Introduction to Matplotlib

Data Boot Camp

Lesson 5.1

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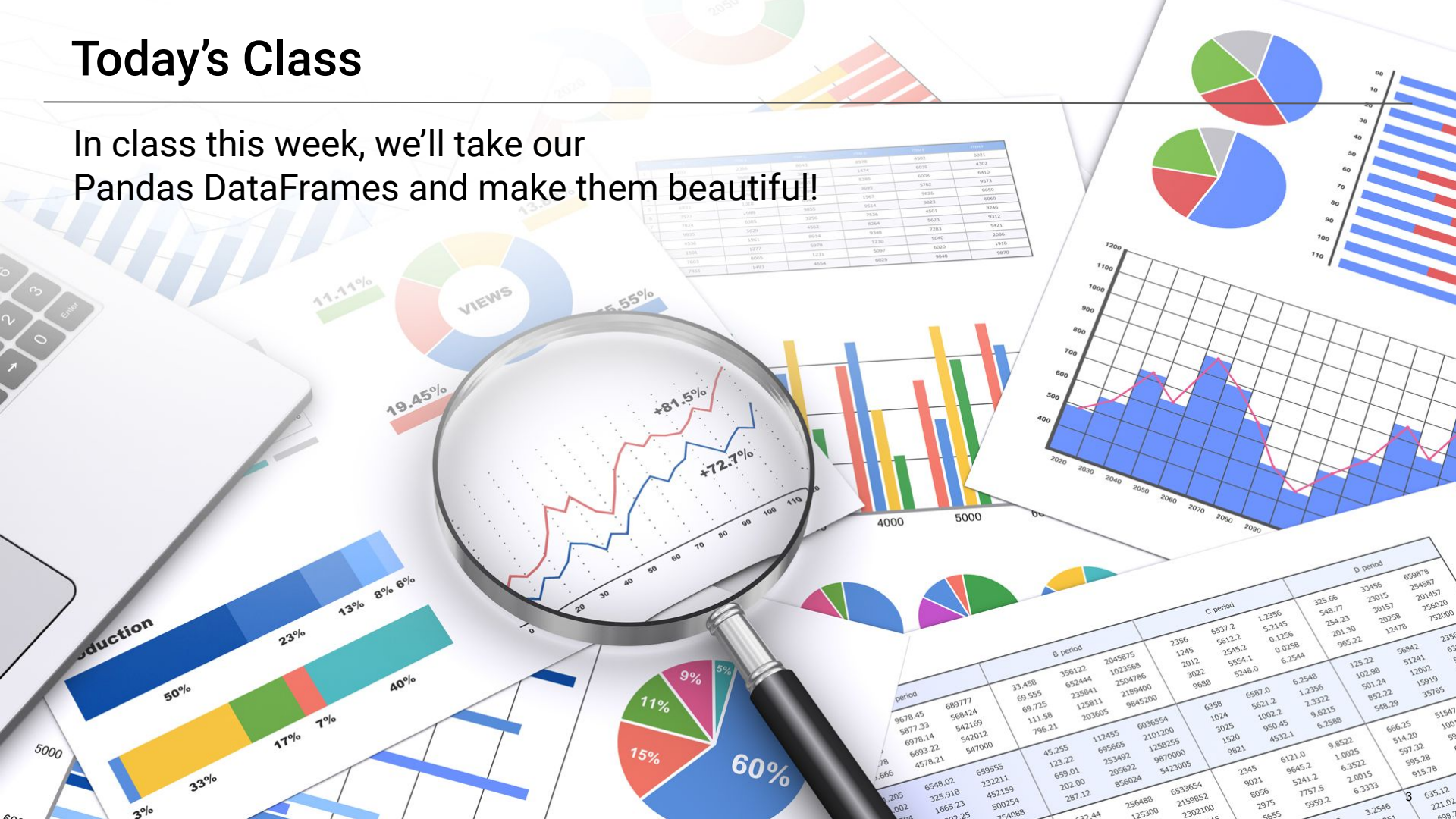
Who’s excited to learn more about Python?

Today's Class

In class this week, we'll take our
Pandas DataFrames and make them beautiful!



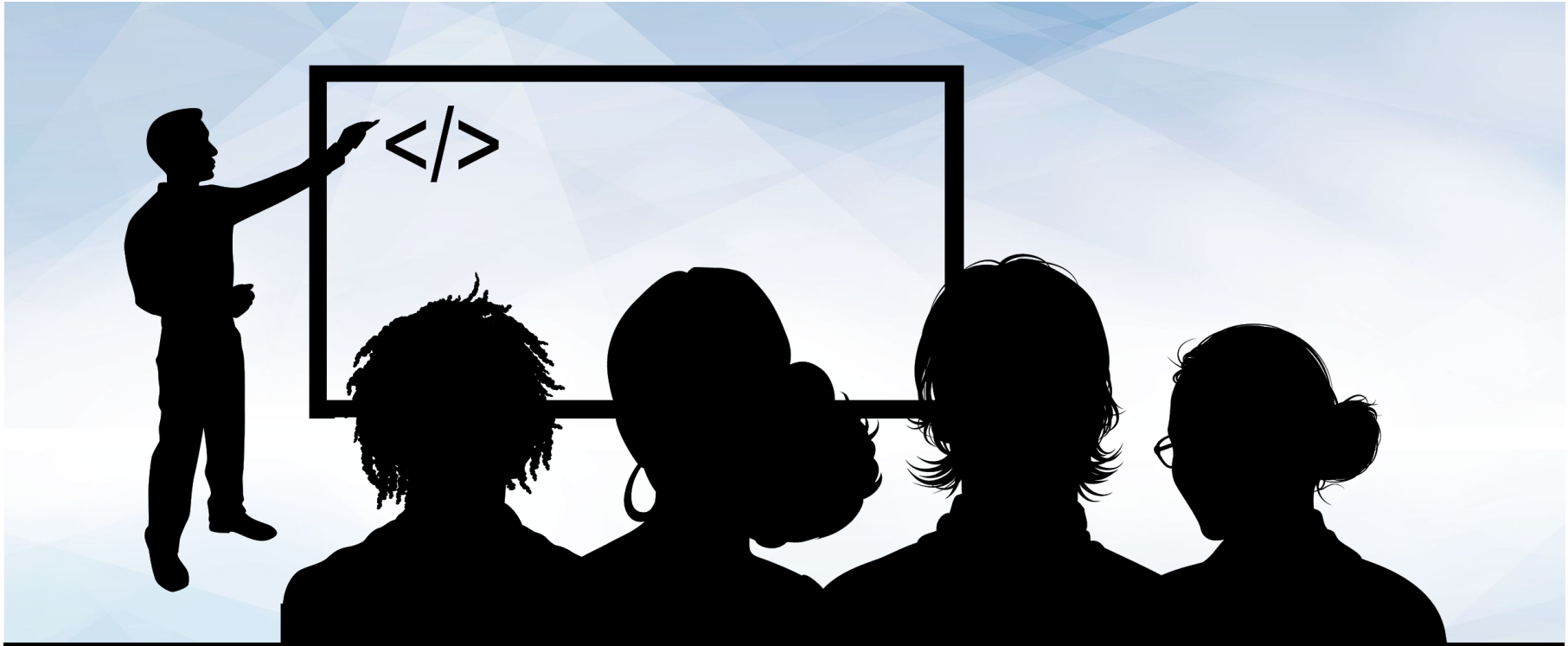
Class Objectives

By the end of today's class, you will be able to:

