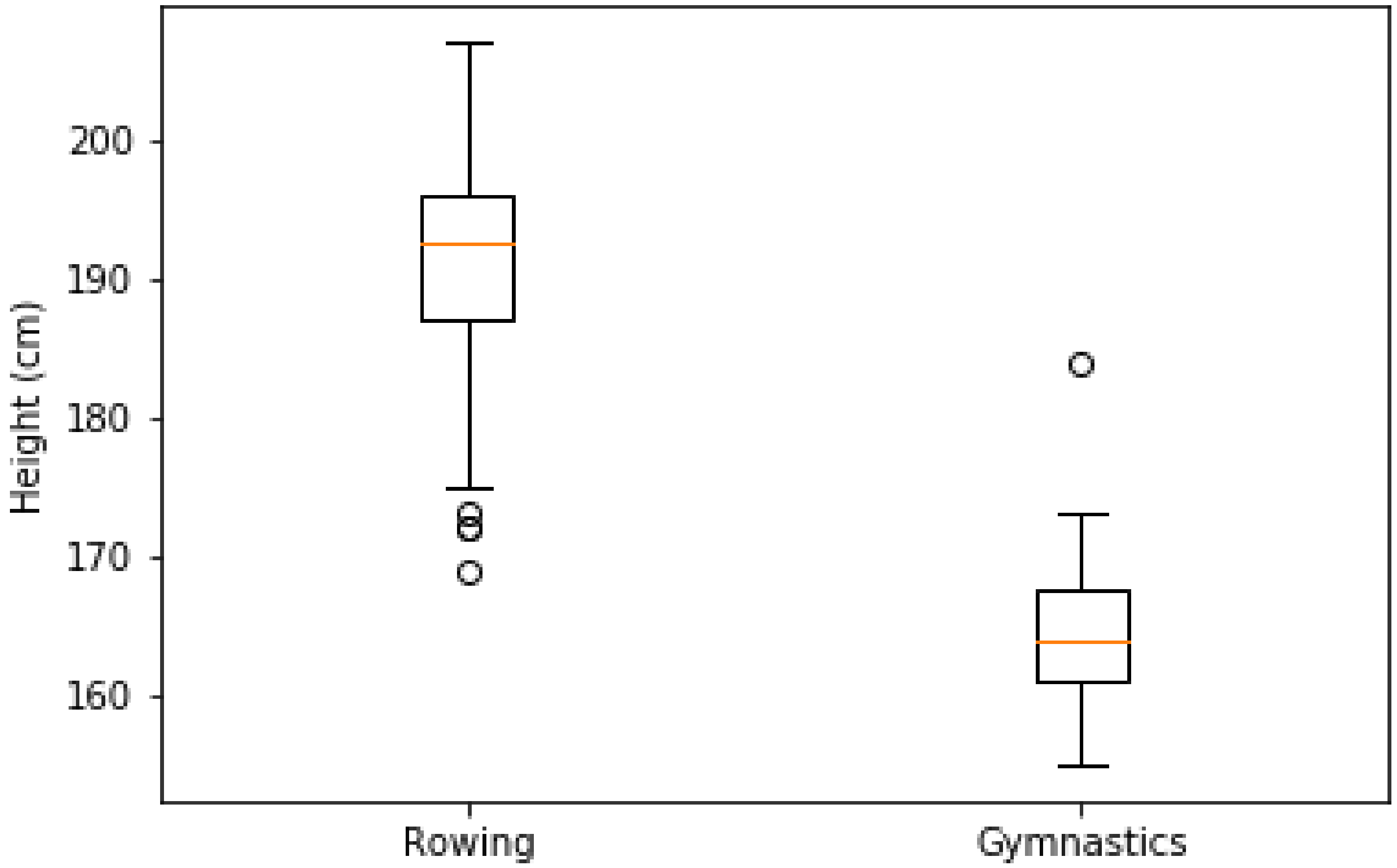
Error bars in plots



Adding boxplots

```python
fig, ax = plt.subplots()
ax.boxplot([mens_rowing["Height"],
            mens_gymnastics["Height"]])
ax.set_xticklabels(["Rowing", "Gymnastics"])
ax.set_ylabel("Height (cm)")

plt.show()
```

