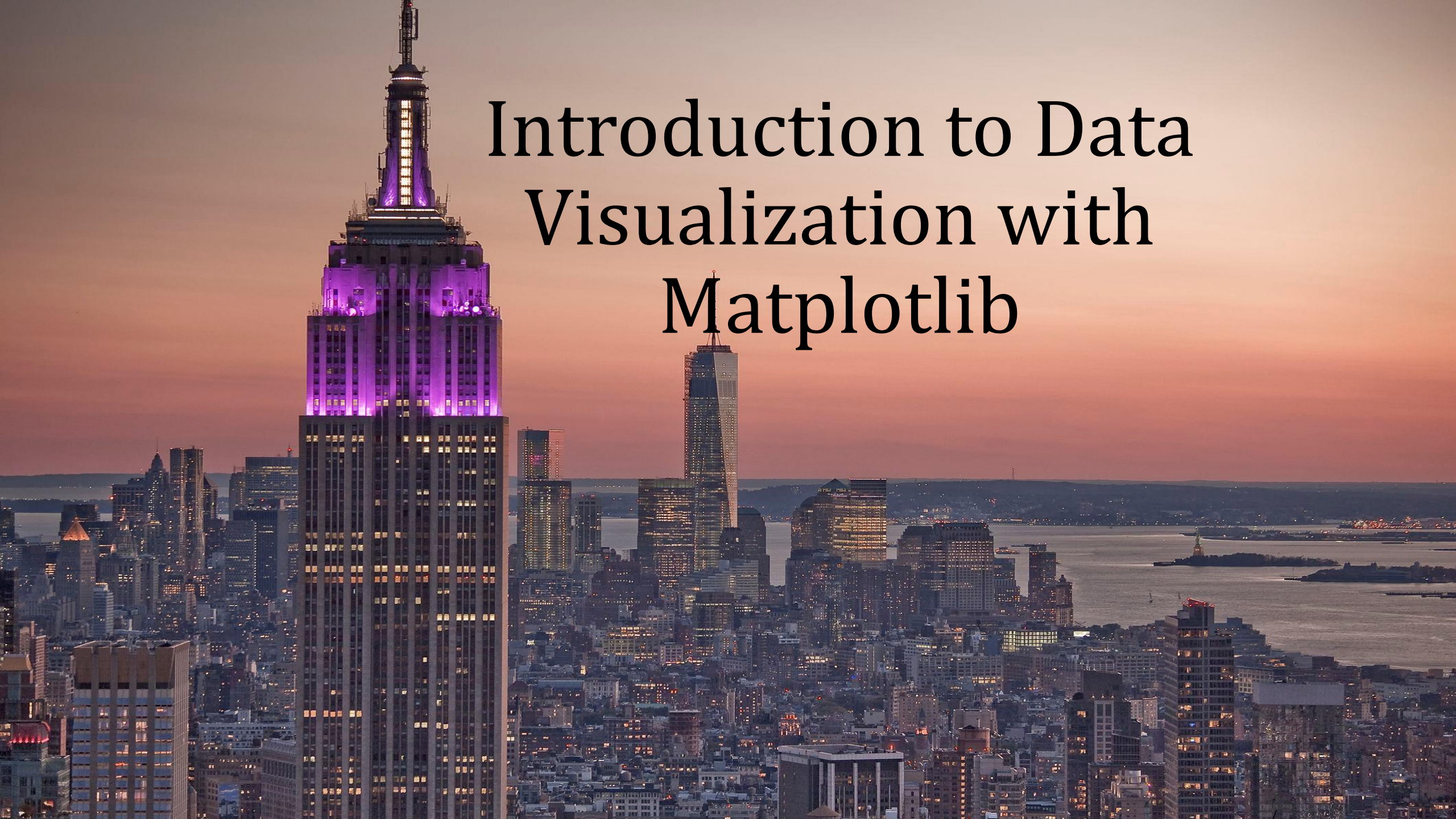
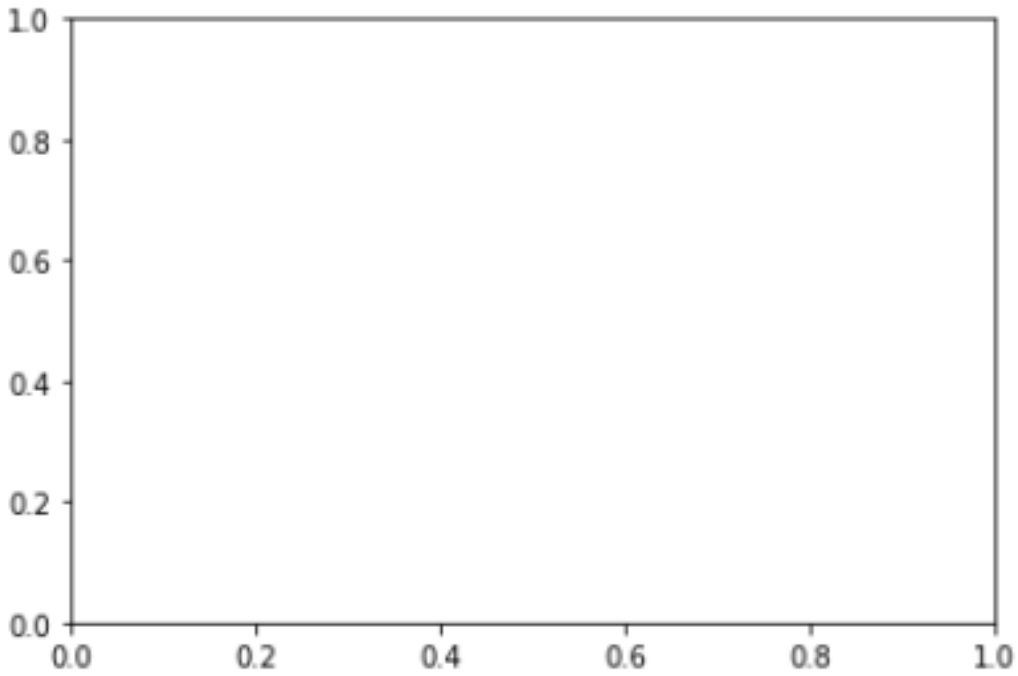


Introduction to Data Visualization with Matplotlib

Introducing the pyplot interface

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



Adding data to axes

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

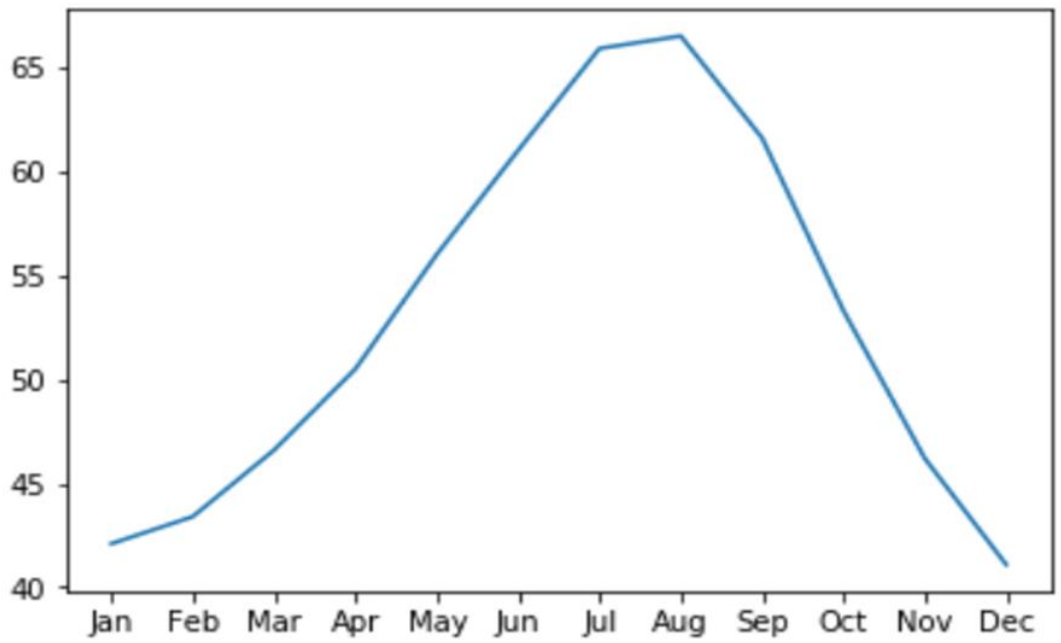
```
DATE
1      Jan
2      Feb
3      Mar
4      Apr
5      May
6      Jun
7      Jul
8      Aug
9      Sep
10     Oct
11     Nov
12     Dec
Name: MONTH, dtype: object
```

```
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
```

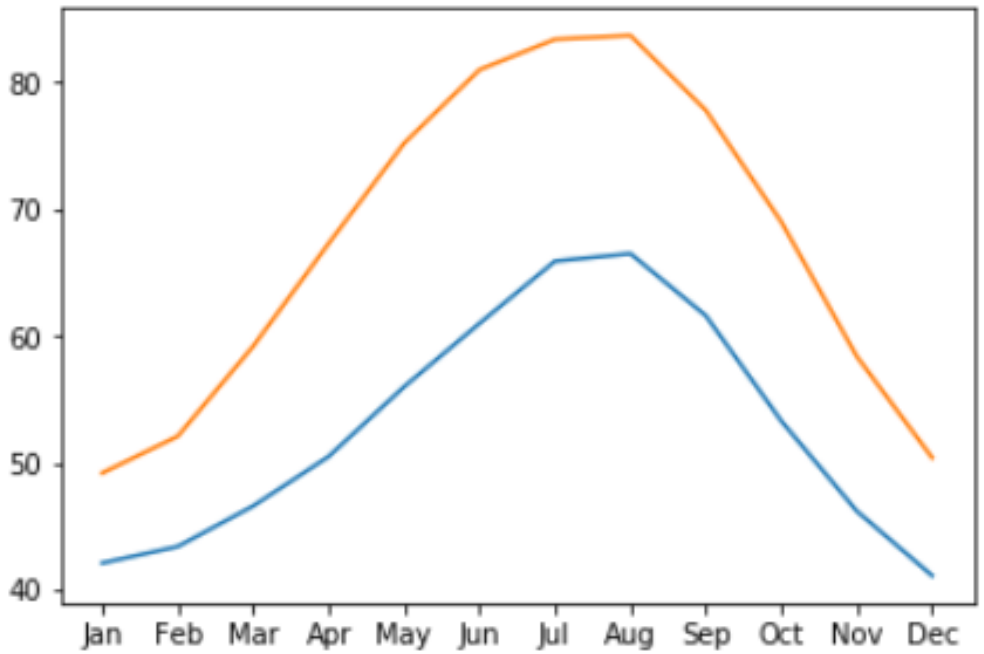
Adding data to axes

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



Adding more data

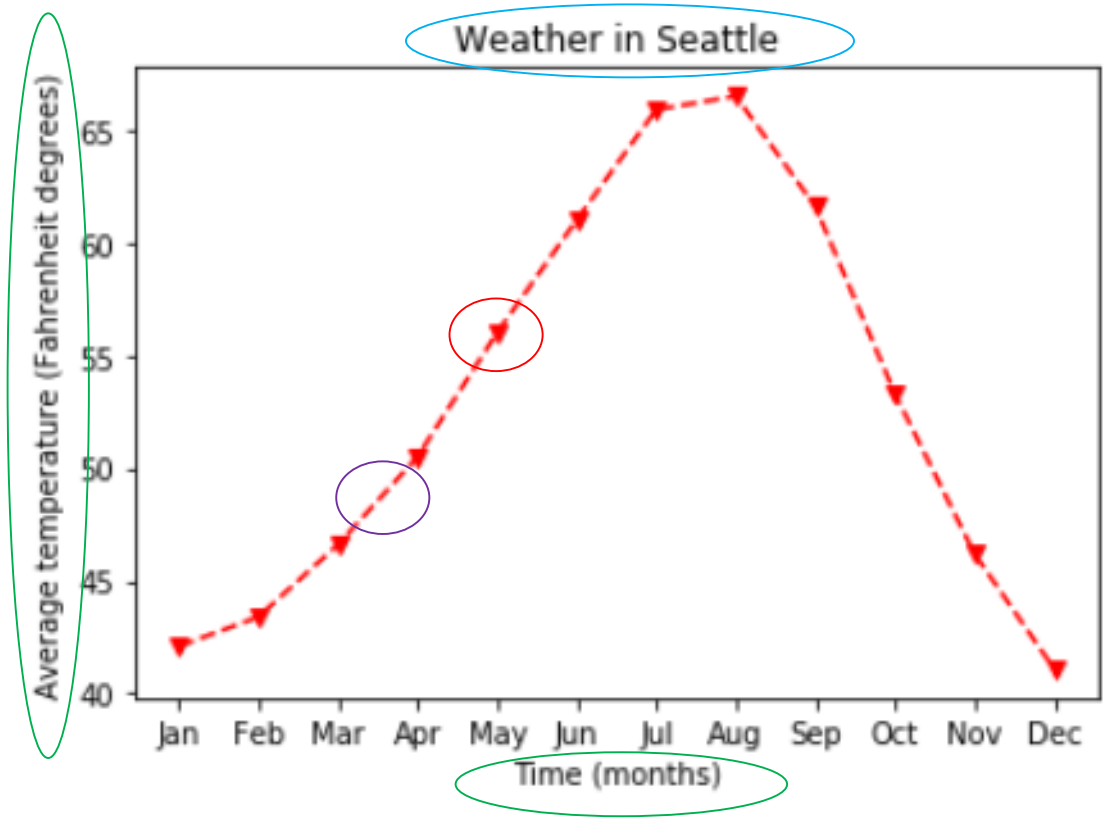
```
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
plt.show()
```