01 Use Matplotlib's Pyplot interface.

02 Create line, bar, scatter, and pie charts and change the appearance of the plots.

03 Identify basic plot configuration options such as `xlim` and `ylim`.



Instructor Demonstration

Introduction to Matplotlib

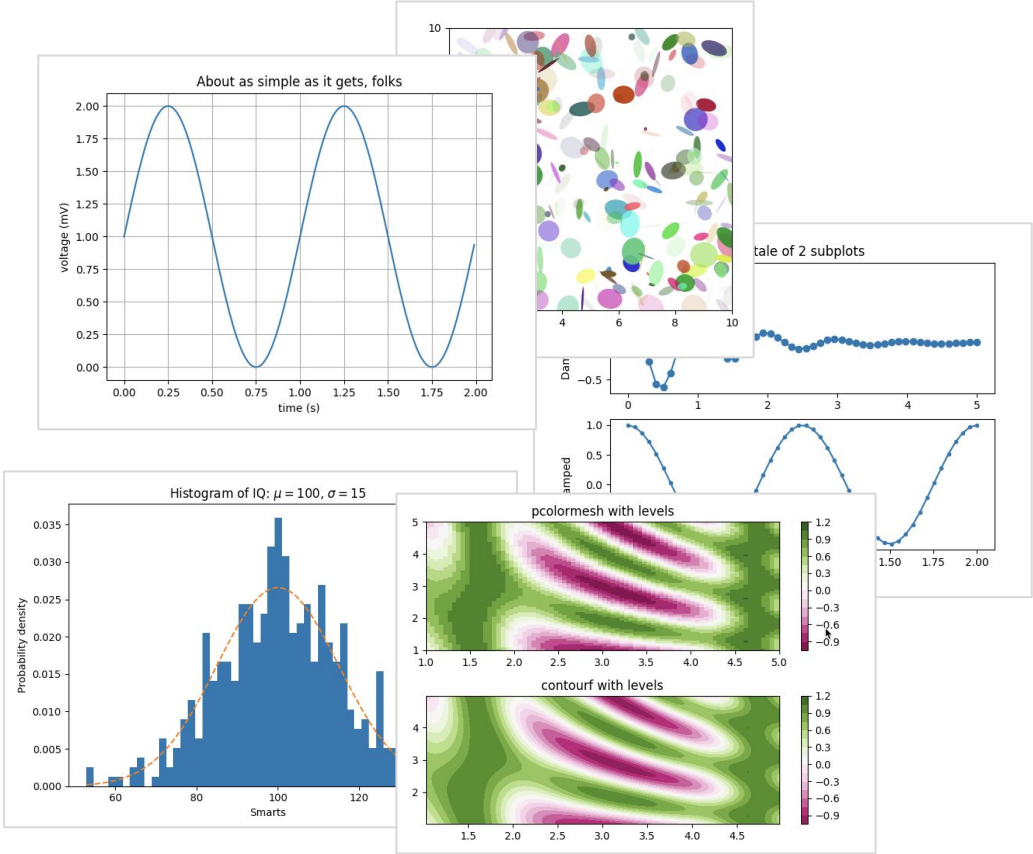
What Is Matplotlib?

Matplotlib: A Python Library that Visualizes a Dataset

- Types of datasets include:
  - Pandas DataFrames
  - Lists, tuples, and dictionaries
  - NumPy arrays

- Types of visualizations include:
  - Bar charts
  - Pie charts
  - Line charts
  - Scatter plots

...And more!



The Pyplot Module = The Heart of Matplotlib

- Accepts many forms of input values.
- Enables custom colors, shapes, labels, etc.
- Does most of the plotting logistics for us; we simply tell it which plot to make.
- Trust us: you'll love it!

General Plotting Process Using Pyplot:

01

Create your dataset.

Data can be generated from functions, pulled from Pandas DataFrames, etc.

02

Generate your plot.

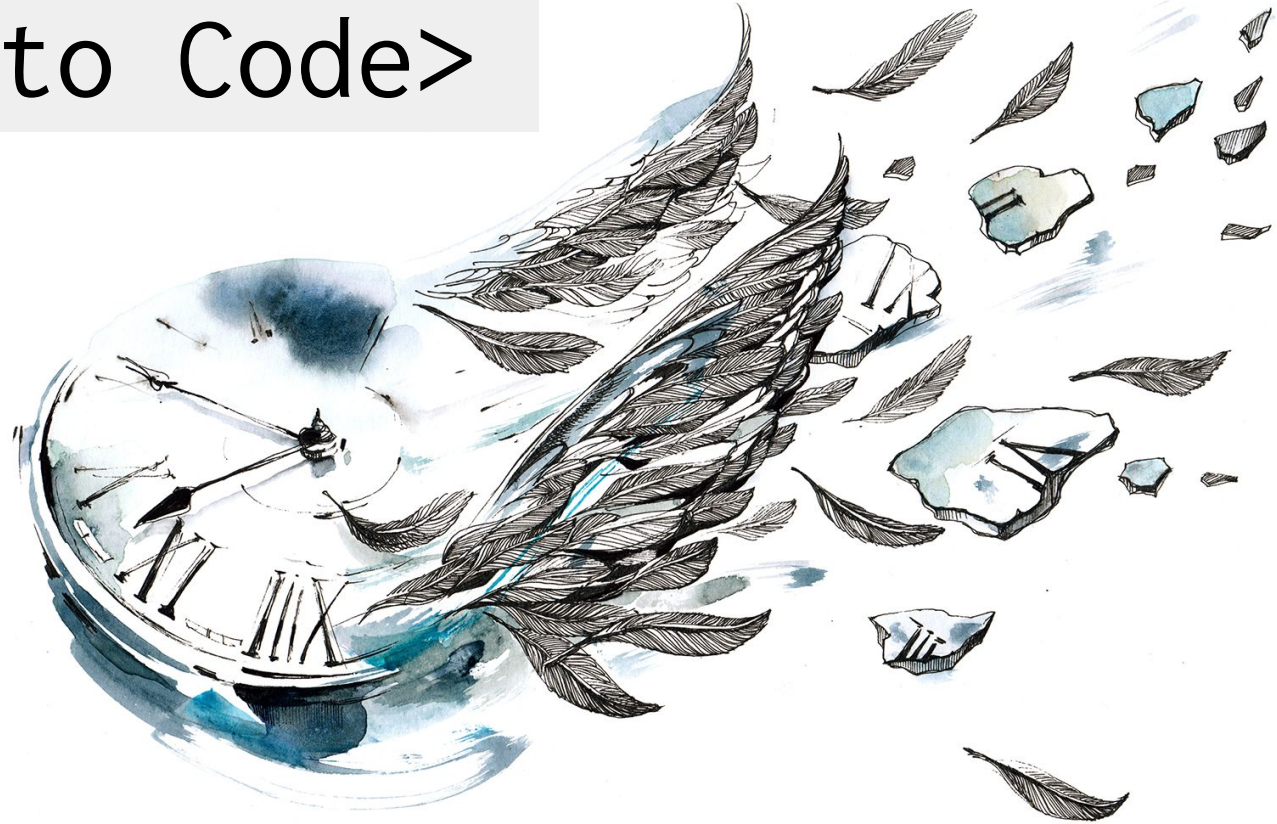
Use the `pyplot.plot()` function to tell Matplotlib what data to use and which plot to make.

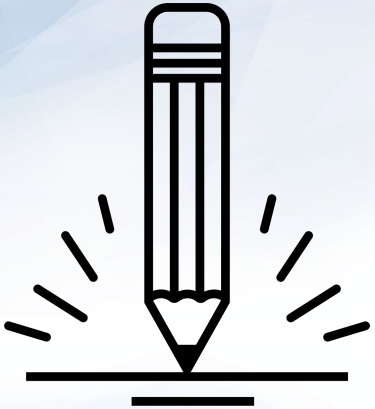
03

Customize your plot.

Change the axis, label the figures, color the data points—make the plot as informative to the reader as possible.