Interpreting boxplots



Try it yourself!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

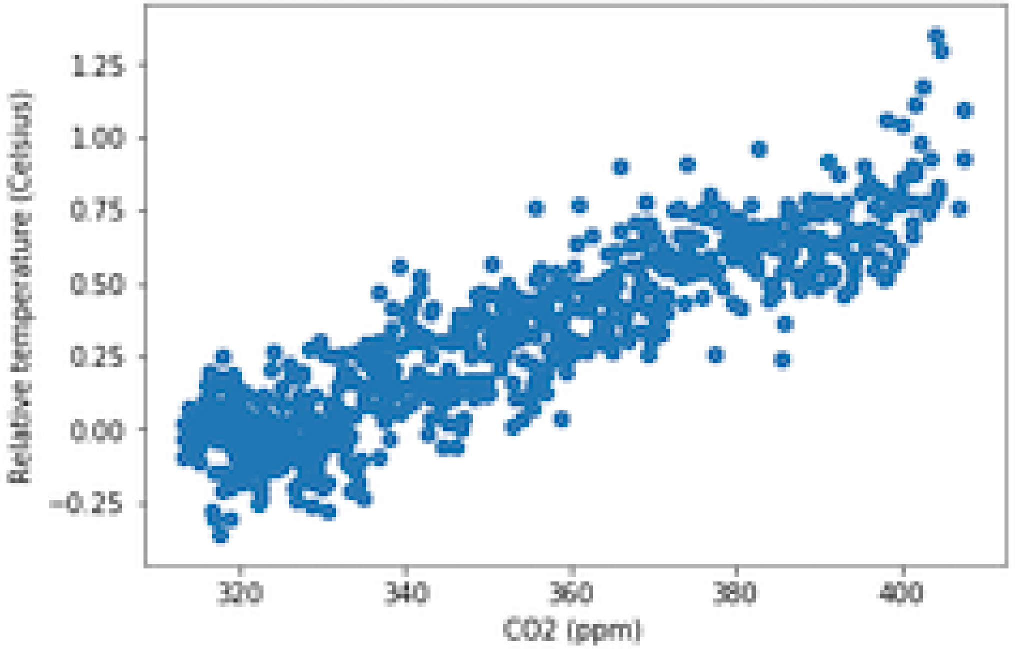
Quantitative comparisons: scatter plots

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

Introducing scatter plots

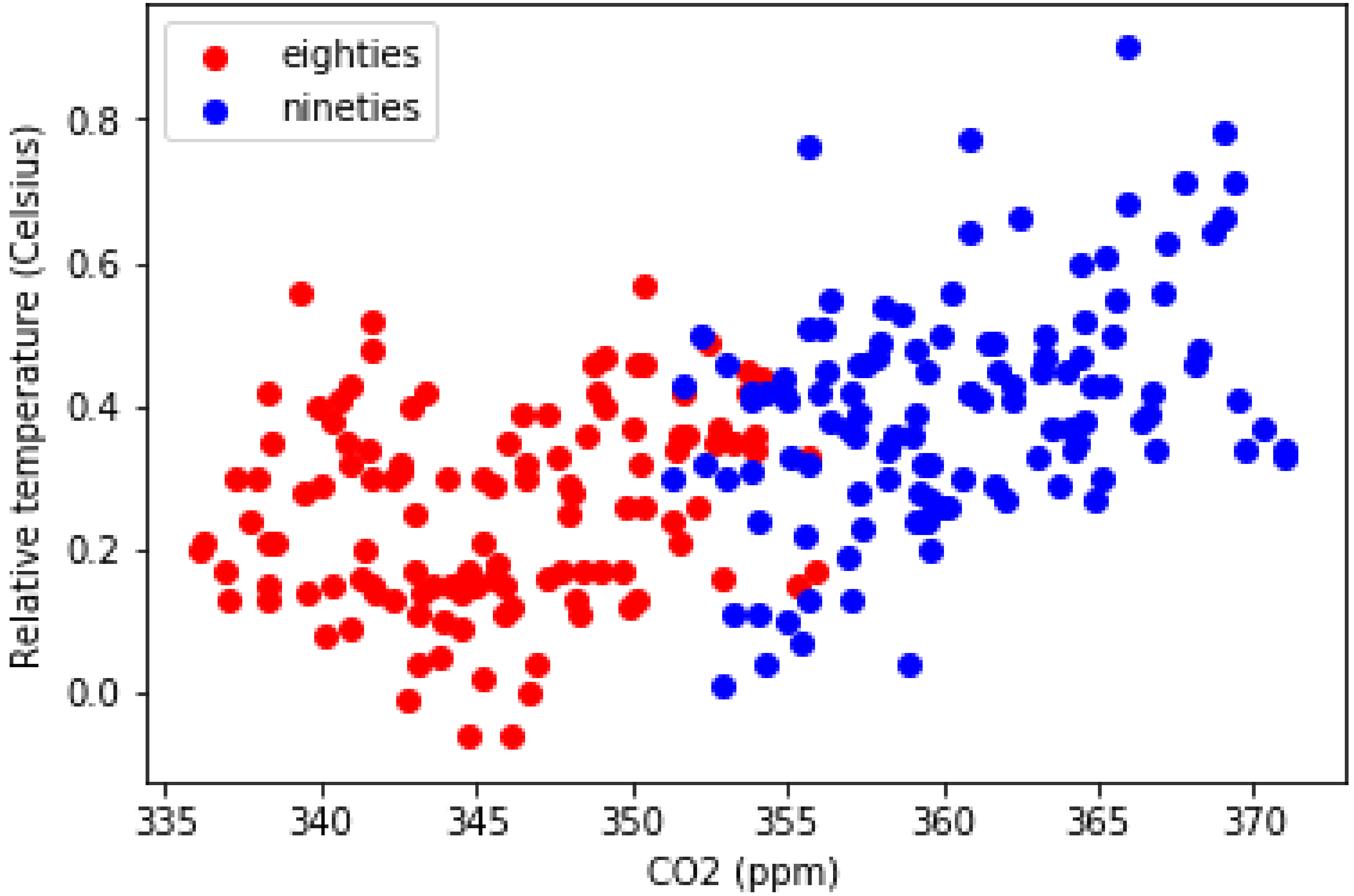
```
fig, ax = plt.subplots()
ax.scatter(climate_change["co2"], climate_change["relative_temp"])
ax.set_xlabel("CO2 (ppm)")
ax.set_ylabel("Relative temperature (Celsius)")
plt.show()
```



Customizing scatter plots

```
eighties = climate_change["1980-01-01":"1989-12-31"]
nineties = climate_change["1990-01-01":"1999-12-31"]
fig, ax = plt.subplots()
ax.scatter(eighties["co2"], eighties["relative_temp"],
           color="red", label="eighties")
ax.scatter(nineties["co2"], nineties["relative_temp"],
           color="blue", label="nineties")
ax.legend()

ax.set_xlabel("CO2 (ppm)")
ax.set_ylabel("Relative temperature (Celsius)")

plt.show()
```

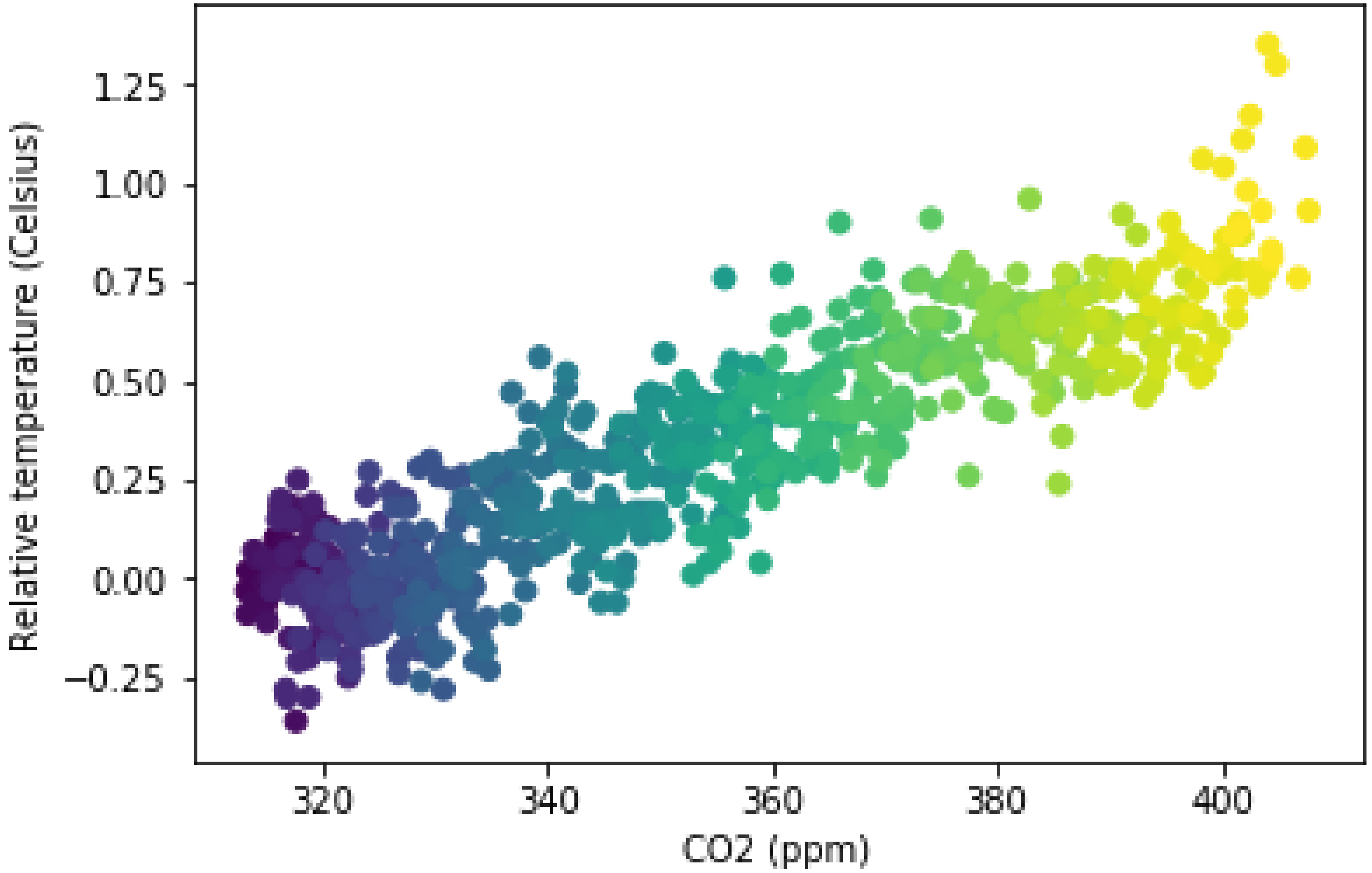
Encoding a comparison by color



Encoding a third variable by color

```
fig, ax = plt.subplots()
ax.scatter(climate_change["co2"], climate_change["relative_temp"],
           c=climate_change.index)
ax.set_xlabel("CO2 (ppm)")
ax.set_ylabel("Relative temperature (Celsius)")
plt.show()
```