Customizing your plots

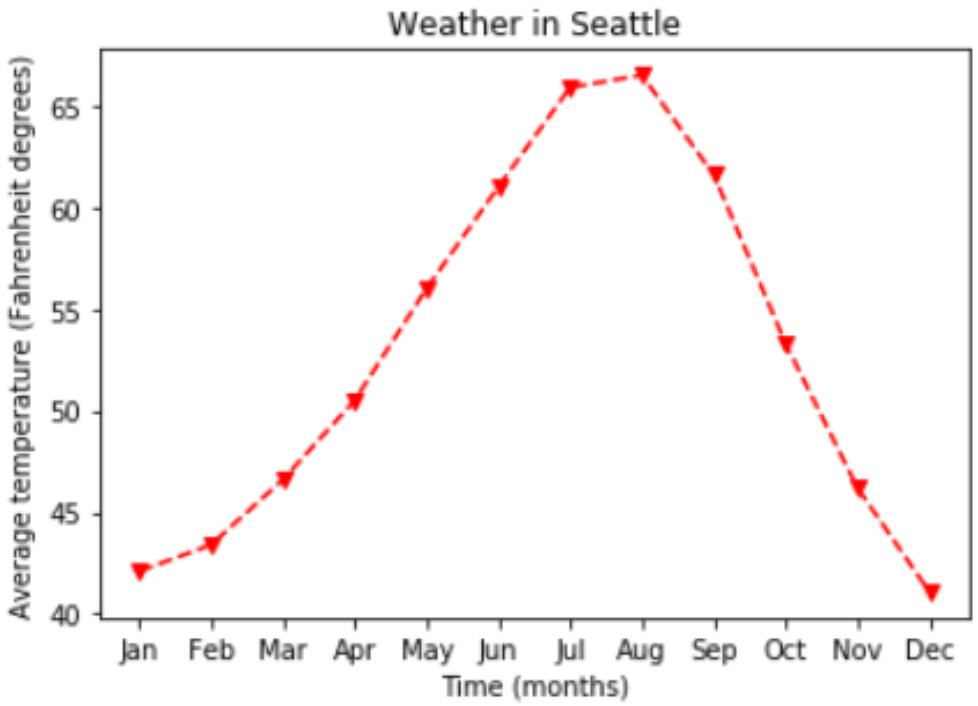
Customizing data appearance

- Adding markers
- Setting the linestyle
- Choosing color
- Customizing the axes labels
- Adding a title



Customizing data appearance

```
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"],
        seattle_weather["MLY-TAVG-NORMAL"],
        marker="v", linestyle="--", color="r")
ax.set_xlabel("Time (months)")
ax.set_ylabel("Average temperature (Fahrenheit degrees)")
ax.set_title("Weather in Seattle")
plt.show()
```



matplotlib.markers

marker	symbol	description
"."		point
","		pixel
"o"		circle
"v"		triangle_down
"^"		triangle_up
"<"		triangle_left
">"		triangle_right
"1"		tri_down
"2"		tri_up
"3"		tri_left
"4"		tri_right
"8"		octagon
"s"		square
"p"		pentagon
"P"		plus (filled)
"*"		star
"h"		hexagon1
"H"		hexagon2

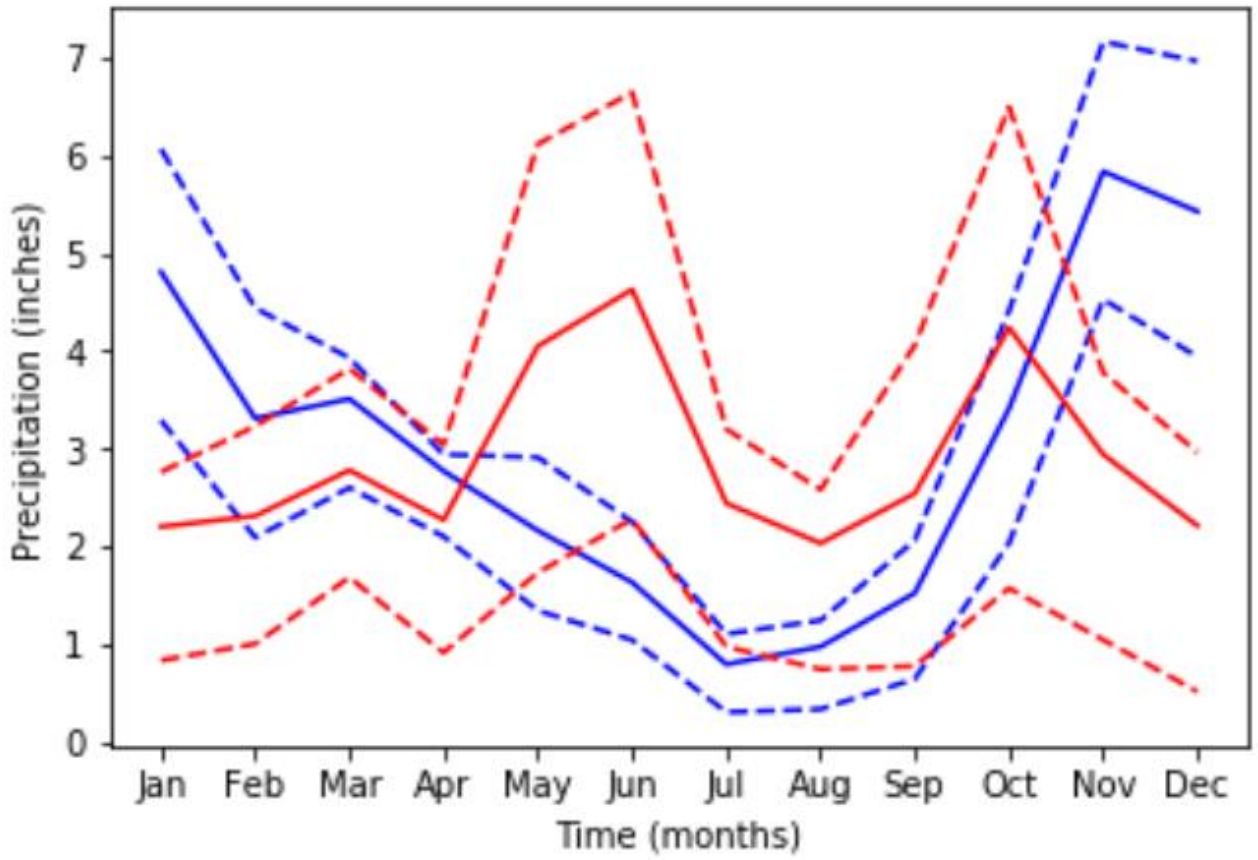
marker	symbol	description
"H"		hexagon2
"+"		plus
"x"		x
"X"		x (filled)
"D"		diamond
"d"		thin_diamond
"|"		vline
"_"		hline
0 (TICKLEFT)		tickleft
1 (TICKRIGHT)		tickright
2 (TICKUP)		tickup
3 (TICKDOWN)		tickdown
4 (CARETLEFT)		caretleft
5 (CARETRIGHT)		caretright
6 (CARETUP)		caretup
7 (CARETDOWN)		caretdown
8 (CARETLEFTBASE)		caretleft (centered at base)
9 (CARETRIGHTBASE)		caretright (centered at base)
10 (CARETUPBASE)		caretup (centered at base)
11 (CARETDOWNBASE)		caretdown (centered at base)
"None", " " or ""		nothing

Linestyle

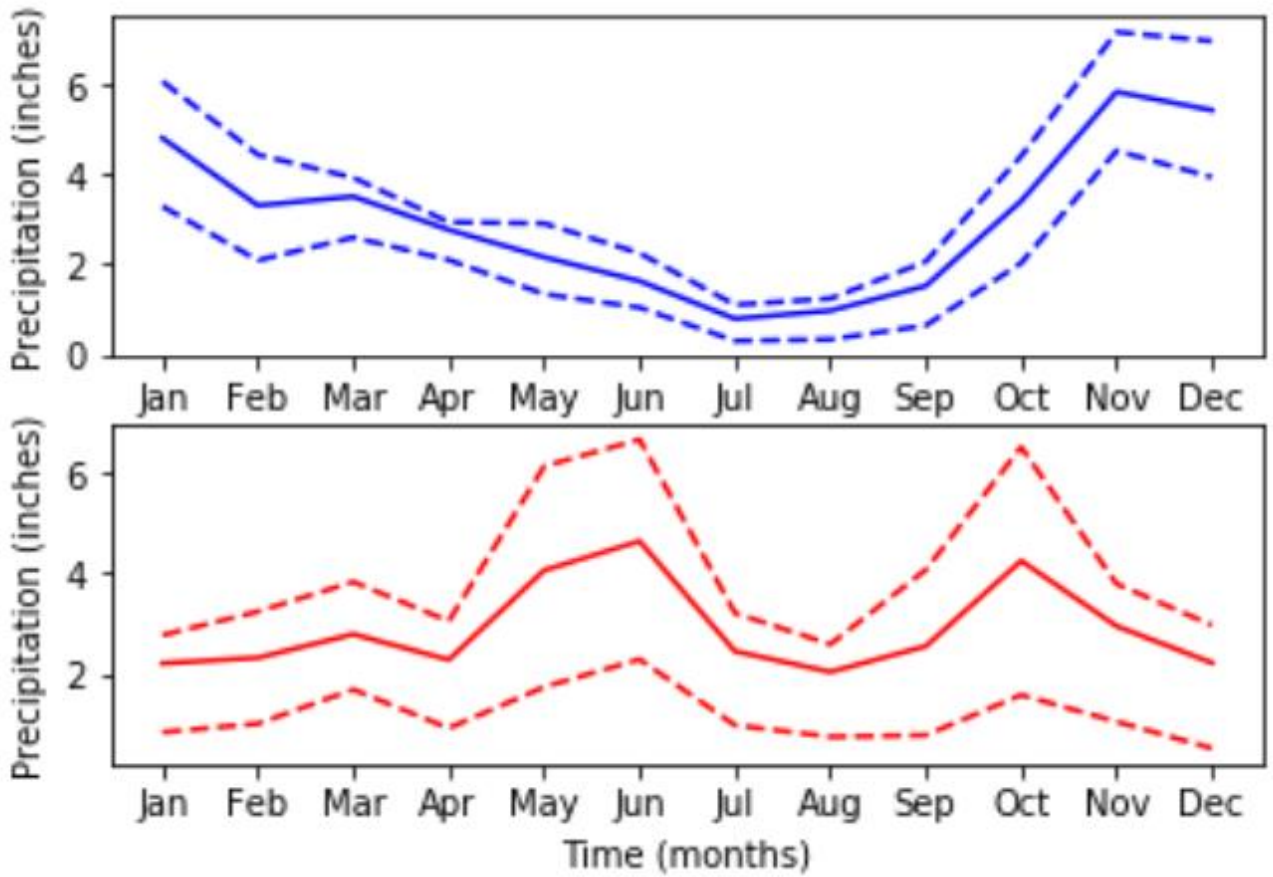
Choosing color


Small multiples

Too much data!