<Time to Code>





Activity: New Jersey Weather

In this activity, you will create a series of line plots using New Jersey temperature data.

(Instructions sent via Slack.)

Suggested Time:
15 Minutes

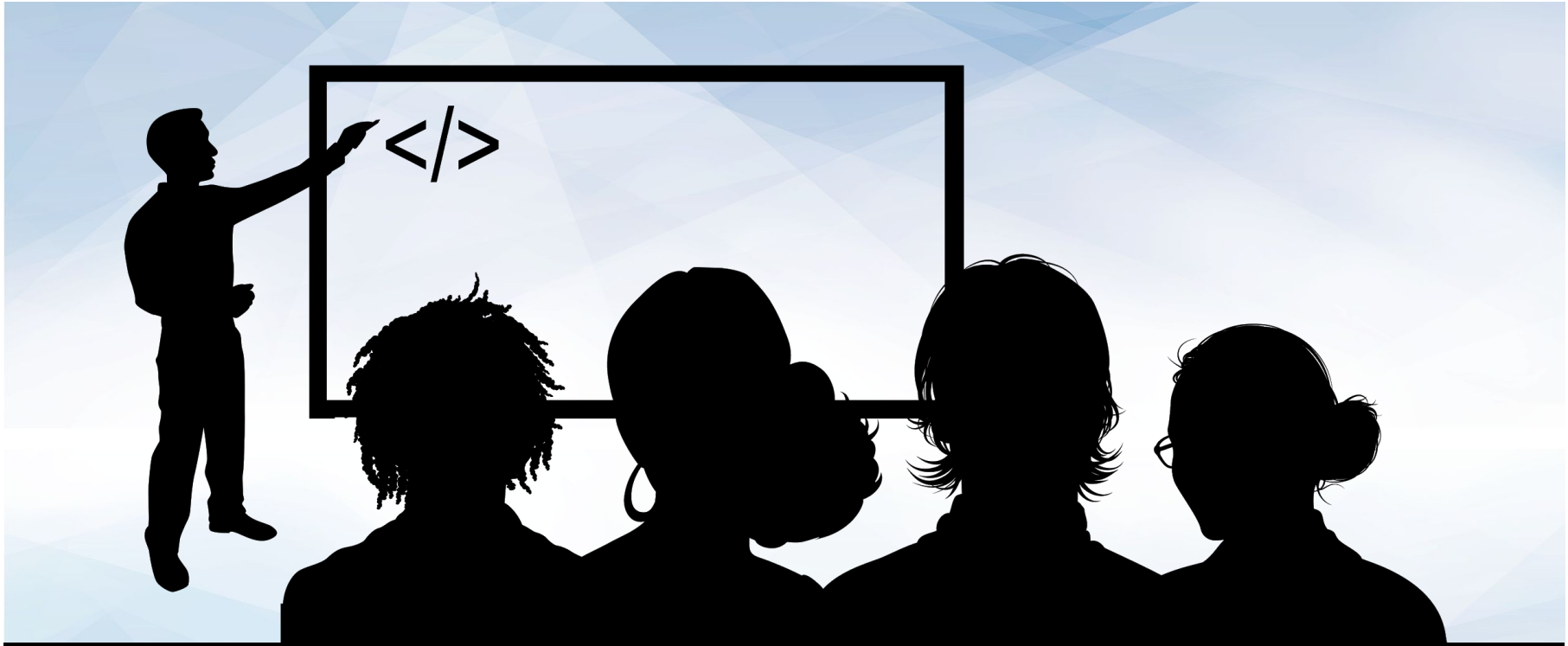
New Jersey Weather Instructions

- Using the following data, plot the monthly averages for temperature in New Jersey:
  - Use the numeric value for months.
  - Average temperature per month in Fahrenheit:
    [39, 42, 51, 62, 72, 82, 86, 84, 77, 65, 55, 44]
- Use list comprehension to convert the temperature to Celsius and plot that line as well.
- Create a third plot that includes both lines.

Hints:

- The formula to convert Fahrenheit to Celsius: `(x-32) * 0.56`
- See the Matplotlib documentation for more information about the PyPlot library.

Time’s Up! Let’s Review.

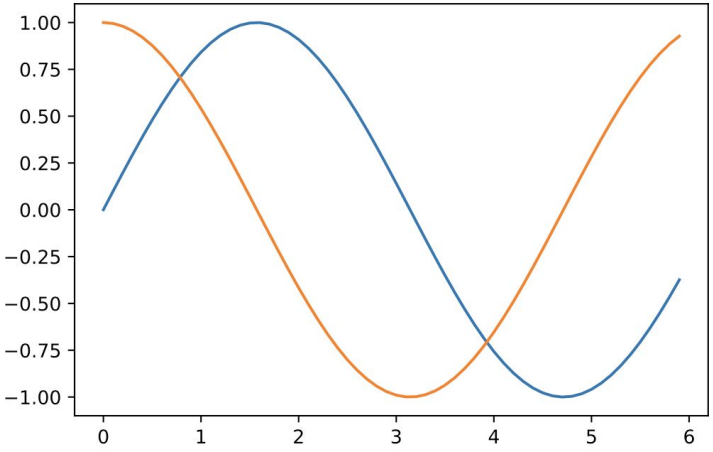


Instructor Demonstration

Configuring Line Plots

Basic Line Plots

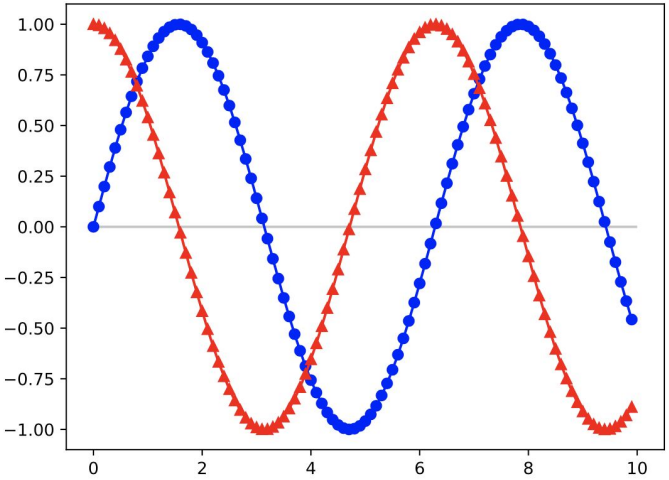
Matplotlib's basic line plots are rather bland.