Encoding time in color



Practice making your own scatter plots!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

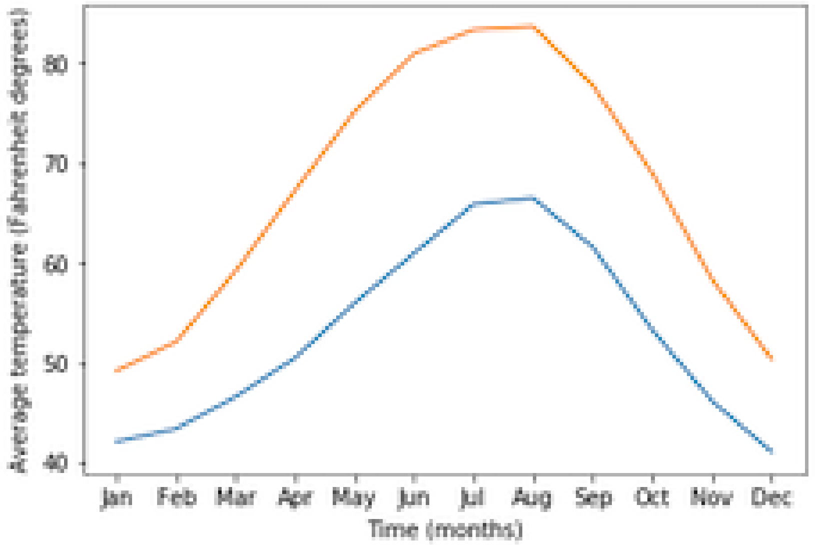
Preparing your figures to share with others

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

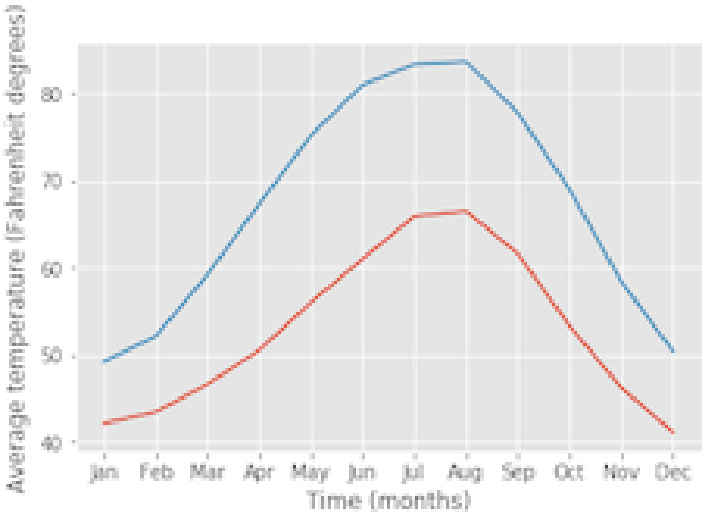
Changing plot style

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
ax.set_xlabel("Time (months)")
ax.set_ylabel("Average temperature (Fahrenheit degrees)")
plt.show()
```



Choosing a style

```
plt.style.use("ggplot")
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
ax.set_xlabel("Time (months)")
ax.set_ylabel("Average temperature (Fahrenheit degrees)")
plt.show()
```



Back to the default

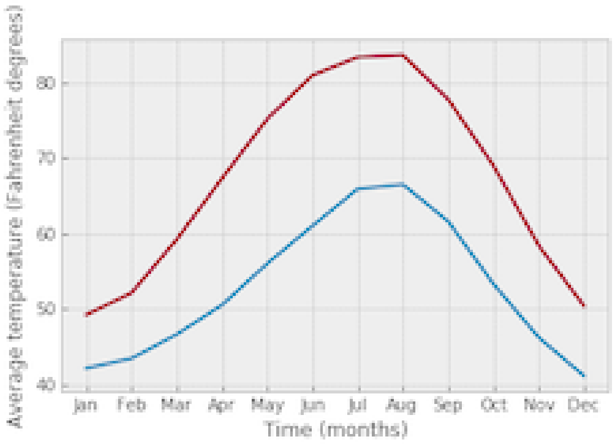
```
plt.style.use("default")
```

The available styles

https://matplotlib.org/gallery/style_sheets/style_sheets_refer

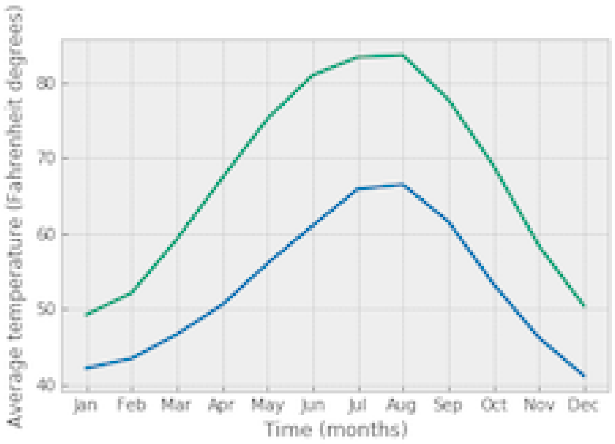
The "bmh" style

```
plt.style.use("bmh")
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
ax.set_xlabel("Time (months)")
ax.set_ylabel("Average temperature (Fahrenheit degrees)")
plt.show()
```



Seaborn styles