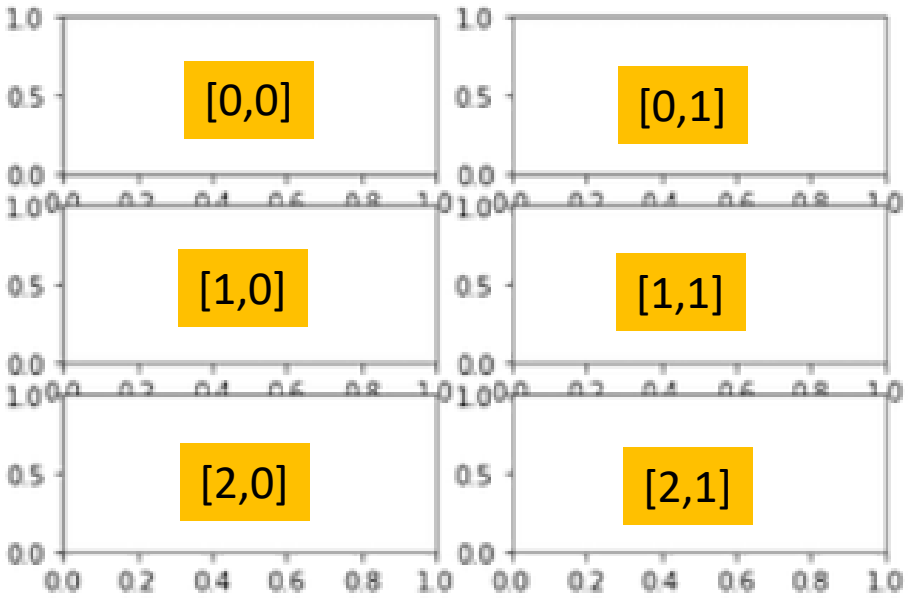
Solution


Precipitation (inches)
0
2
4
6
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Precipitation (inches)
2
4
6
Time (months)

Small multiples with plt.subplots

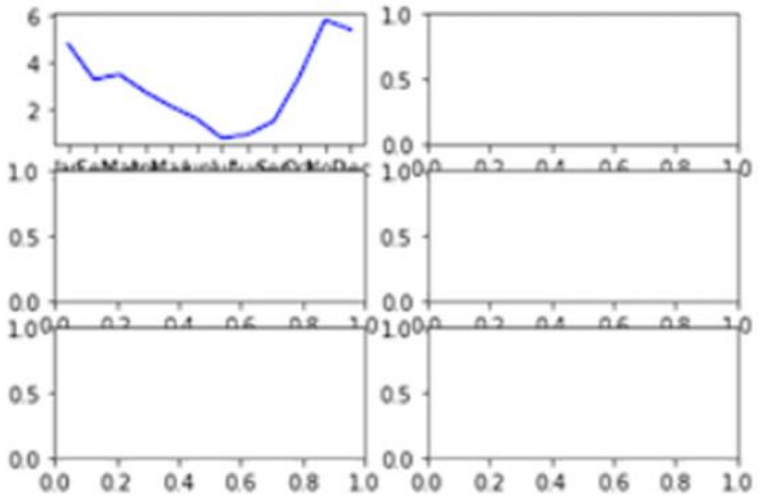
```
fig, ax = plt.subplots()
```

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

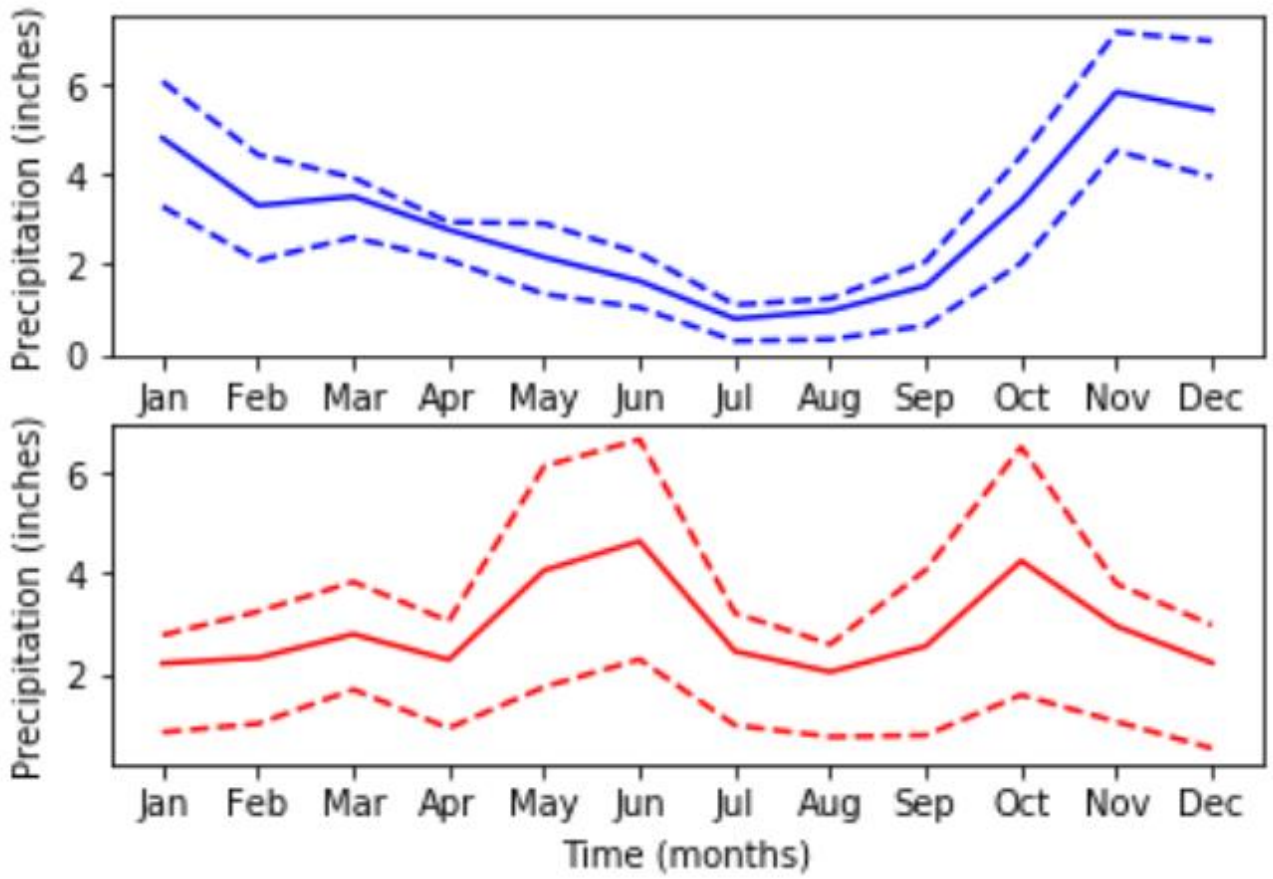


Adding data to subplots

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

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



Subplots with data

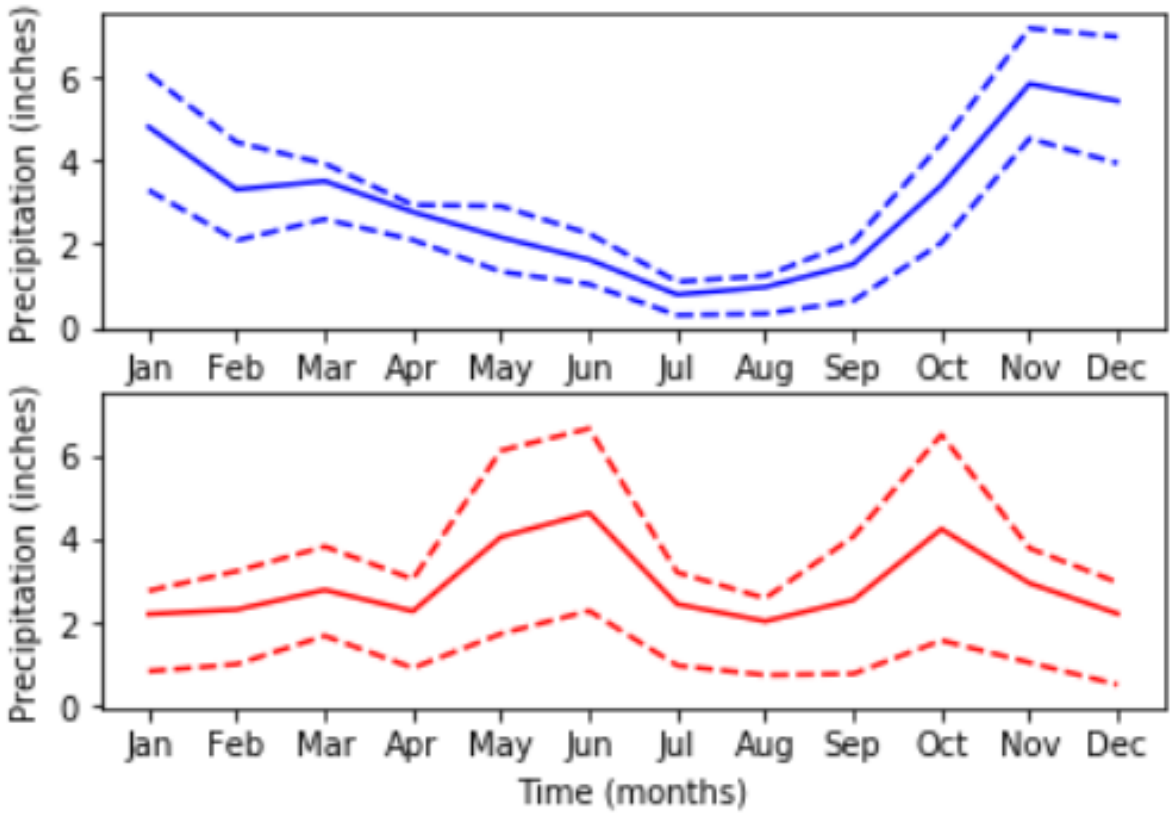


Subplots with data

```
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()
```

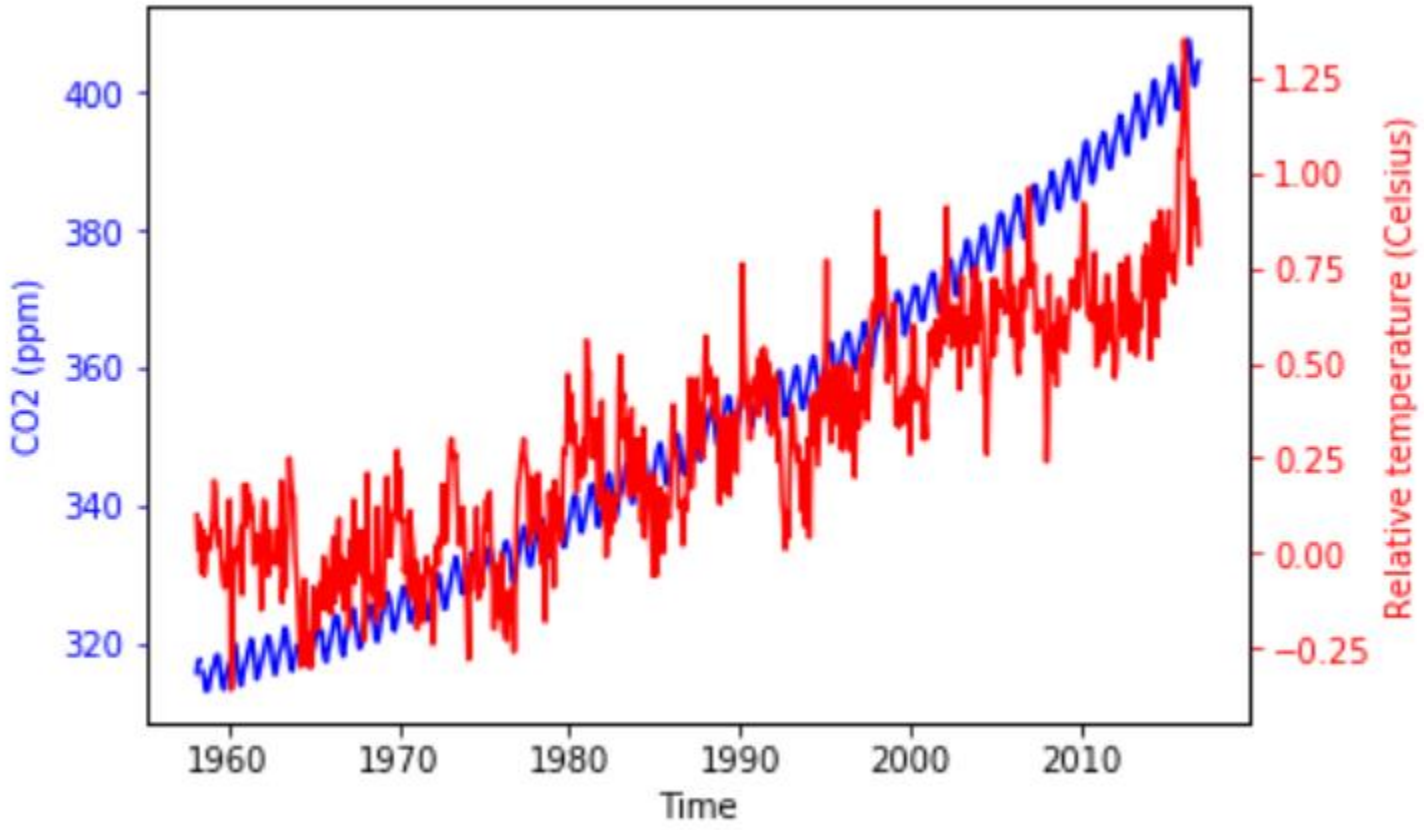
Sharing the y-axis range

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



Plotting time-series with different variables

Example


CO2 (ppm)
400
380
360
340
320
1960
1970
1980
1990
2000
2010
Time
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
Relative temperature (Celsius)