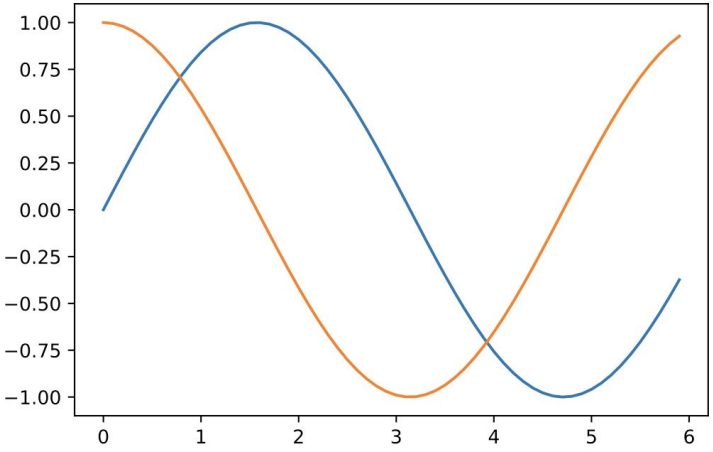
Custom colors

Custom markers

Reference Lines



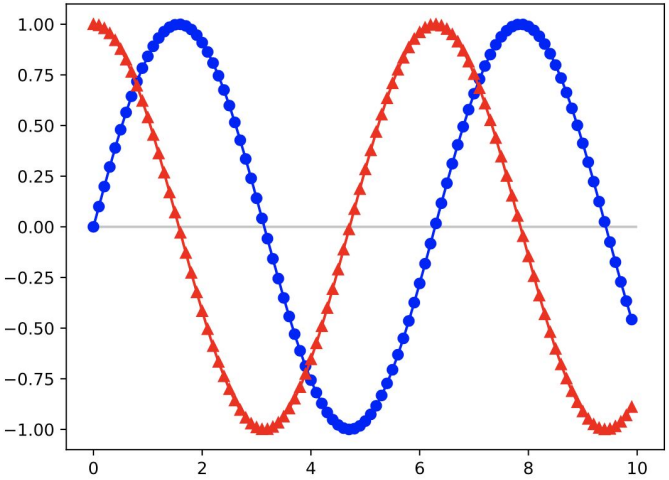
Basic Line Plots



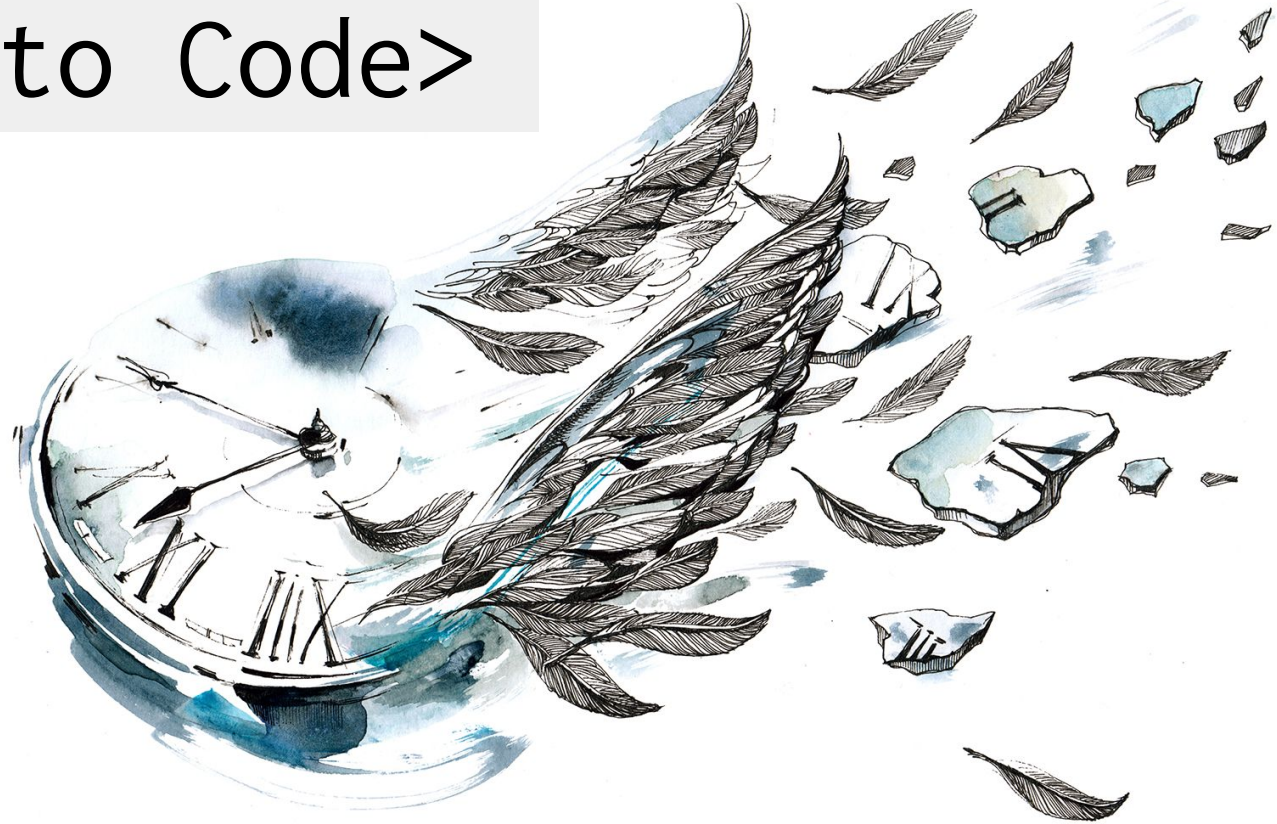
color='red' or 'blue'

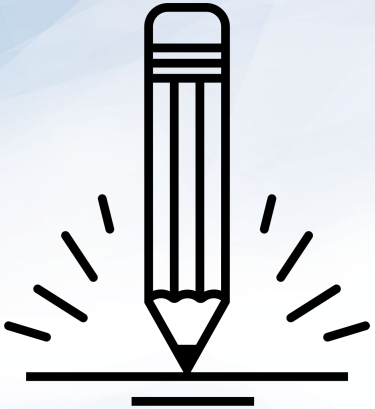
marker ='o', '^'

plt.hlines()



<Time to Code>





Activity: Legendary Temperature

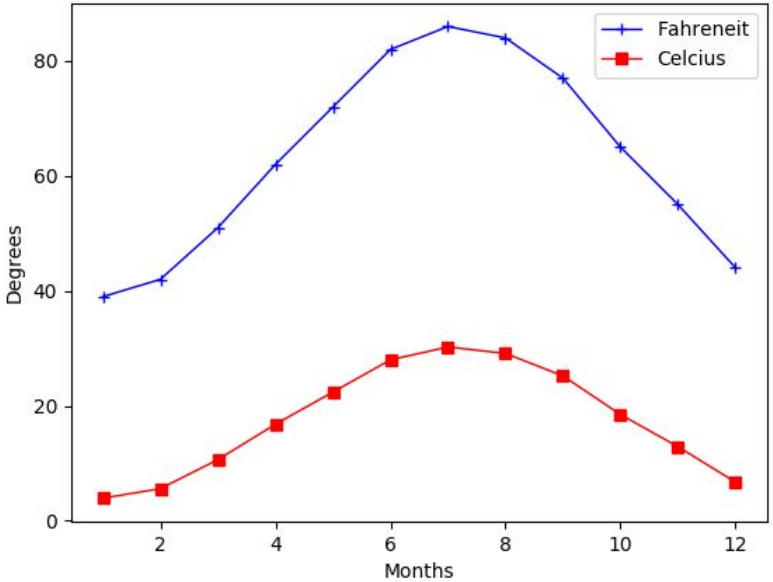
In this activity, you will edit the line plots created earlier to make them more visually interesting.

(Instructions sent via Slack.)