```
plt.style.use("seaborn-colorblind")
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
ax.set_xlabel("Time (months)")
ax.set_ylabel("Average temperature (Fahrenheit degrees)")
plt.show()
```



Guidelines for choosing plotting style

- Dark backgrounds are usually less visible
- If color is important, consider choosing colorblind-friendly options
  - "seaborn-colorblind" or "tableau-colorblind10"
- If you think that someone will want to print your figure, use less ink
- If it will be printed in black-and-white, use the "grayscale" style

Practice choosing the right style for you!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

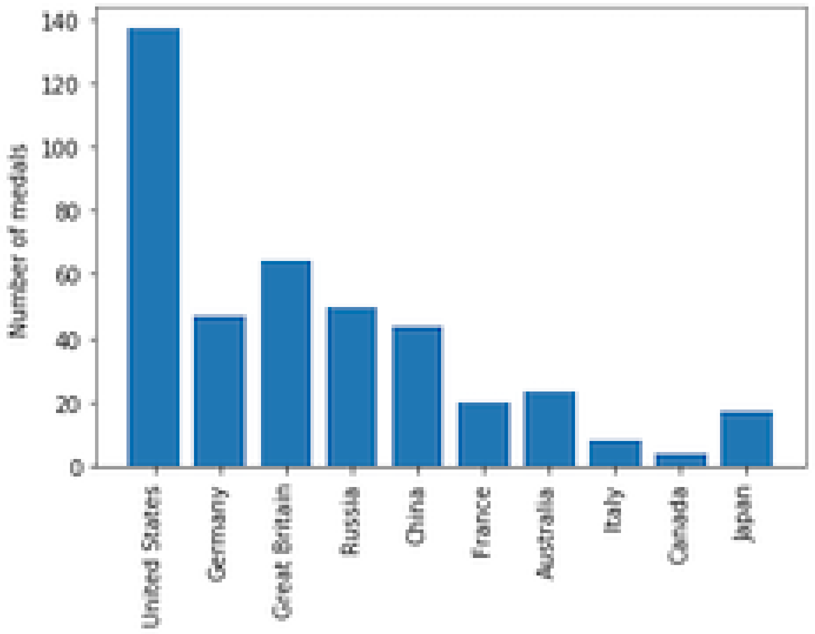
Sharing your visualizations with others

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

A figure to share

```
fig, ax = plt.subplots()

ax.bar(medals.index, medals["Gold"])
ax.set_xticklabels(medals.index, rotation=90)
ax.set_ylabel("Number of medals")

plt.show()
```



Saving the figure to file

```
fig, ax = plt.subplots()

ax.bar(medals.index, medals["Gold"])
ax.set_xticklabels(medals.index, rotation=90)
ax.set_ylabel("Number of medals")

fig.savefig("gold_medals.png")
```

```
ls
```

```
gold_medals.png
```

Different file formats

```python
fig.savefig("gold_medals.jpg")
```

```python
fig.savefig("gold_medals.jpg", quality=50)
```

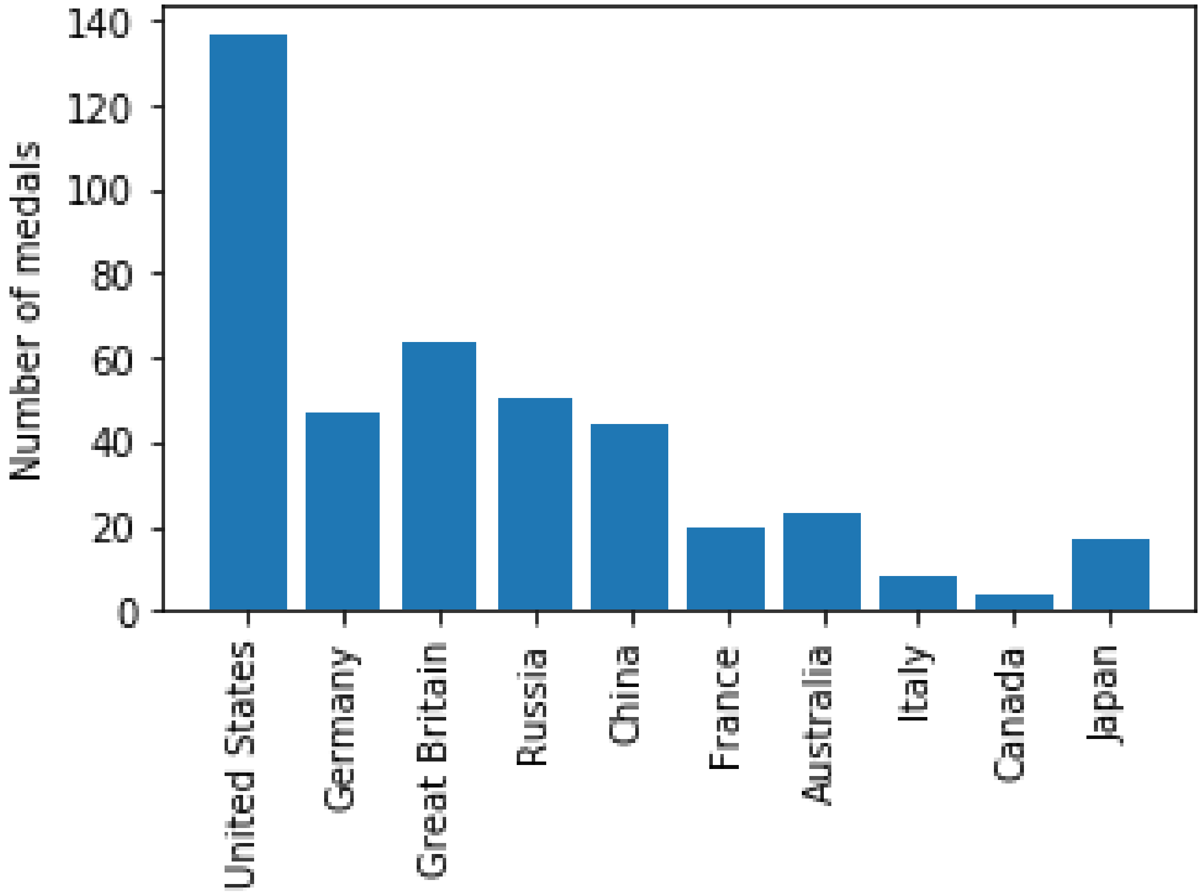
```python
fig.savefig("gold_medals.svg")
```

Resolution

```
fig.savefig("gold_medals.png", dpi=300)
```

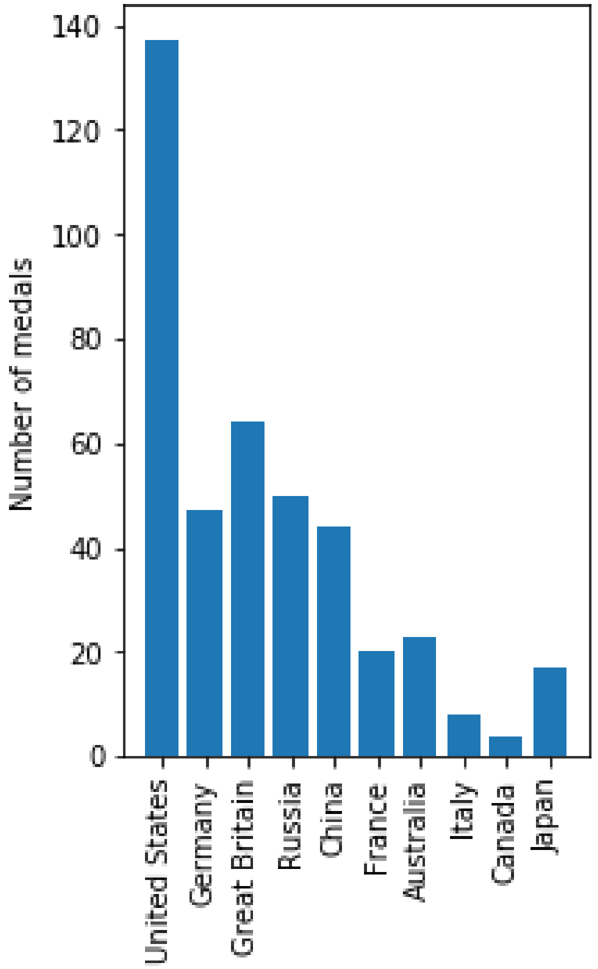
Size

```
fig.set_size_inches([5, 3])
```



Another aspect ratio

```
fig.set_size_inches([3, 5])
```



Practice saving your visualizations!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Automating figures from data

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

Why automate?

- Ease and speed
- Flexibility
- Robustness
- Reproducibility

How many different kinds of data?