Plotting two time-series together

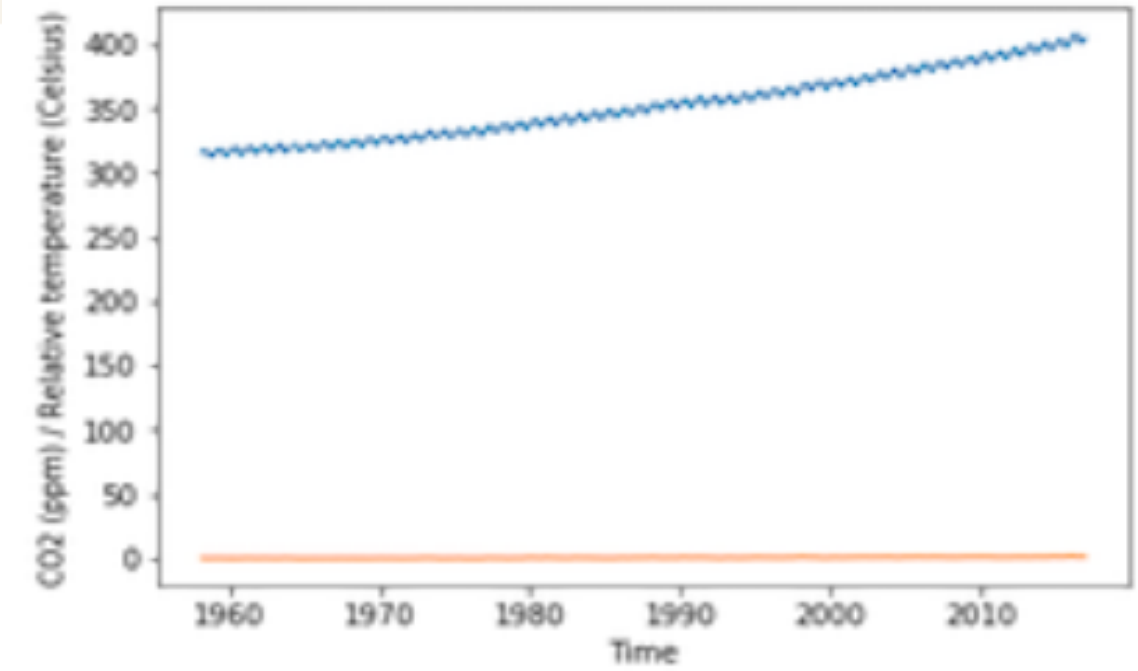
```
import pandas as pd
climate_change = pd.read_csv('climate_change.csv',
                             parse_dates=["date"],
                             index_col="date")
```

```
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]
```

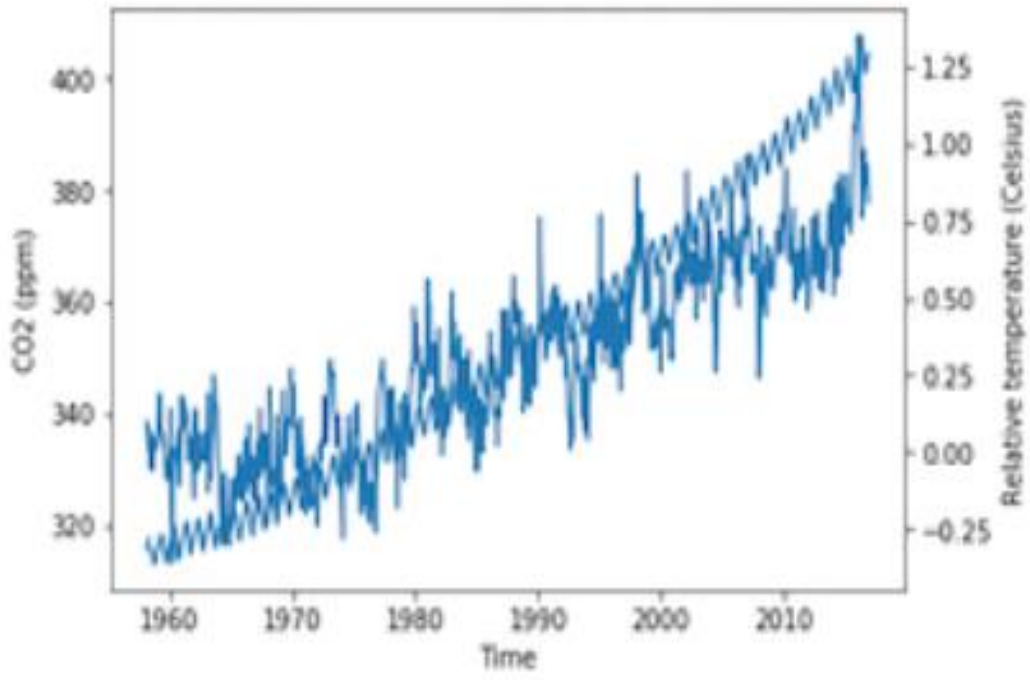
Plotting two time-series together

```
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()
```

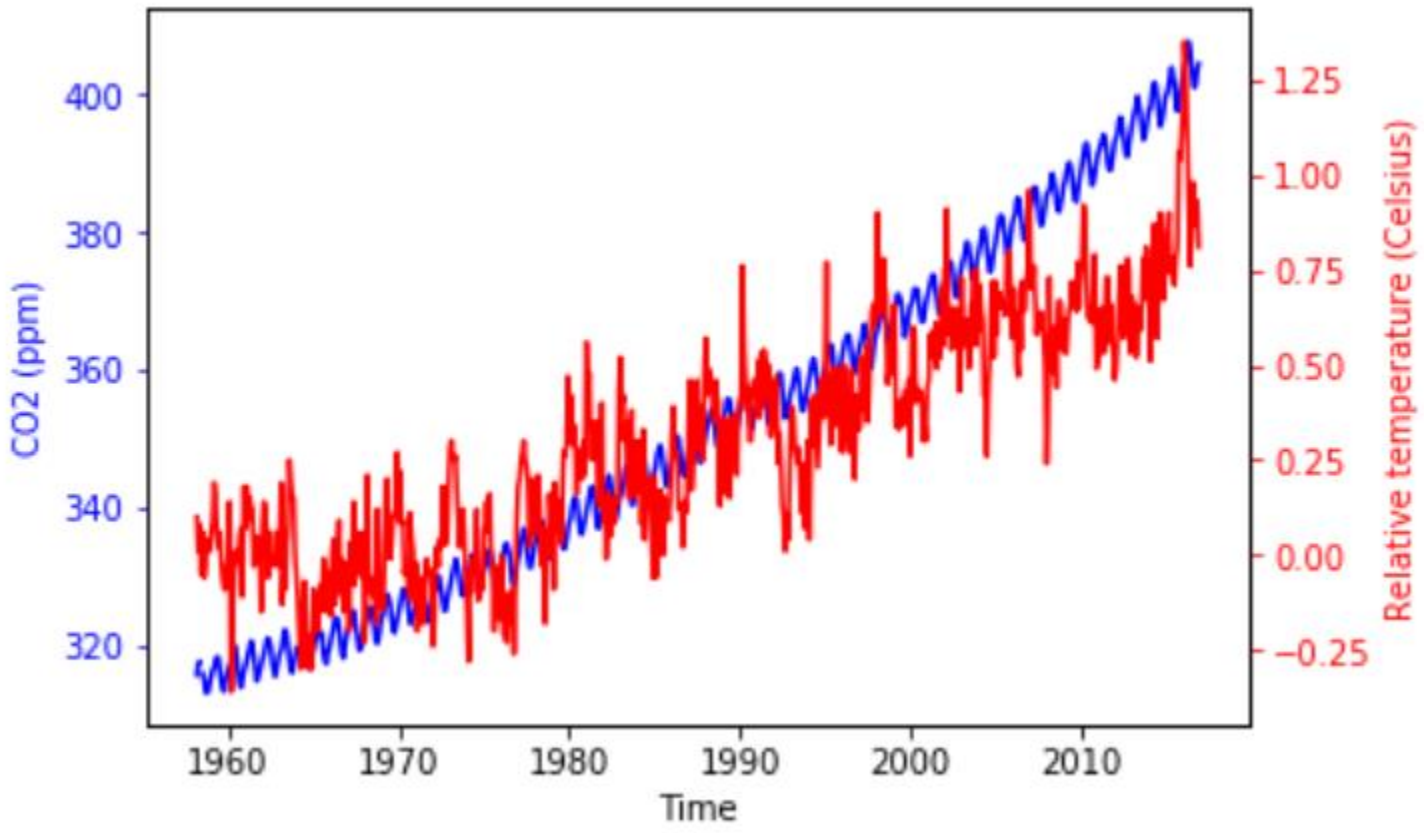


Separating variables by color

```
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')
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()
```

Change the appearance of ticks, tick labels, and gridlines.

Result

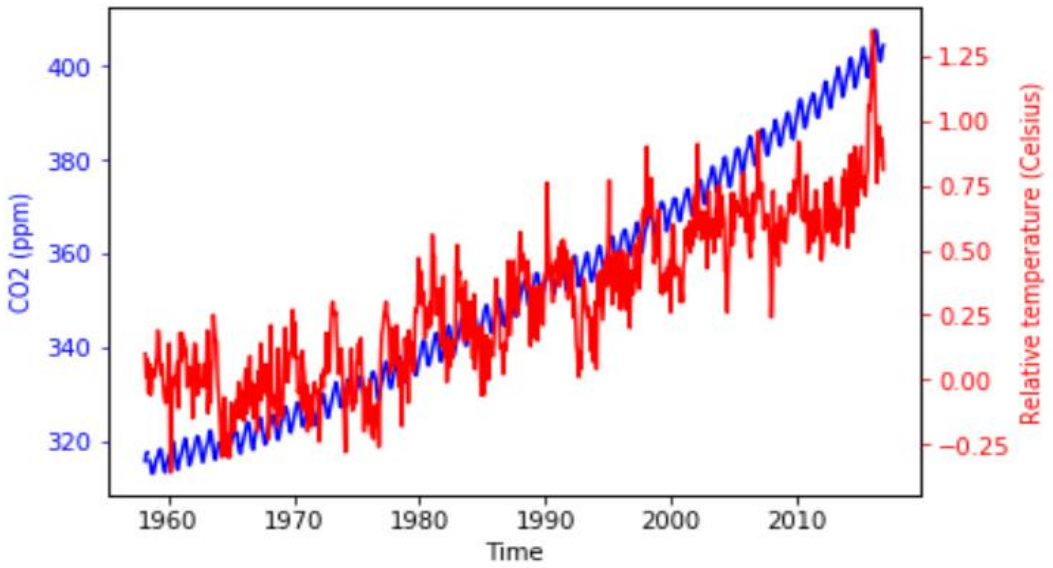

CO2 (ppm)
400
380
360
340
320
1960
1970
1980
1990
2000
2010
Time
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
Relative temperature (Celsius)