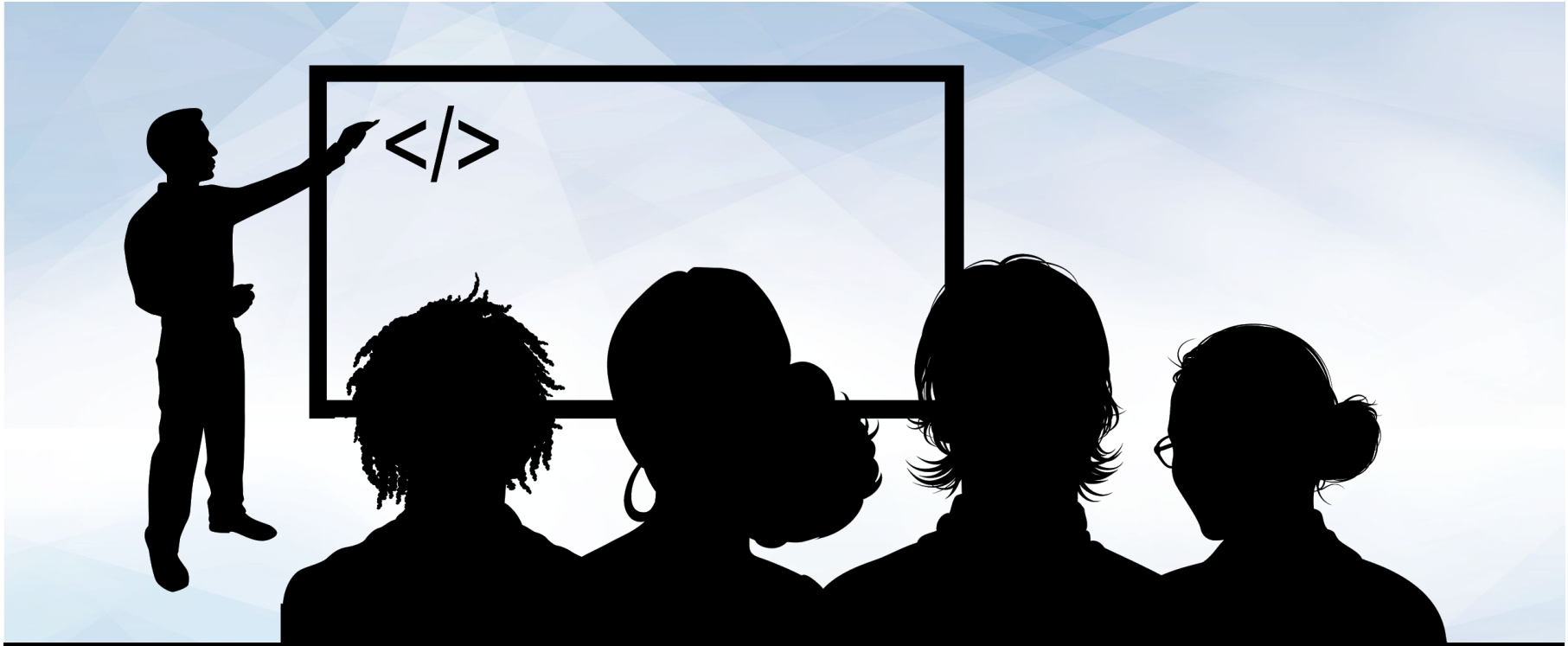
Suggested Time:
15 Minutes

Legendary Temperature Instructions

- Modify the New Jersey temperature line charts you created earlier so that they match the image shown.
- Once you have created the plot, use the Matplotlib documentation to find additional formatting that could be added to the chart.



Time’s Up! Let’s Review.



Instructor Demonstration

Aesthetics

The best plots,
like the best code,
are easy to read.

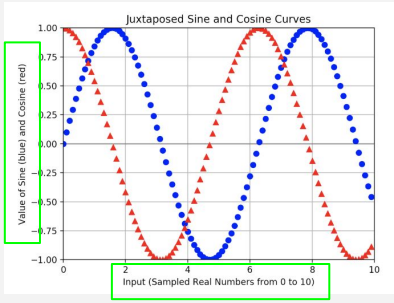
Q

What are ways to improve readability of plots?

Steps to Improve Readability of Plots

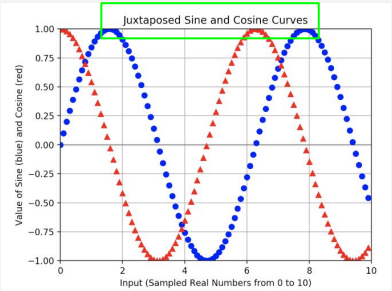
01

Add labels to the *x* and *y* axes.



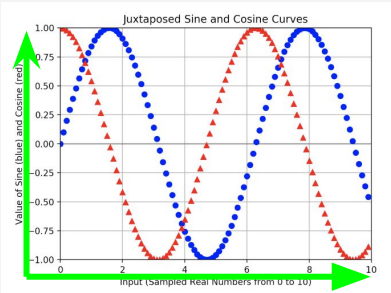
02

Add titles to plots.



03

Limit the boundaries of the *x* and *y* axes.



Changing Aesthetics in Pyplot

01

Add labels to the *x* and *y* axes.

```
plt.xlabel()
plt.ylabel()
```

02

Add titles to plots.

```
plt.title()
```

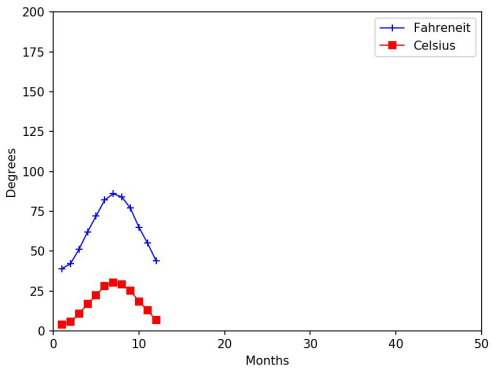
03

Limit the boundaries of the *x* and *y* axes.

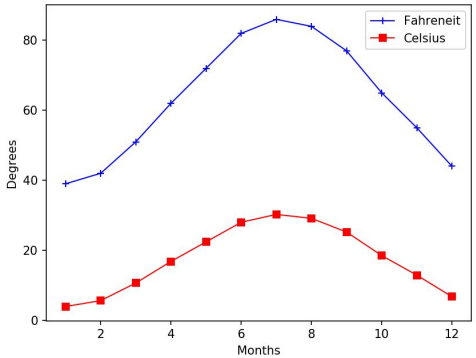
```
plt.xlim()
plt.ylim()
```

Advantages of Adding Aesthetics

- Adding labels makes graphics easier to understand and prevents them from being inadvertently misleading.
- Limiting the range of the plot maximizes the data-to-ink ratio:
  - “Ink” used to make data/Total “ink” of the plot
  - It’s best to use the least amount of ink to show the most amount of data.