```
summer_2016_medals["Sport"]
```

```
ID
62            Rowing
65         Taekwondo
73          Handball
             ...
134759      Handball
135132    Volleyball
135205        Boxing
Name: Sport, Length: 976, dtype: object
```

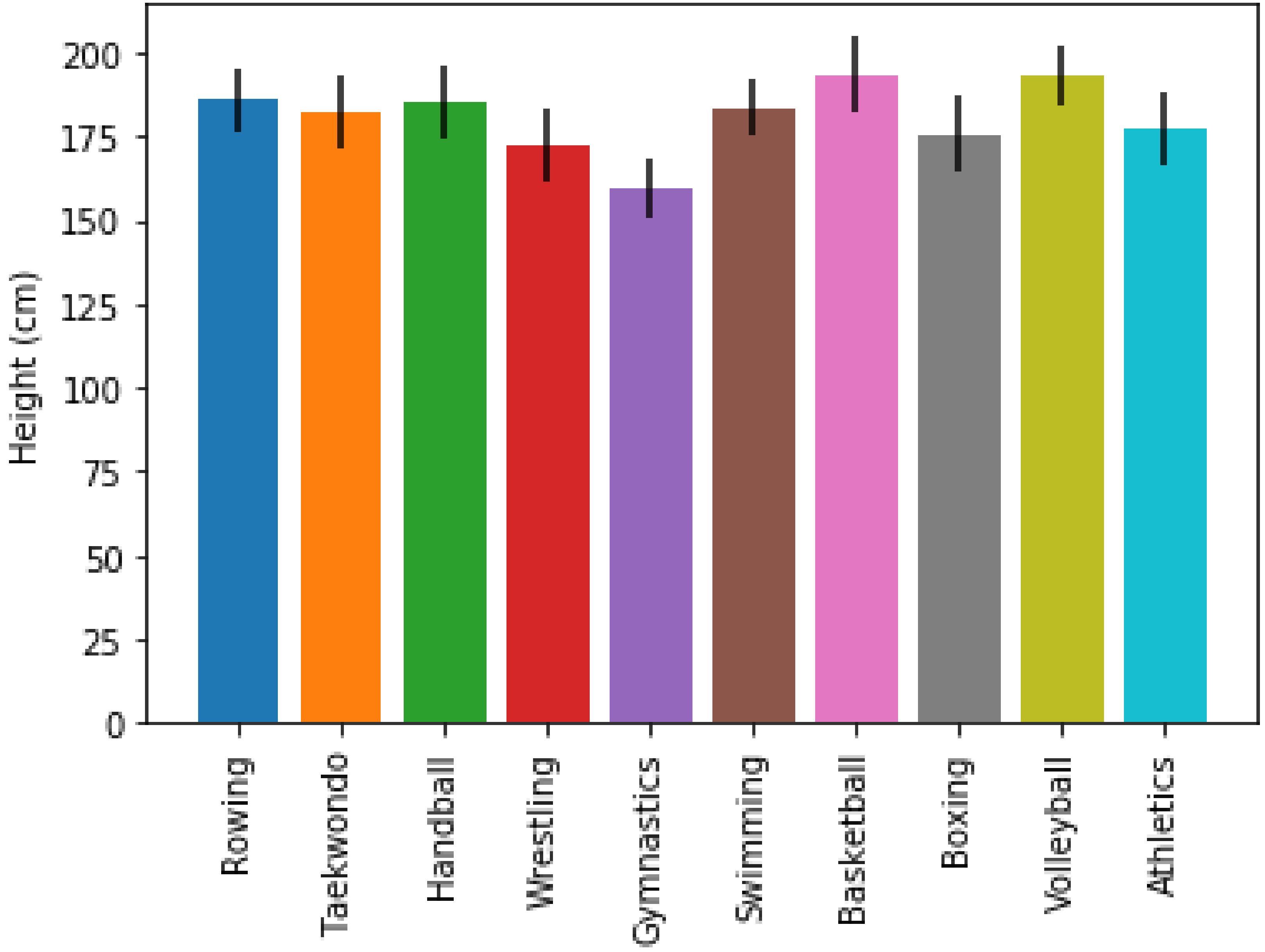
Getting unique values of a column

```
sports = summer_2016_medals["Sport"].unique()
print(sports)
['Rowing' 'Taekwondo' 'Handball' 'Wrestling'
'Gymnastics' 'Swimming' 'Basketball' 'Boxing'
'Volleyball' 'Athletics']
```

Bar-chart of heights for all sports

```
fig, ax = plt.subplots()