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

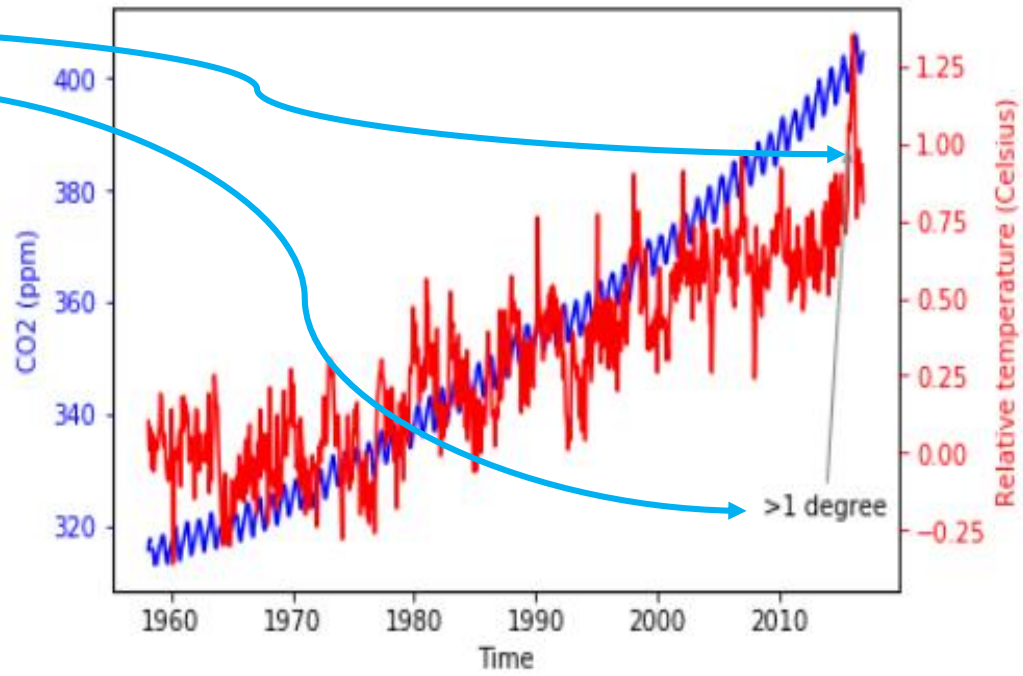
```
fig, ax = plt.subplots()
plot_timeseries(ax, climate_change.index, climate_change['co2'],
                'blue', 'Time', 'CO2 (ppm)')
ax2 = ax.twinx()
plot_timeseries(ax, climate_change.index,
                 climate_change['relative_temp'],
                'red', 'Time', 'Relative temperature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



Annotating timeseries data

Annotation

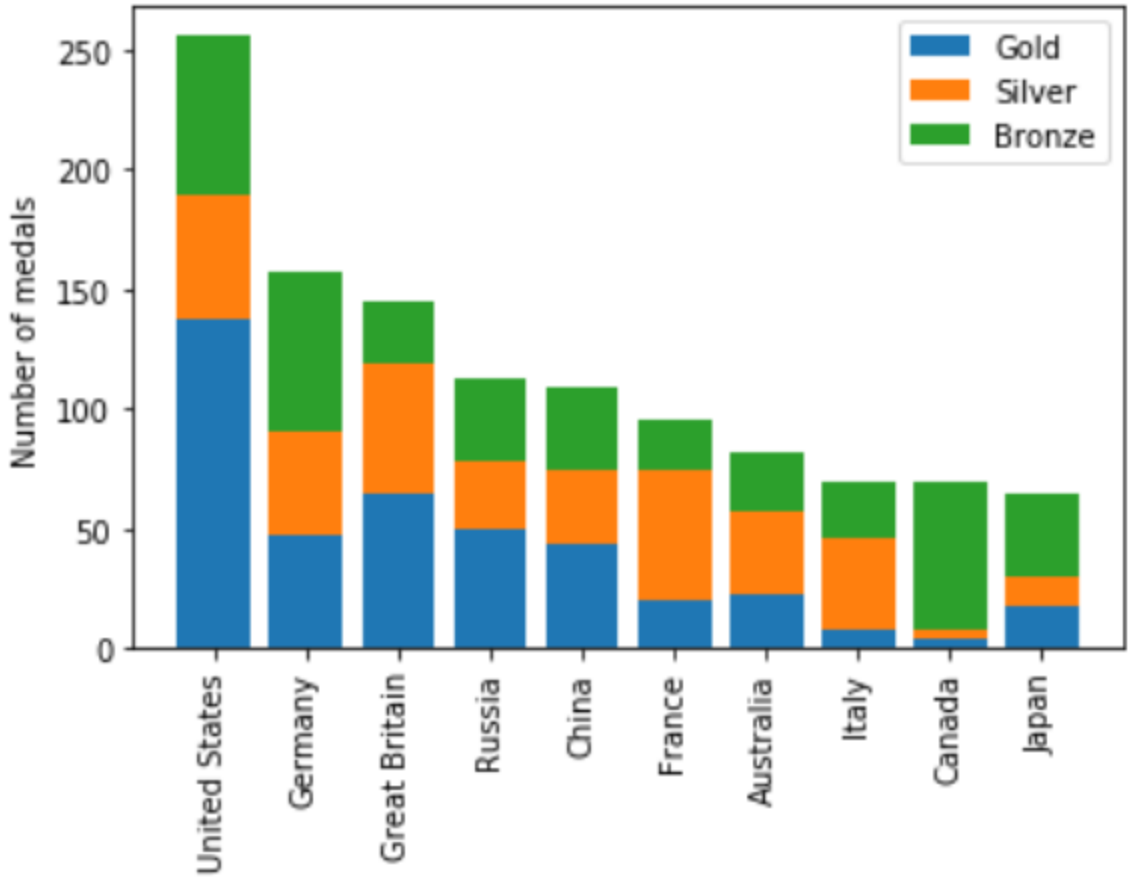
```
fig, ax = plt.subplots()
plot_timeseries(ax, climate_change.index, climate_change['co2'],
                'blue', 'Time', 'CO2 (ppm)')
ax2 = ax.twinx()
plot_timeseries(ax2, climate_change.index,
                 climate_change['relative_temp'],
                'red', 'Time', 'Relative temperature (Celsius)')
ax2.annotate(">1 degree",
             xy=(pd.Timestamp('2015-10-06'), 1),
             xytext=(pd.Timestamp('2008-10-06'), -0.2),
             arrowprops={"arrowstyle":"->", "color":"gray"})
plt.show()
```



[Customizing annotations]

Quantitative comparisons: bar charts

Bar charts

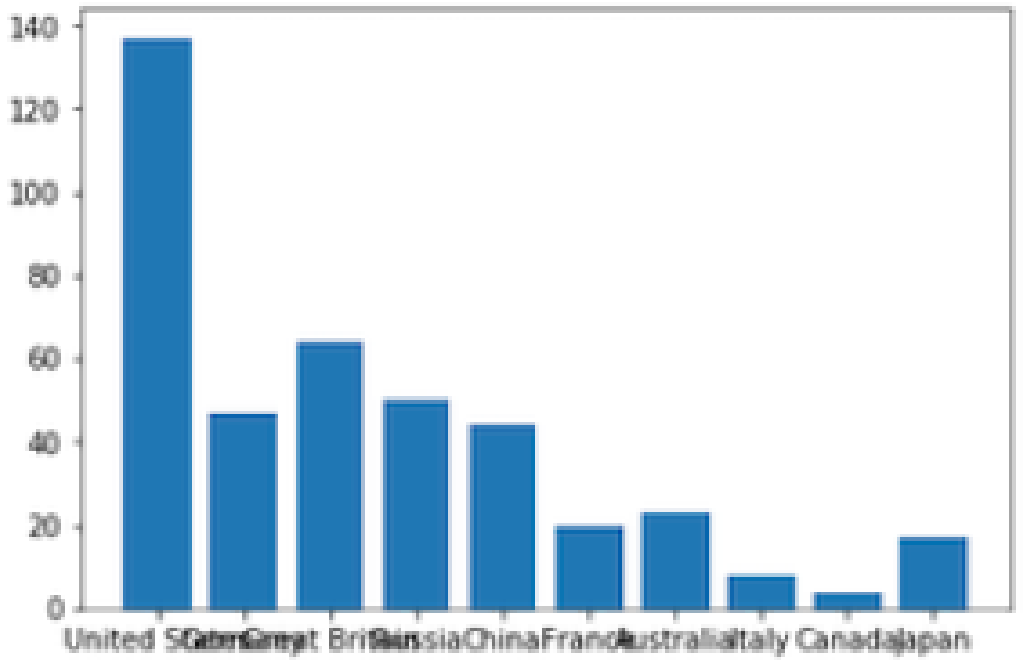

Gold
Silver
Bronze
Number of medals
250
200
150
100
50
0
United States
Germany
Great Britain
Russia
China
France
Australia
Italy
Canada
Japan

Data: 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
```

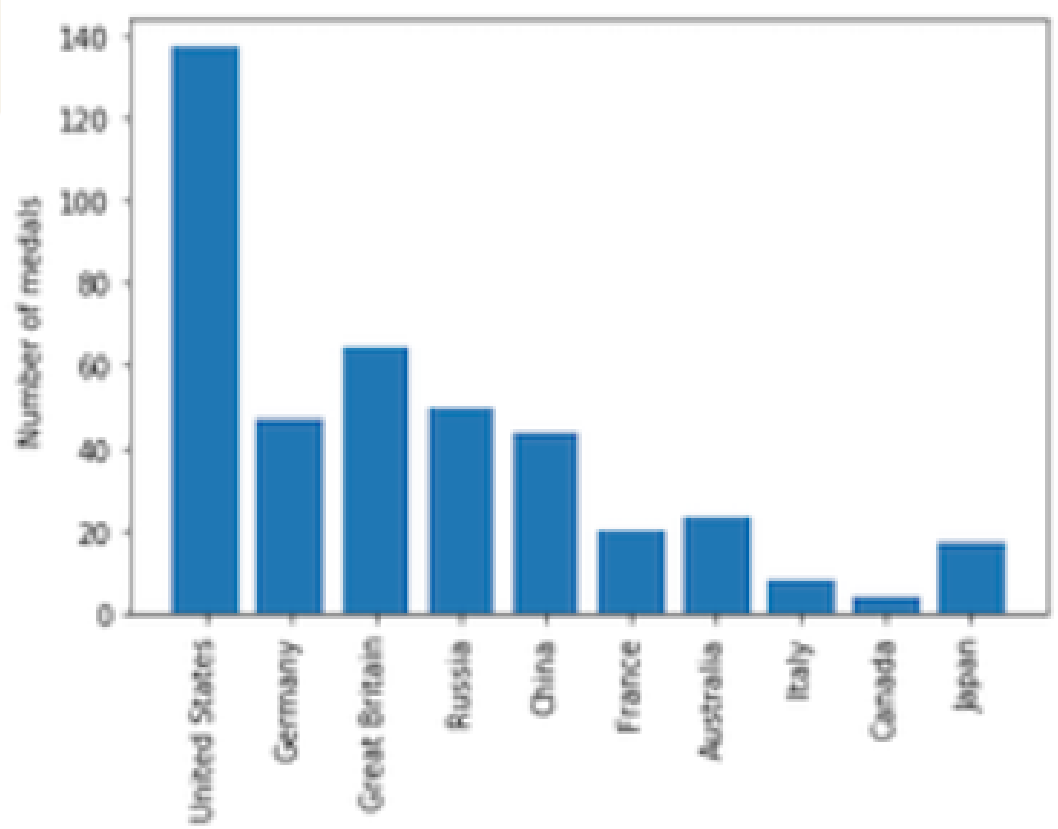
Olympic medals: visualizing the data

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



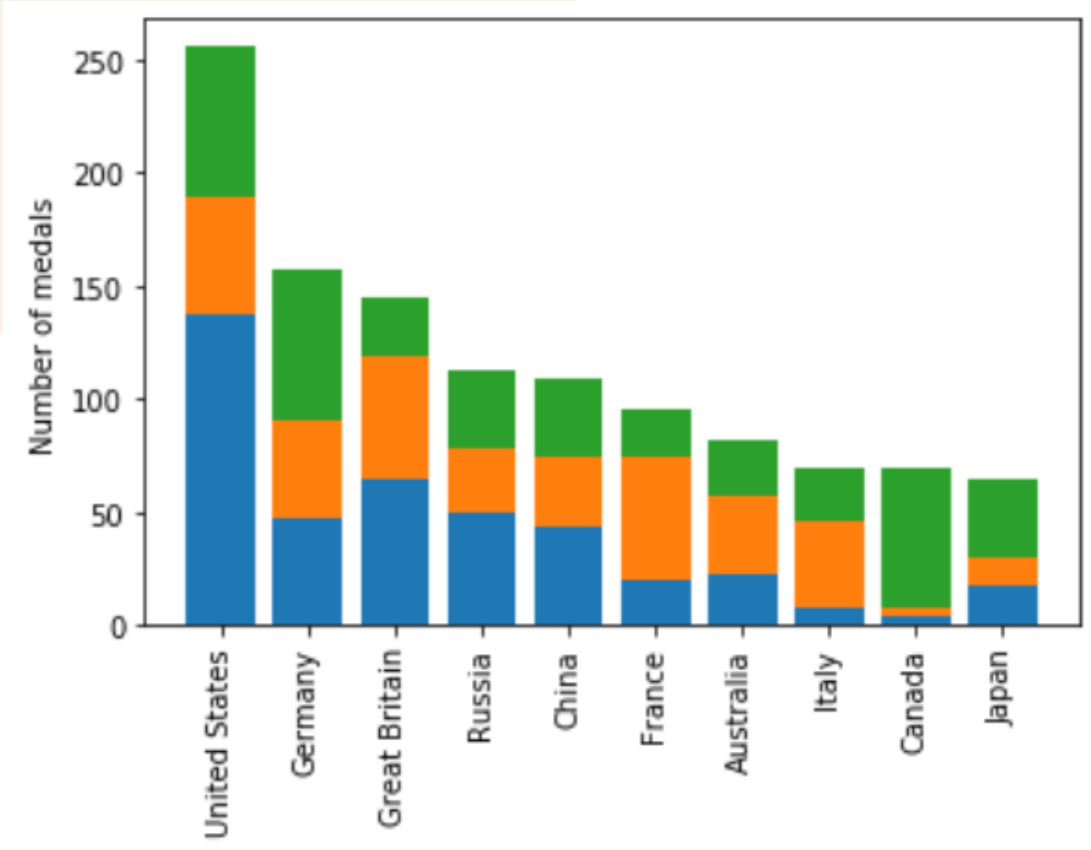
Interlude: rotate the tick labels

```
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()
```