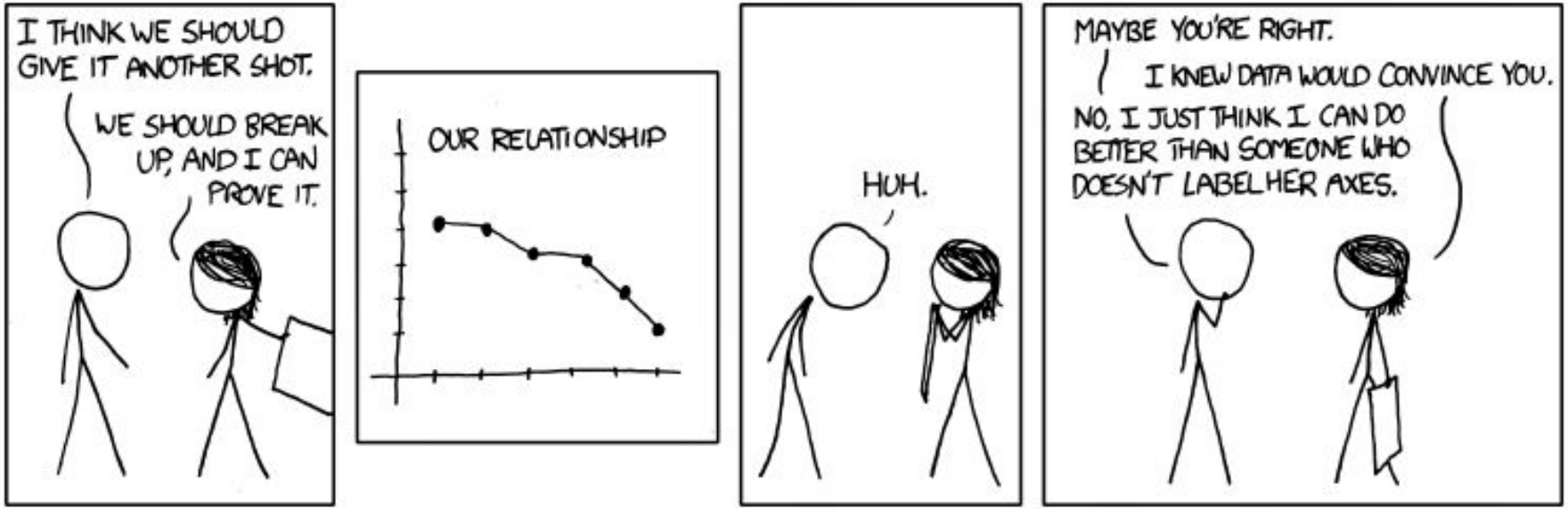
Low data-to-ink ratio



High data-to-ink ratio

Convincing

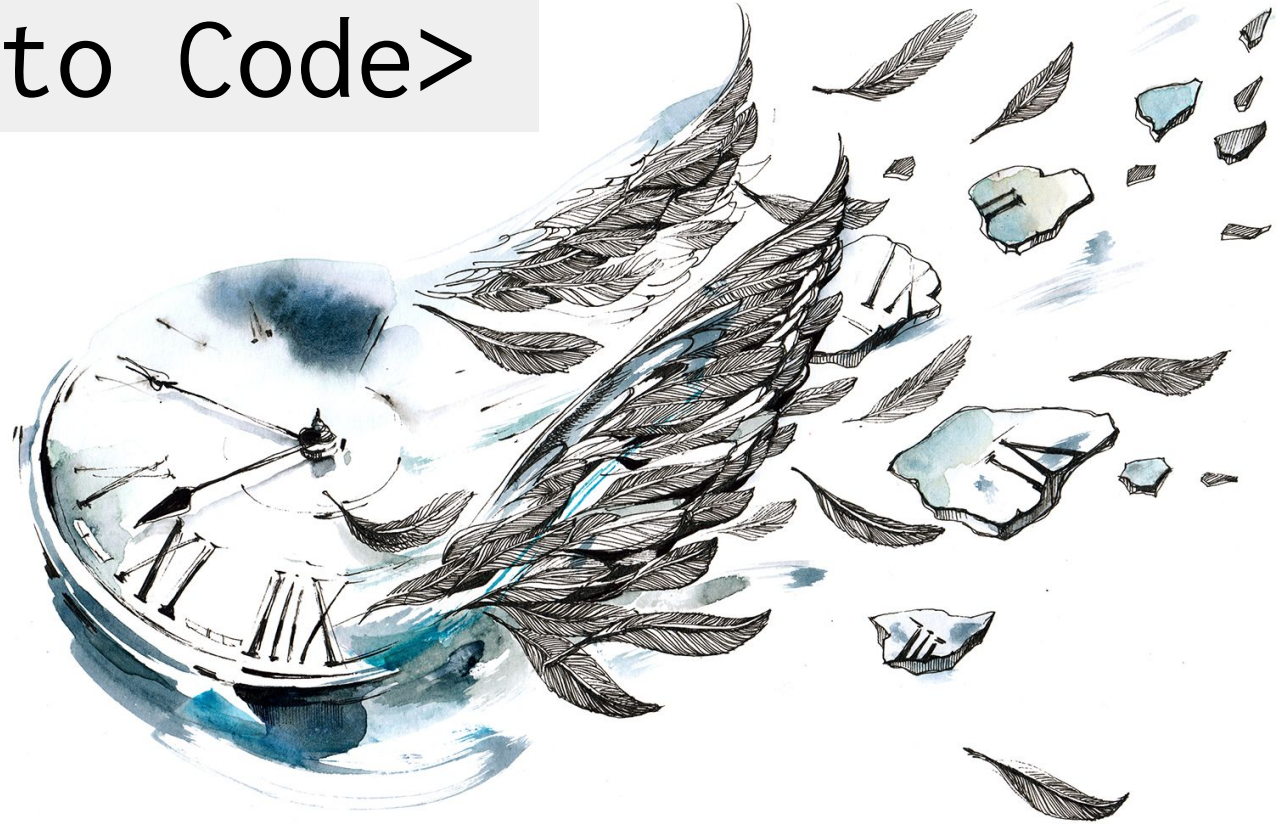
I< < Prev Random Next > >I



I< < Prev Random Next > >I

Permanent link to this comic: https://xkcd.com/833/
Image URL (for hotlinking/embedding): https://imgs.xkcd.com/comics/convincing.png

<Time to Code>



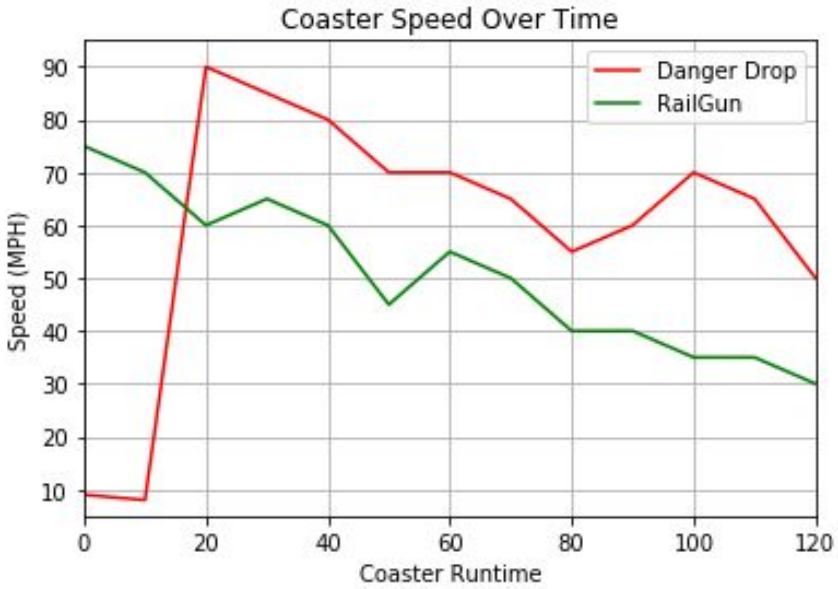
Activity: Coaster Speed

In this activity, you will create a line chart that graphs the speed of a roller coaster over time. You will then style the chart and add some aesthetics to it.

Suggested Time:
10 Minutes

Coaster Speed Instructions

- Create a line chart with two plots using the following data:
  - Danger Drop: [9, 8, 90, 85, 80, 70, 70, 65, 55, 60, 70, 65, 50]
  - RailGun: [75, 70, 60, 65, 60, 45, 55, 50, 40, 40, 35, 35, 30]
- Both coasters are 120 seconds long, and the speed was measured every 10 seconds.
- Apply styling and labels that match the image provided.