for sport in sports:
  sport_df = summer_2016_medals[summer_2016_medals["Sport"] == sport]
  ax.bar(sport, sport_df["Height"].mean(),
         yerr=sport_df["Height"].std())
ax.set_ylabel("Height (cm)")
ax.set_xticklabels(sports, rotation=90)
plt.show()
```

Figure derived automatically from the data



Practice automating visualizations!

INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Where to go next

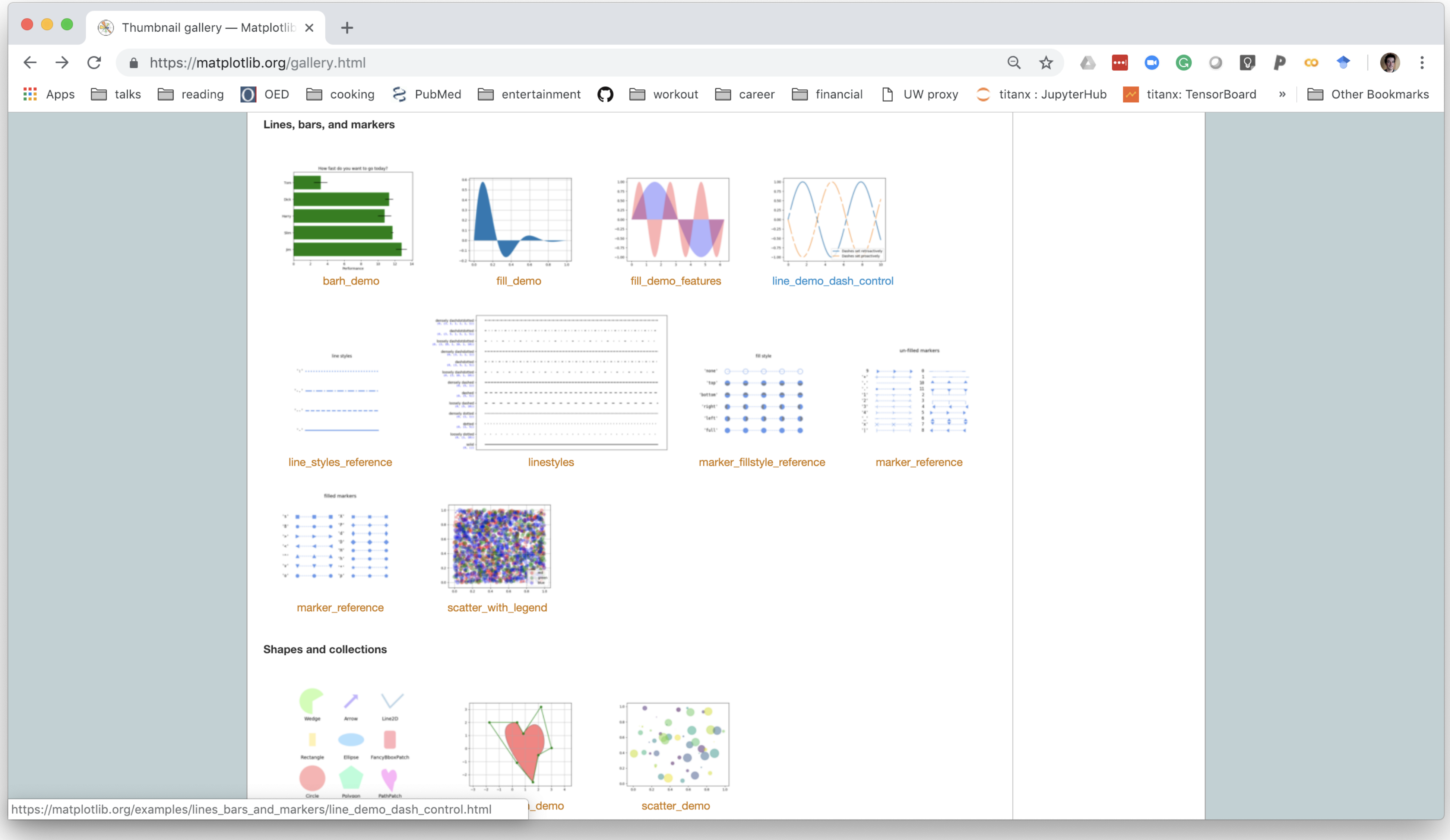
INTRODUCTION TO DATA VISUALIZATION WITH MATPLOTLIB

Ariel Rokem
Data Scientist

The Matplotlib gallery

https://matplotlib.org/gallery.html

Gallery of examples



Lines, bars, and markers