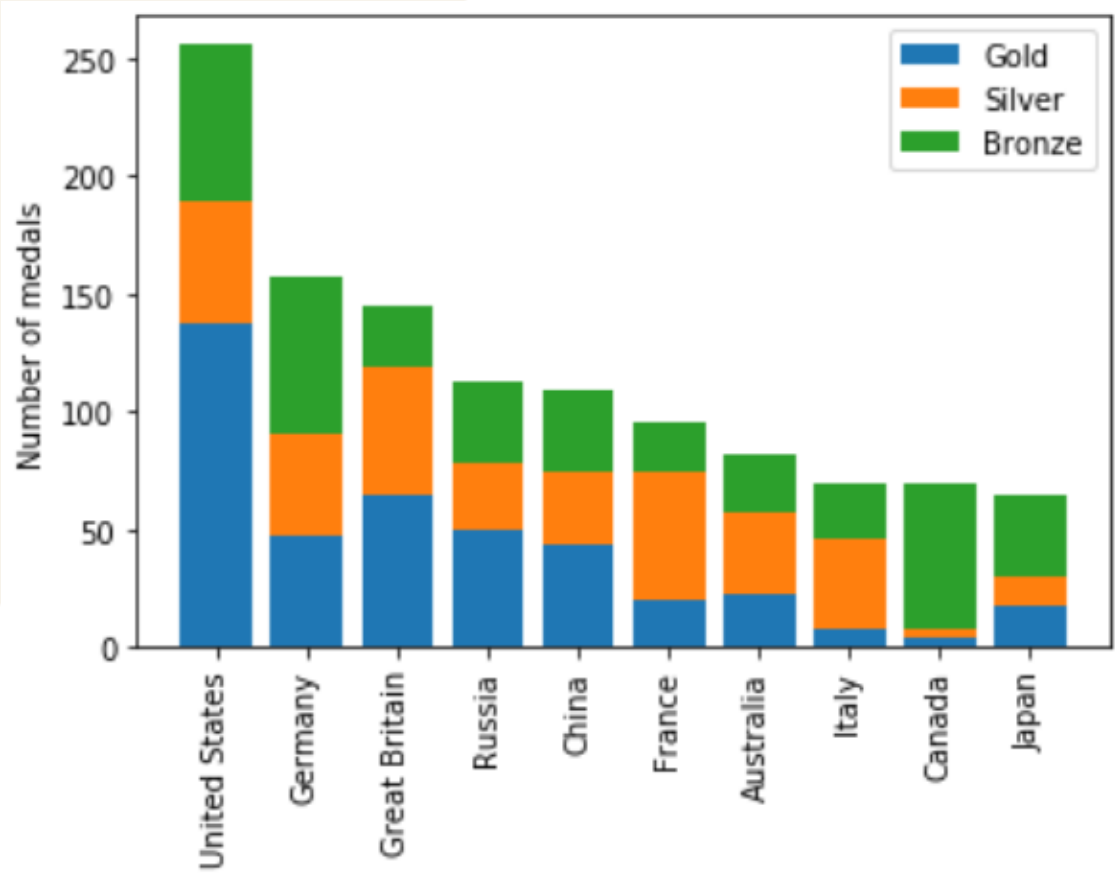
Olympic medals: visualizing the other medals

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

ax.bar(medals.index, medals["Silver"], bottom=medals["Gold"])
ax.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()
```



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()
```



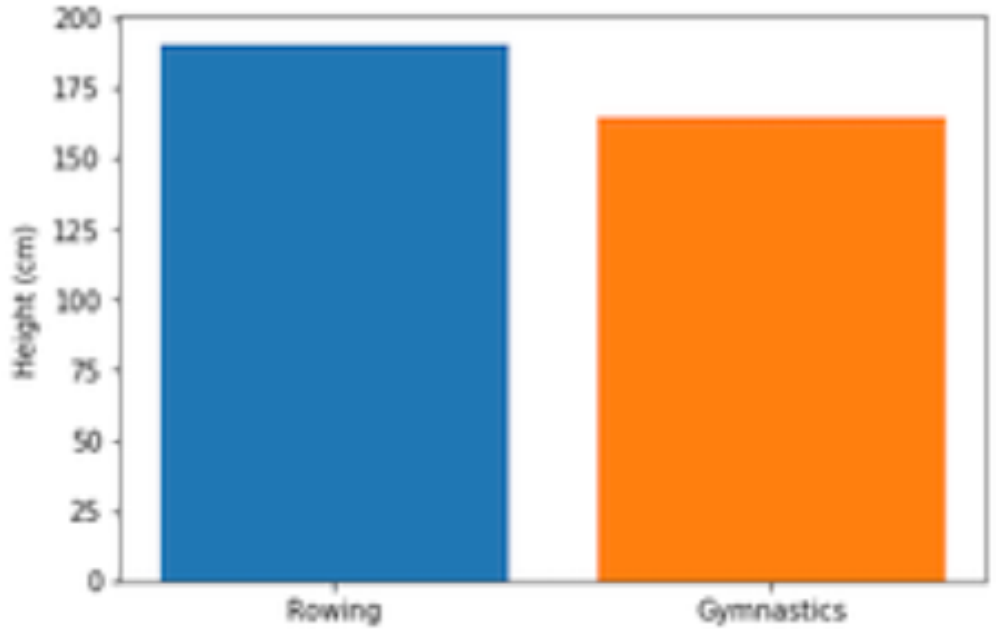
Quantitative comparisons: histograms

Histograms:
men_Rowing
men_gymnastics

	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 Barcukh	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

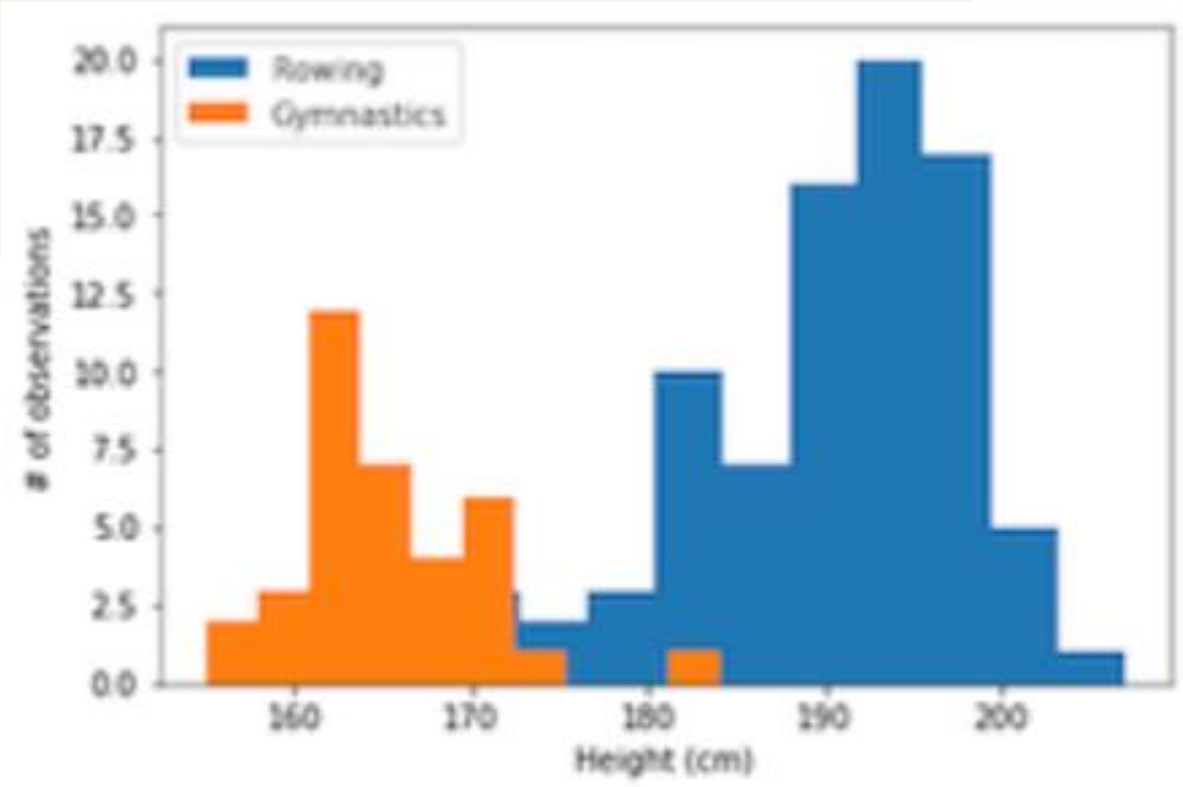
A bar chart again

```
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()
```



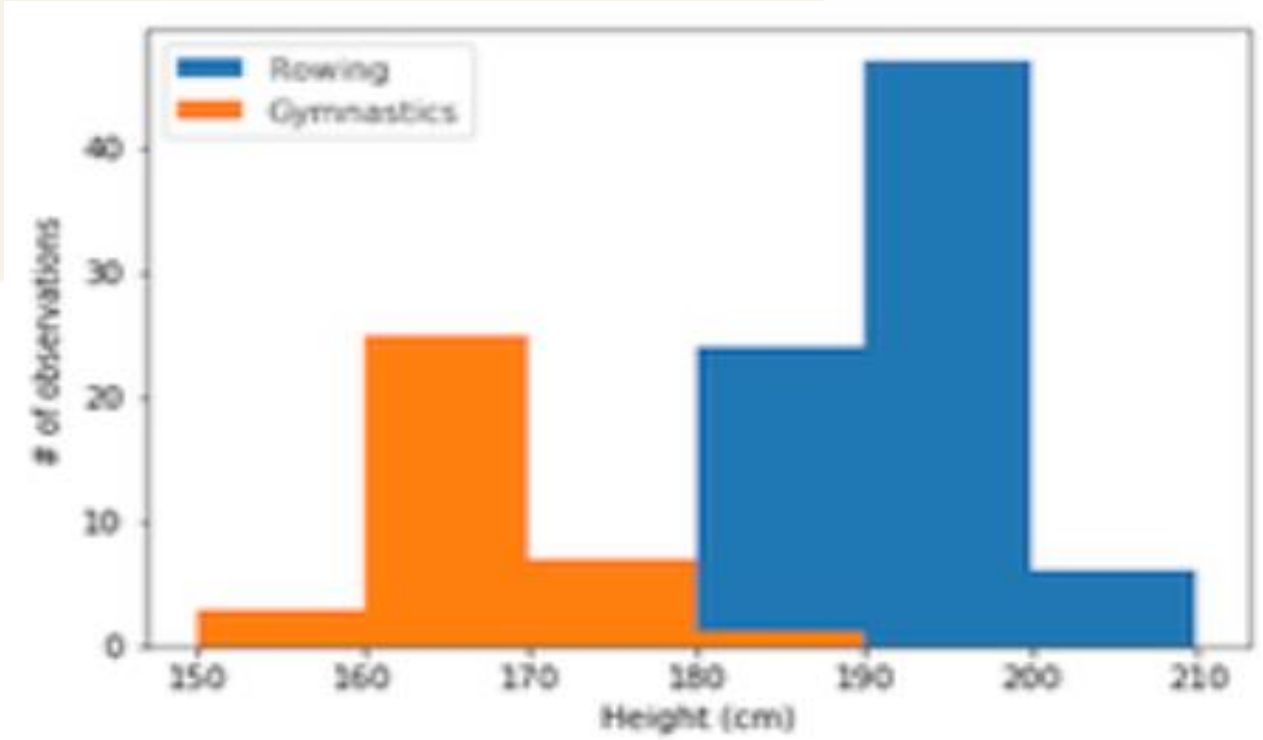
Introducing histograms

```
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()
```