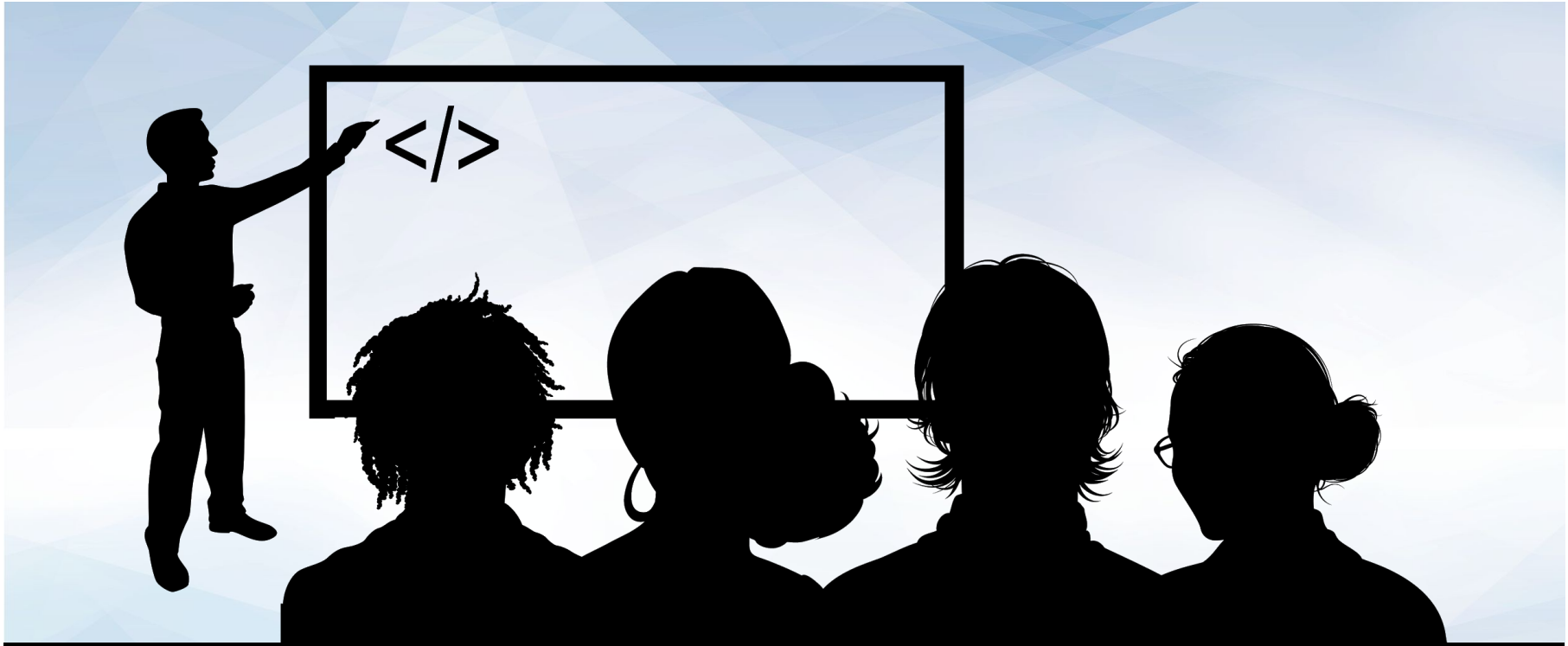


Time’s Up! Let’s Review.

Countdown timer

15:00

(with alarm)



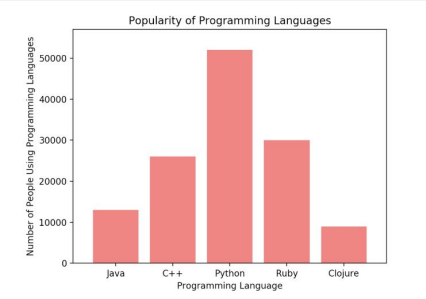
Instructor Demonstration

Different Plots

Matplotlib: Not Just for Line Plots!

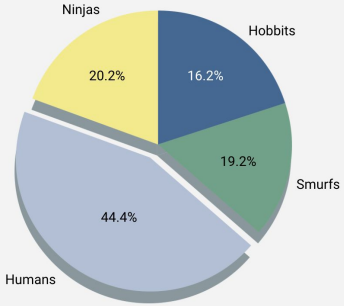
01 Bar Charts

Useful for comparing different entities to one another



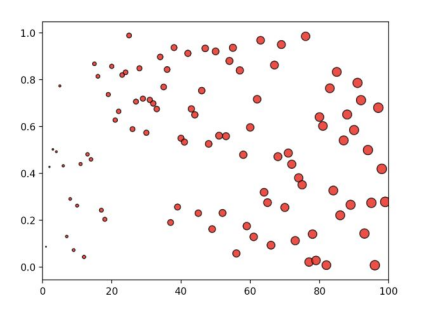
02 Pie Charts

Useful for demonstrating different elements of a complete dataset

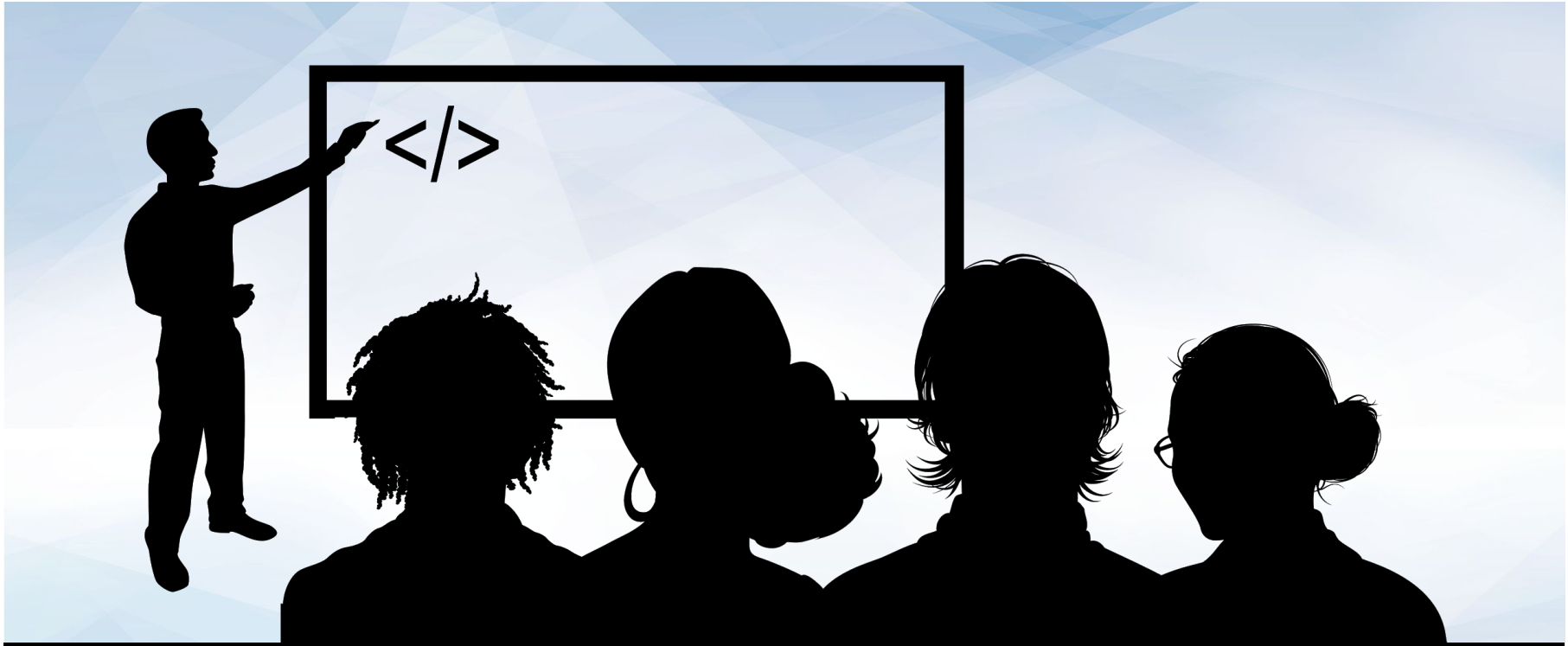


03 Scatter Plots

Useful for displaying where values fall in respect to two factors



It’s **very** important to choose the right plot for a given dataset!