barh_demo

fill_demo

fill_demo_features

line_demo_dash_control

line_styles_reference

linestyles

marker_fillstyle_reference

marker_reference

marker_reference

scatter_with_legend

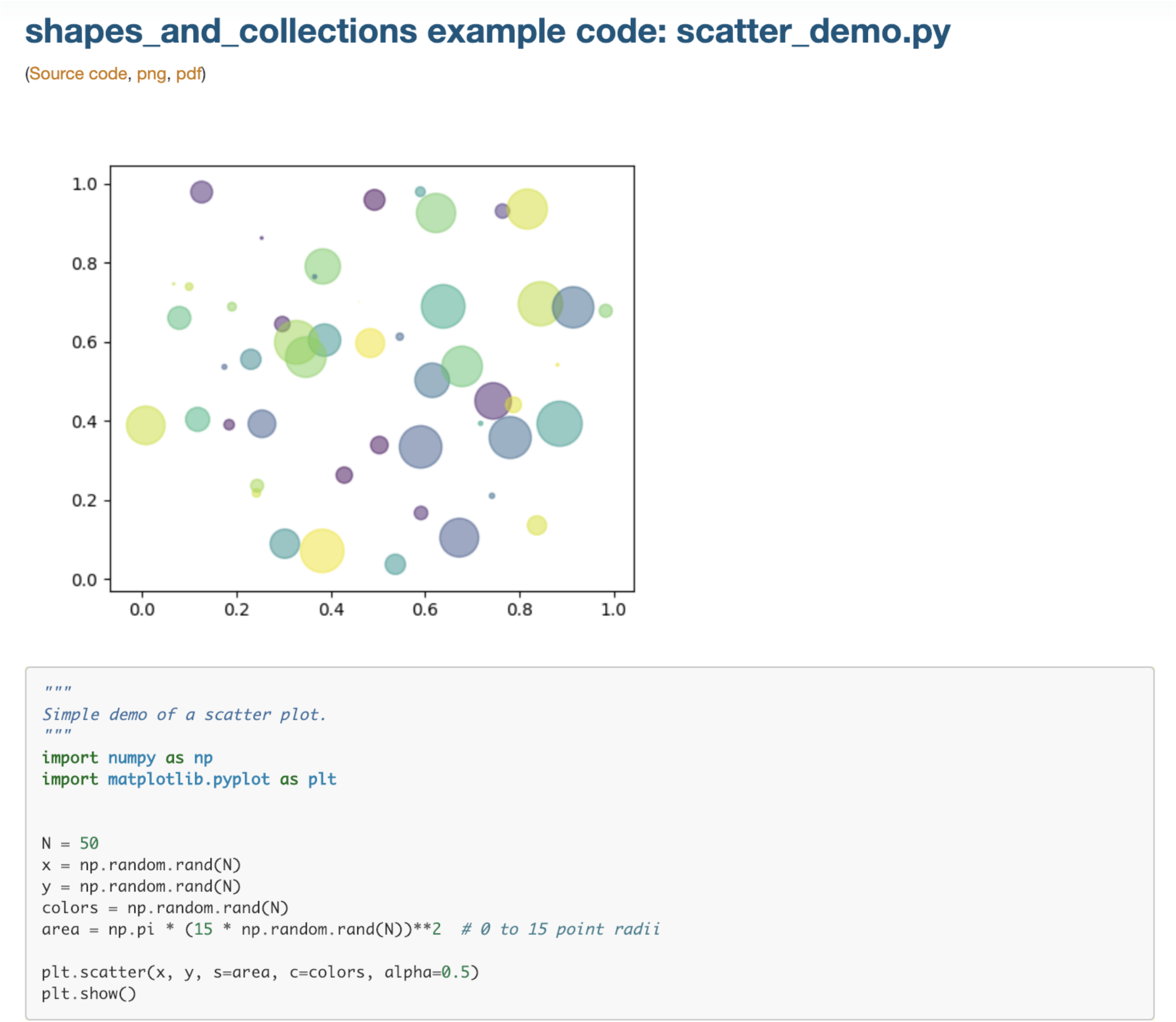
Shapes and collections

_demo

scatter_demo

https://matplotlib.org/examples/lines_bars_and_markers/line_demo_dash_control.html

Example page with code

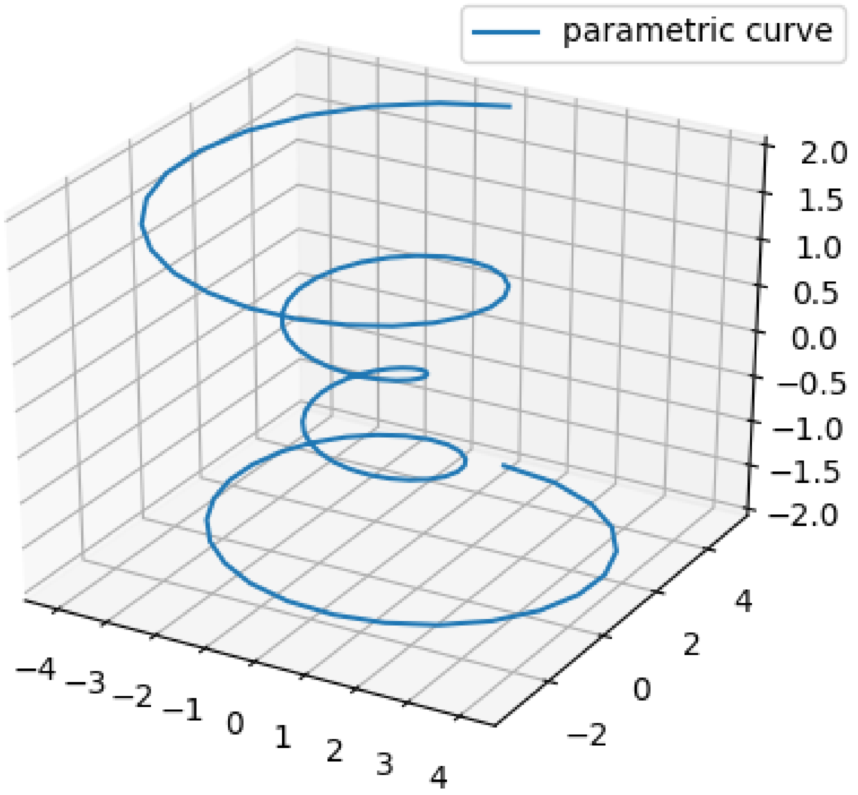


shapes_and_collections example code: scatter_demo.py

(Source code, png, pdf)

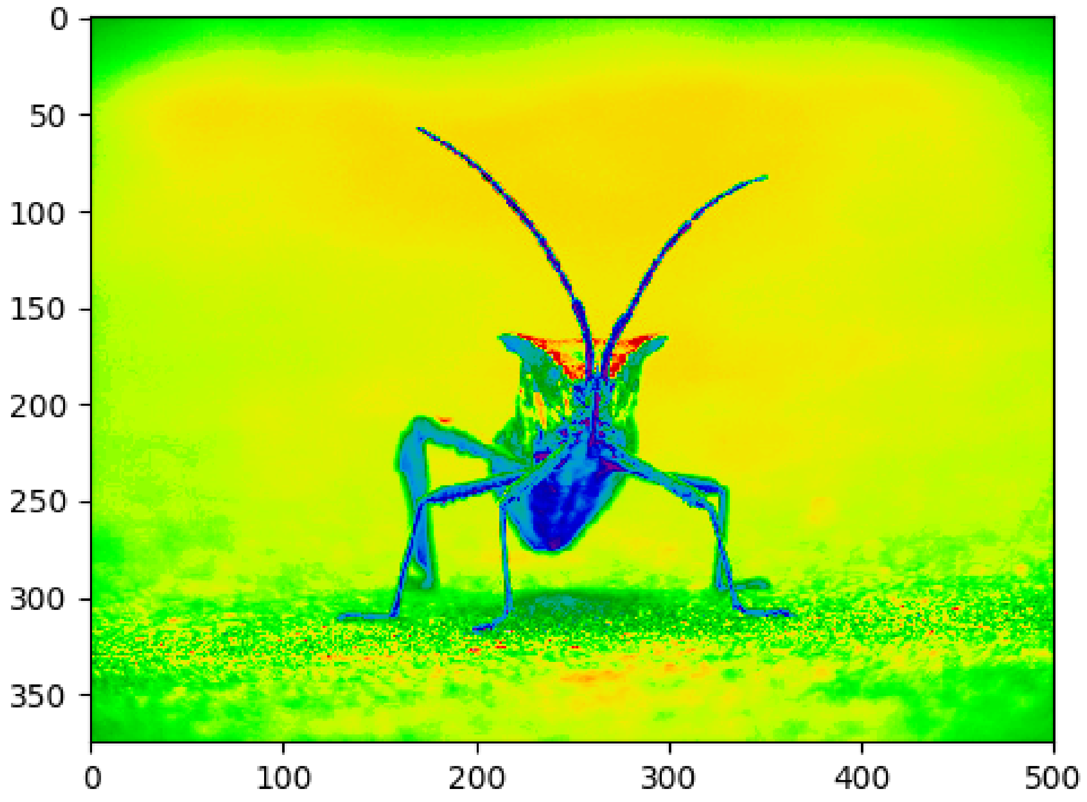
```
"""
Simple demo of a scatter plot.
"""
import numpy as np
import matplotlib.pyplot as plt