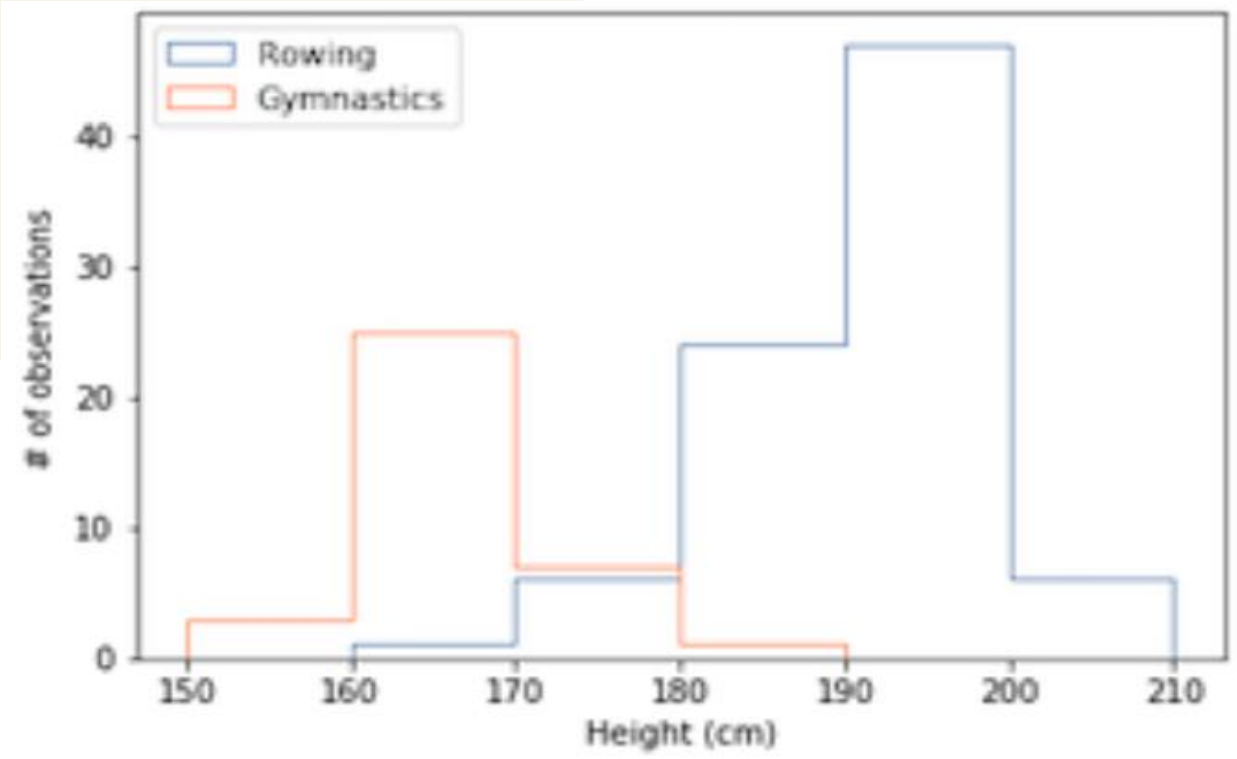
Customizing histograms: setting bin boundaries

```
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()
```



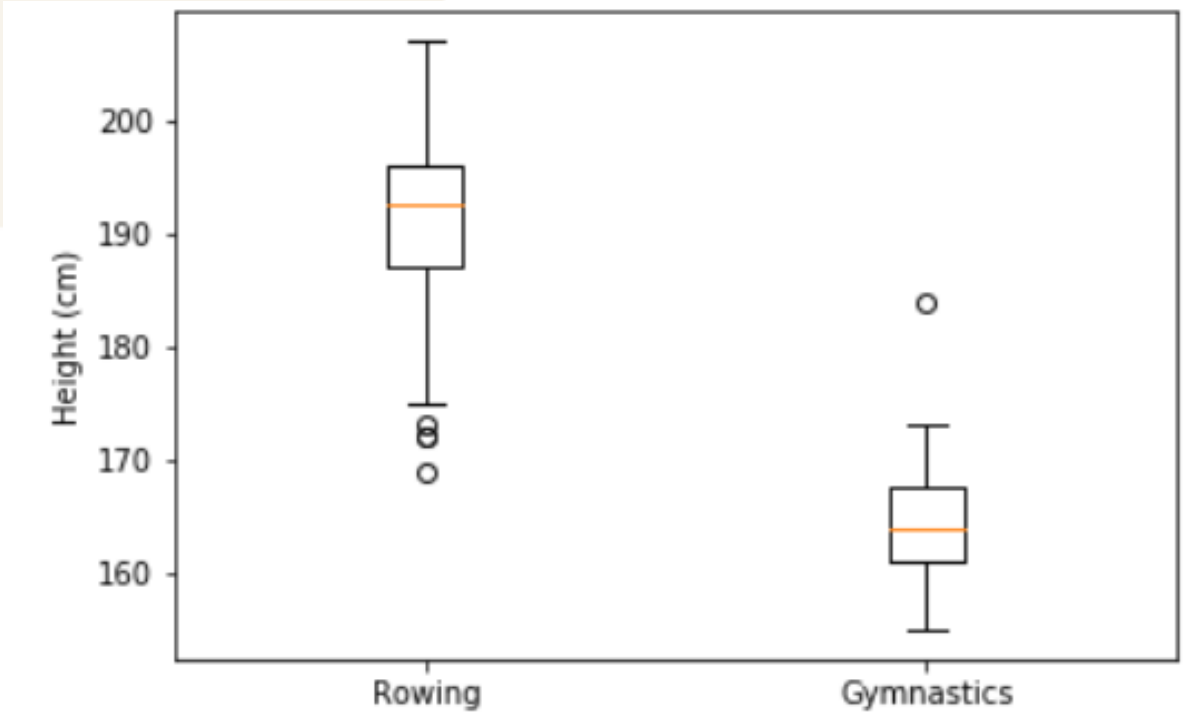
Customizing histograms: transparency

```
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()
```



Adding boxplots

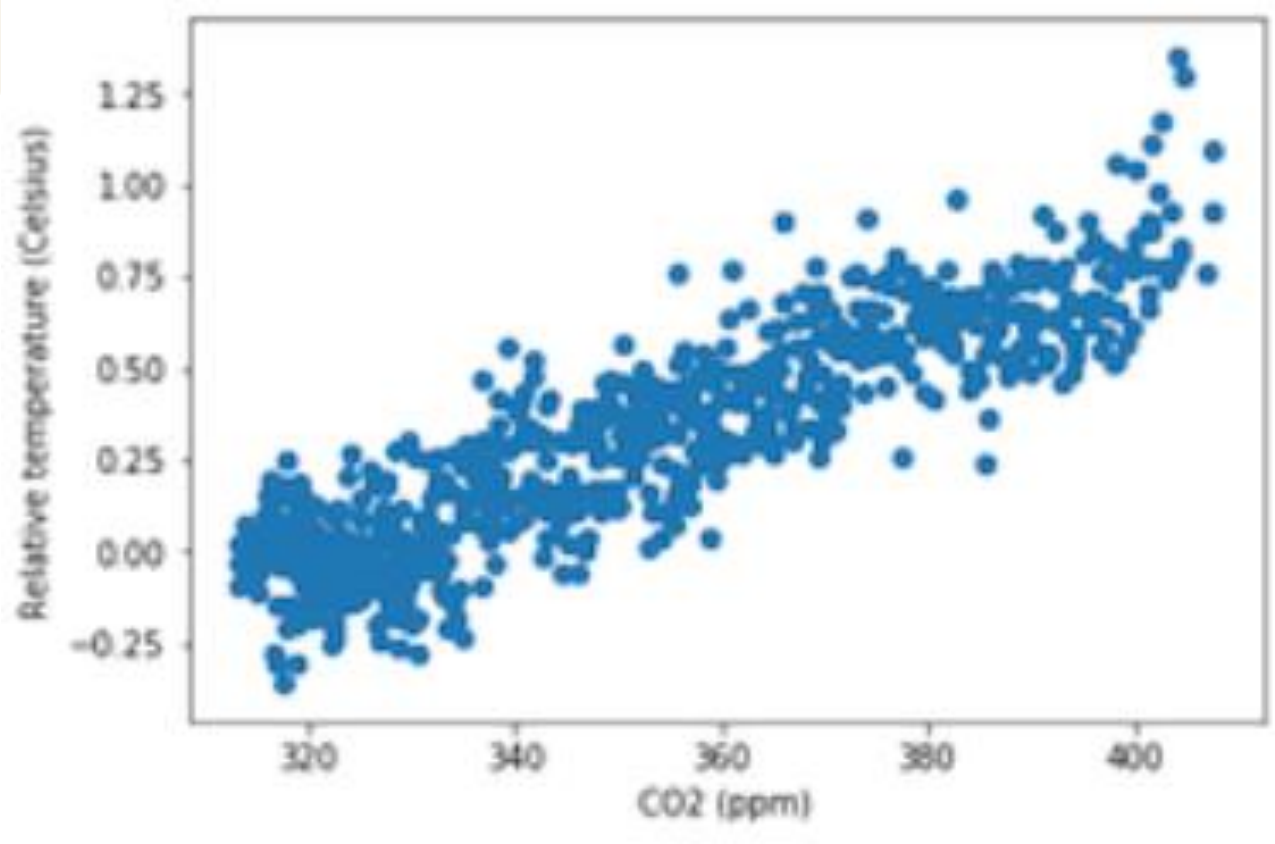
```
fig, ax = plt.subplots()
ax.boxplot([mens_rowing["Height"],
            mens_gymnastics["Height"]])
ax.set_xticklabels(["Rowing", "Gymnastics"])
ax.set_ylabel("Height (cm)")

plt.show()
```



Quantitative comparisons: scatter plots

Introducing scatter plots

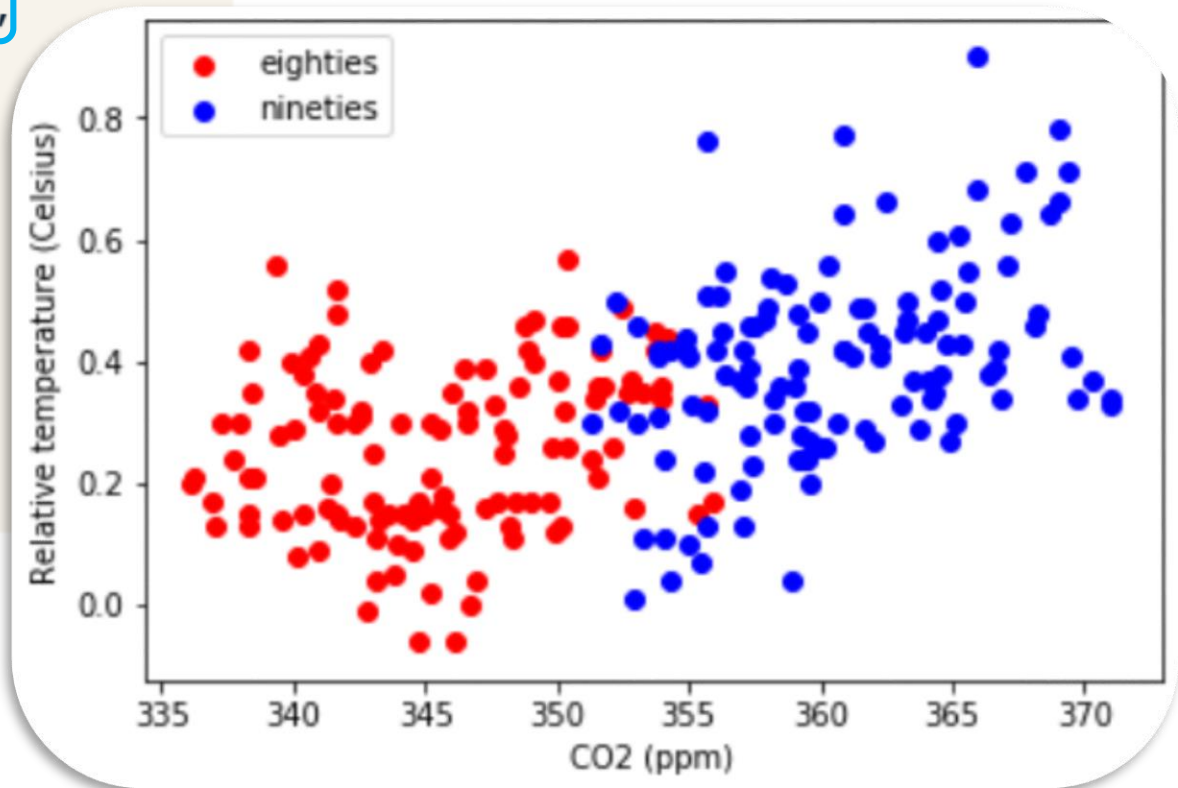
```
fig, ax = plt.subplots()
ax.scatter(climate_change["co2"], climate_change["relative_temp"])
ax.set_xlabel("CO2 (ppm)")
ax.set_ylabel("Relative temperature (Celsius)")
plt.show()
```