N = 50
x = np.random.rand(N)
y = np.random.rand(N)
colors = np.random.rand(N)
area = np.pi * (15 * np.random.rand(N))**2  # 0 to 15 point radii

plt.scatter(x, y, s=area, c=colors, alpha=0.5)
plt.show()
```

Plotting data in 3D



https://matplotlib.org/mpl_toolkits/mplot3d/tutorial.html

Visualizing images with pseudo-color



https://matplotlib.org/users/image_tutorial.html

Animations

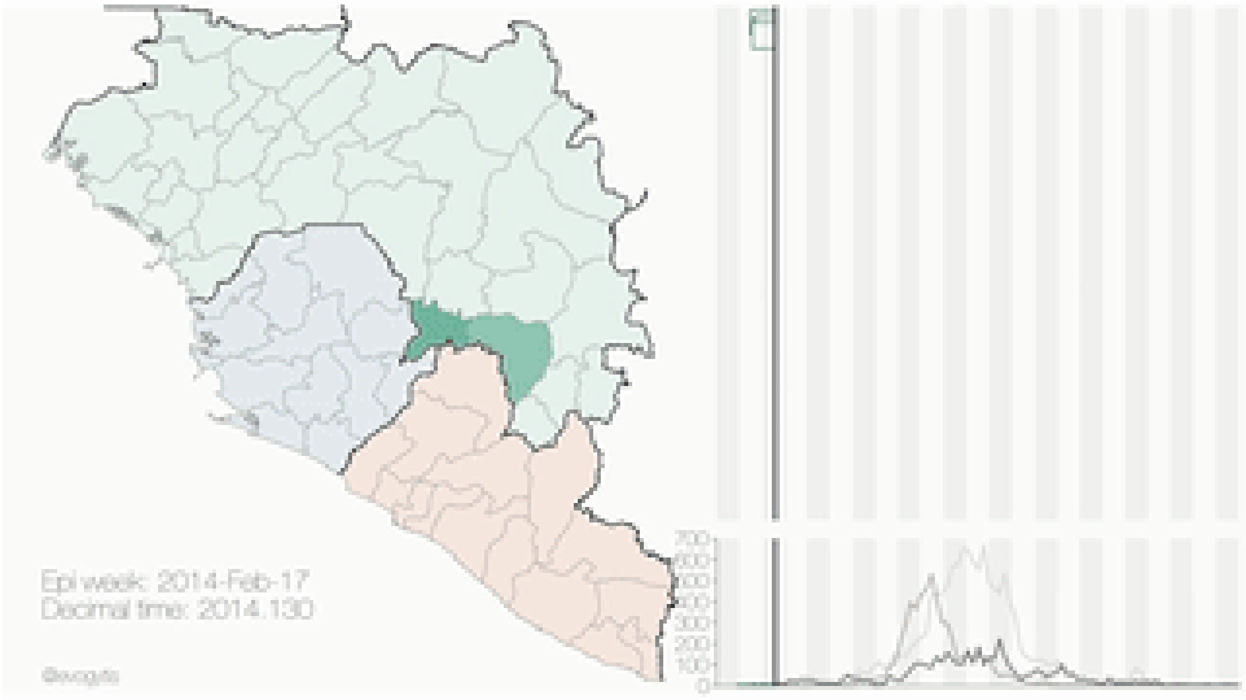
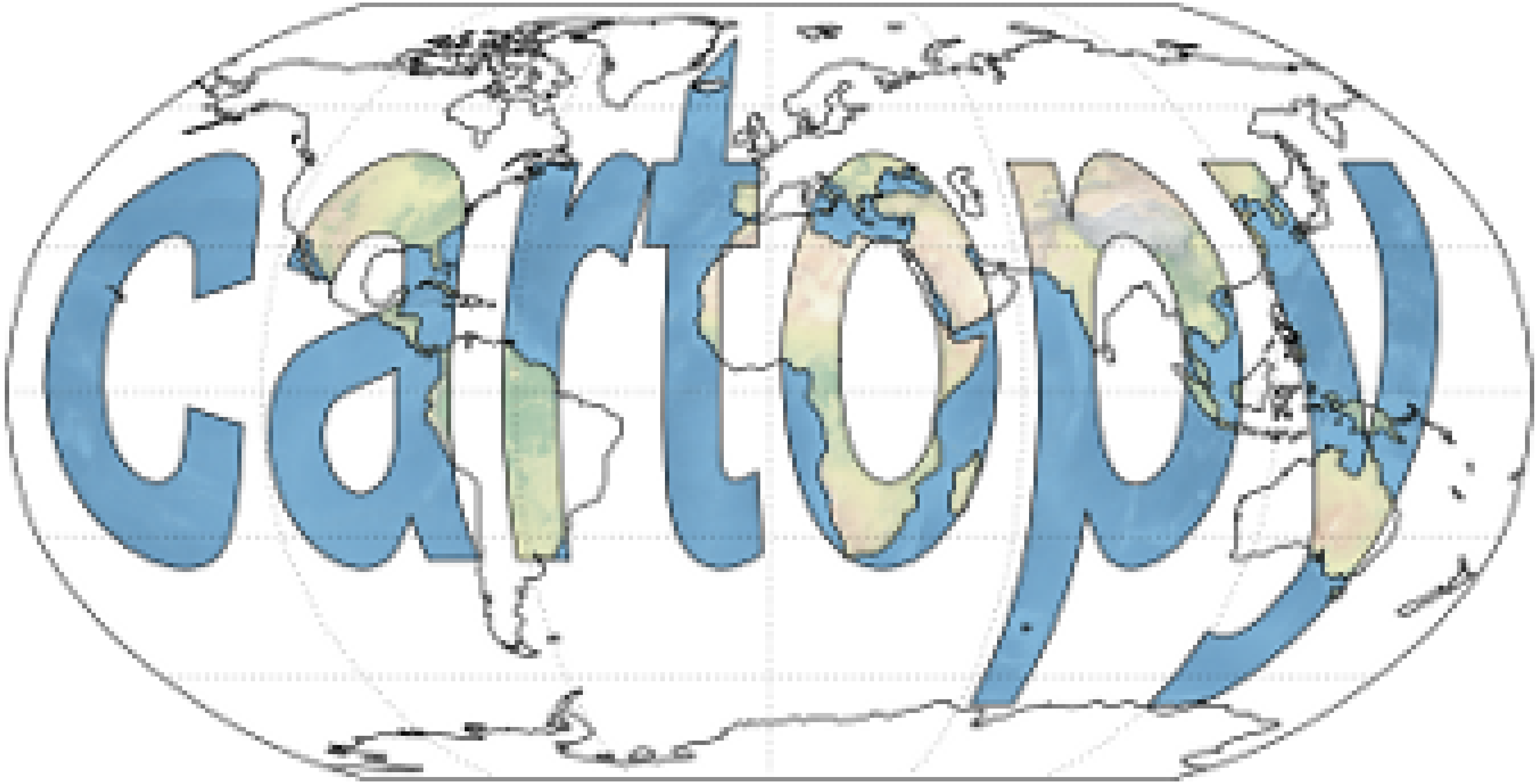


Image credit: **Gytis Dudas** and **Andrew Rambaut**

https://matplotlib.org/api/animation_api.html

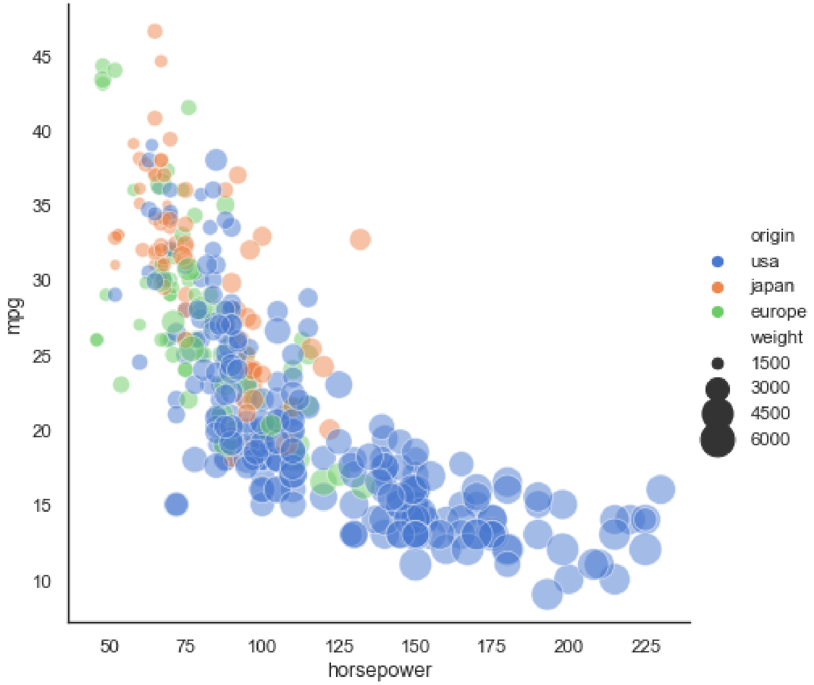
Using Matplotlib for geospatial data



https://scitools.org.uk/cartopy/docs/latest/

Pandas + Matplotlib = Seaborn

```
seaborn.relplot(x="horsepower", y="mpg", hue="origin", size="weight",
                sizes=(40, 400), alpha=.5, palette="muted",
                height=6, data=mpg)
```



Seaborn example gallery

https://seaborn.pydata.org/examples/index.html

Good luck visualizing your data!