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()
```

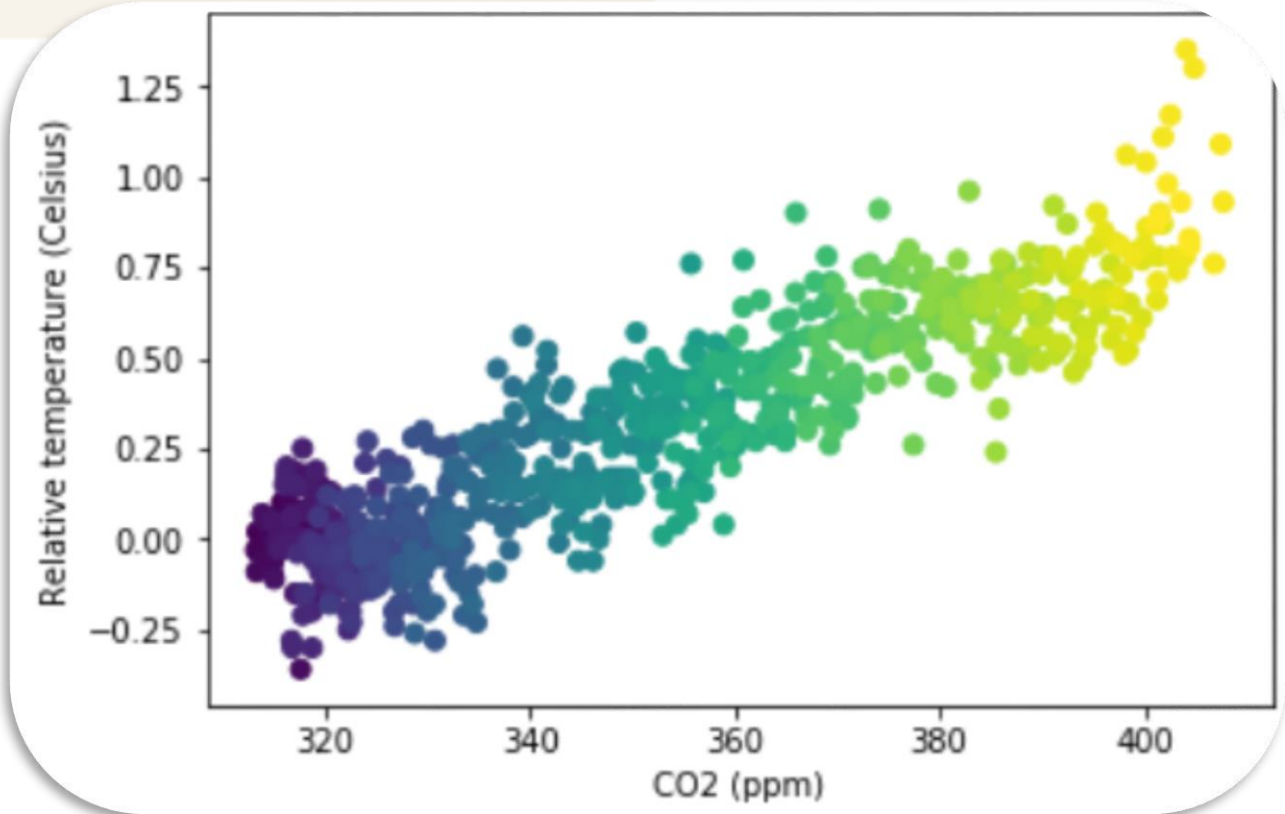
Two DataFrame in a plot



Encoding a third variable by color

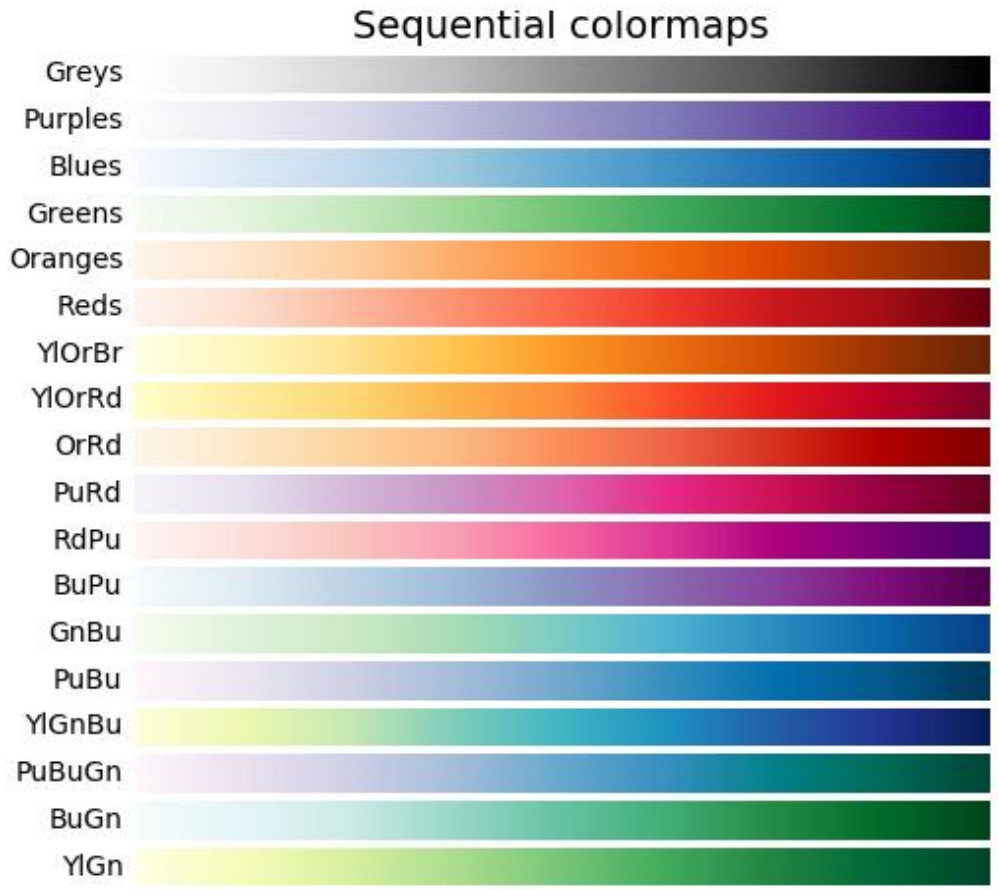
```
fig, ax = plt.subplots()
ax.scatter(climate_change["co2"], climate_change["relative_temp"],
           c=climate_change.index)
ax.set_xlabel("CO2 (ppm)")
ax.set_ylabel("Relative temperature (Celsius)")
plt.show()
```

cmap=‘’colormap names’’



color example code: colormaps_reference.py

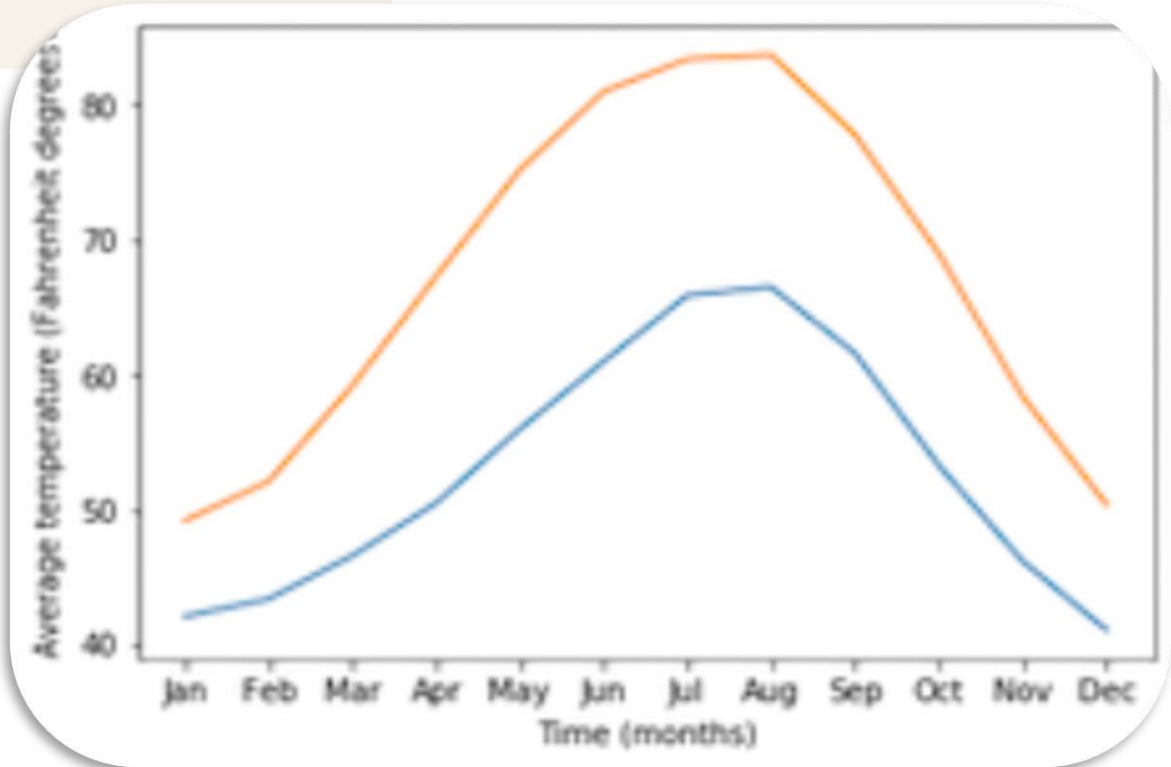
[colormaps]



Preparing your figures to share with others

Changing plot style

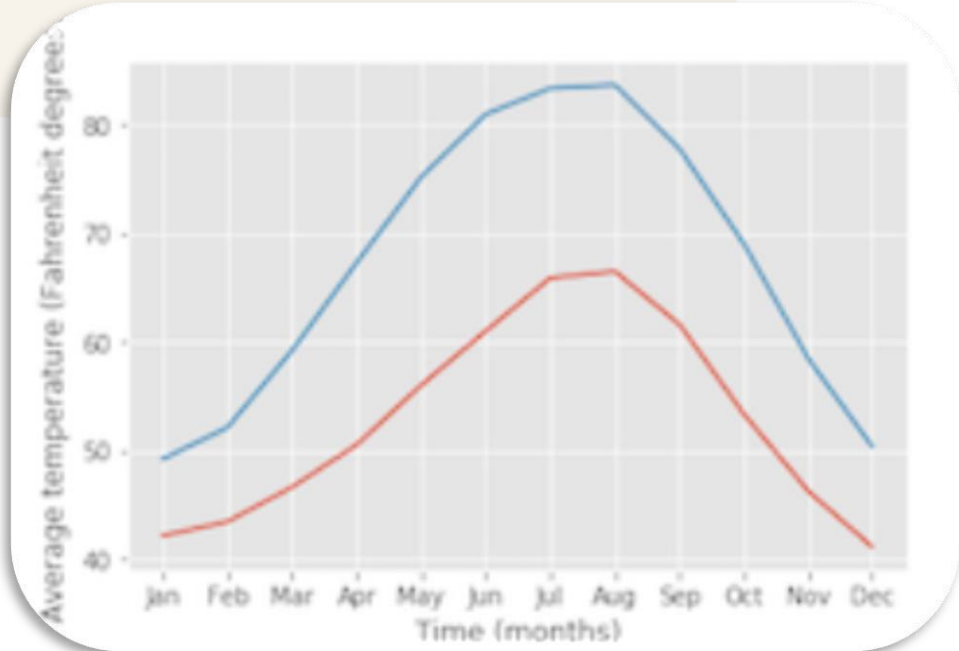
```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
ax.plot(seattle_weather["MONTH"], seattle_weather["MLY-TAVG-NORMAL"])
ax.plot(austin_weather["MONTH"], austin_weather["MLY-TAVG-NORMAL"])
ax.set_xlabel("Time (months)")
ax.set_ylabel("Average temperature (Fahrenheit degrees)")
plt.show()
```



Changing plot 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()
```

plot style



Back to the default

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

Let's practice!