Instructor Demonstration

Bar Charts

Bar Charts Help to Visualize Univariate Data

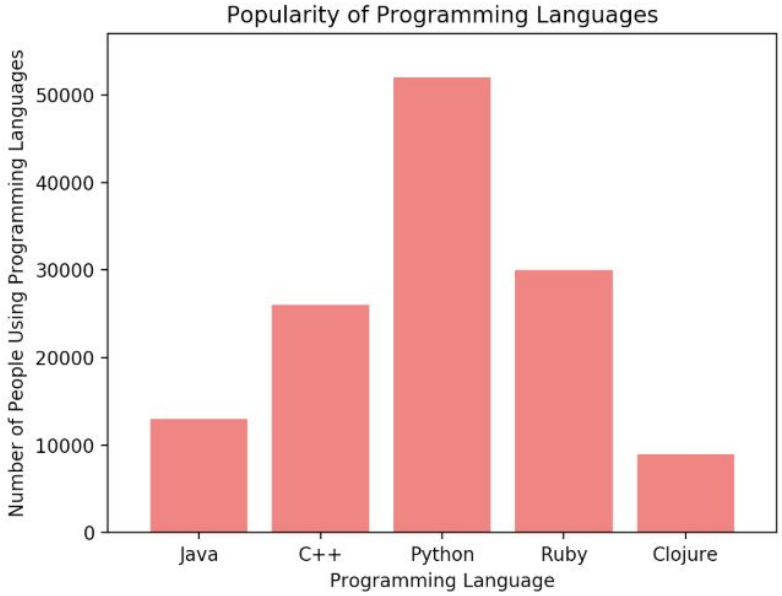
- **Univariate data** refers to data with **one** variable, or one type of measurement.

  Examples:

  - Amount of rainfall, in inches
  - Number of votes in a poll
  - Number of people per category

- Bar charts are particularly useful when a single variable is being counted multiple times.

- Another way to think of this is categorical data.

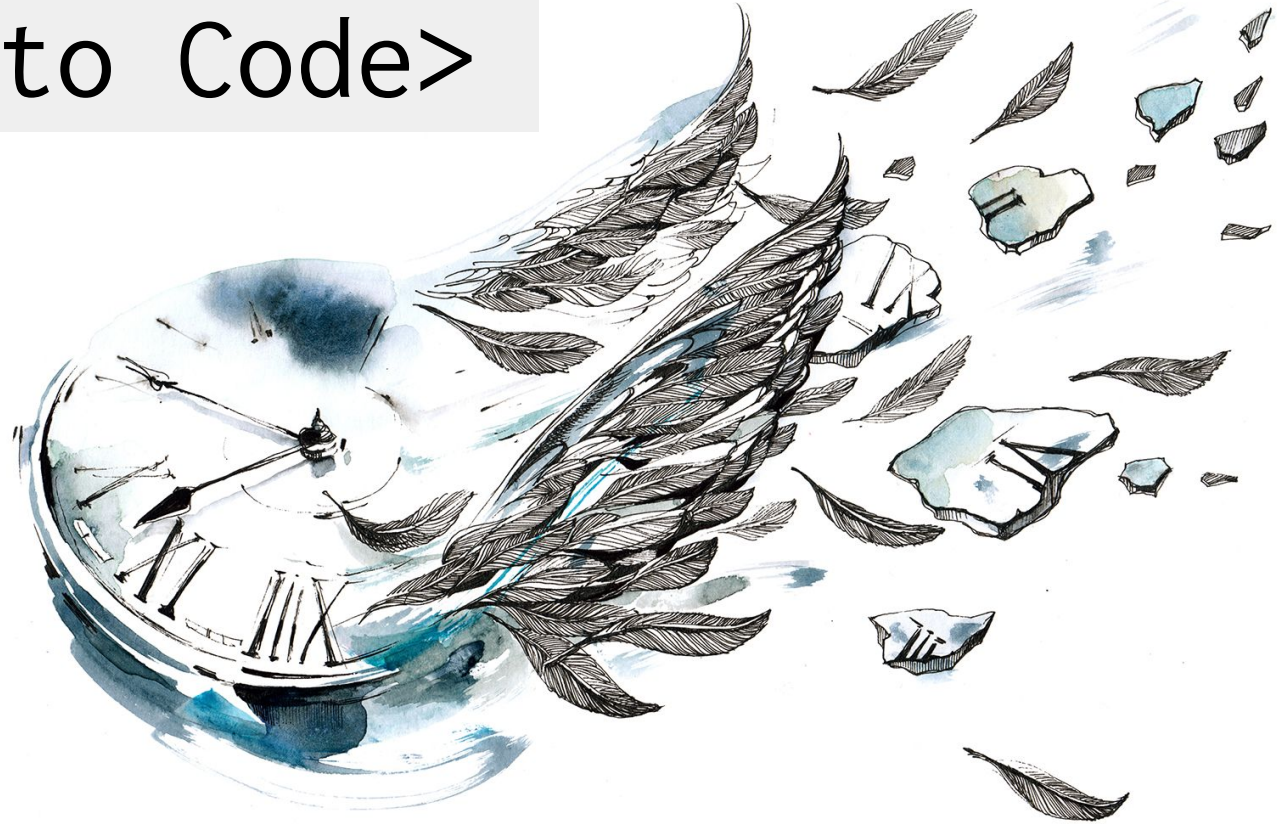


Bar charts are **NOT** effective for visualizing **bivariate** data.

- Bivariate data refers to data with **two** variables. Anything you can plot as a line or scatter plot is bivariate data.
- Example: A dataset comparing the number of ice cream bars sold versus daily temperature.

Think of other examples where a bar chart would be effective.

<Time to Code>



Activity: Bars Bar Chart

In this activity, you will create a bar chart that visualizes the density of bars within major U.S. cities.

(Instructions sent via Slack.)

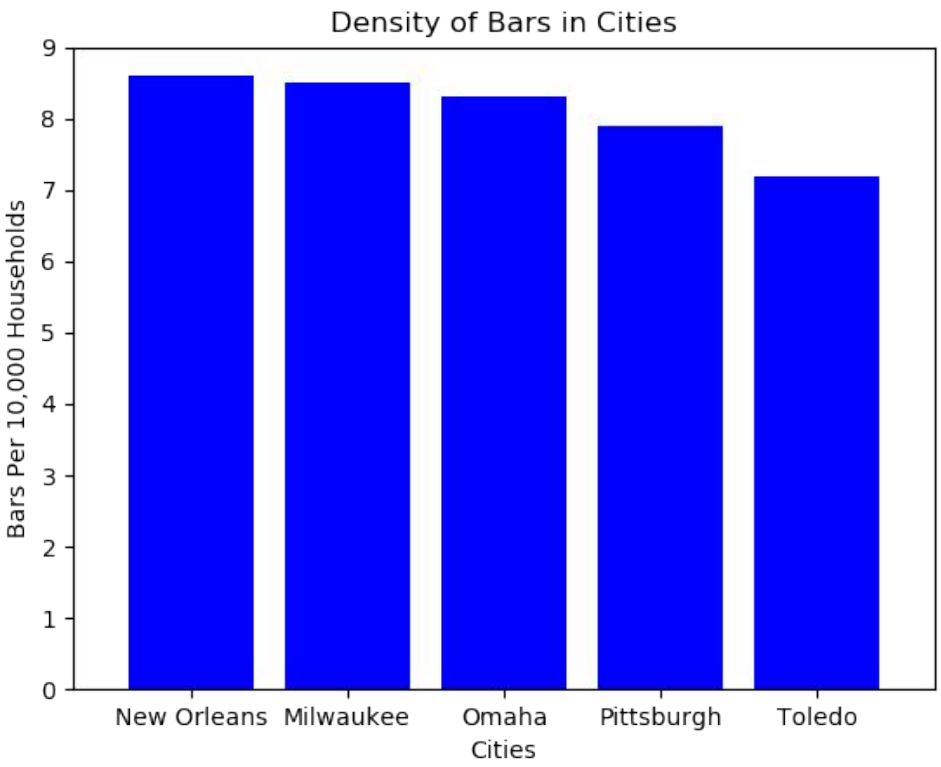
Suggested Time:
10 Minutes

Bars Bar Chart Instructions

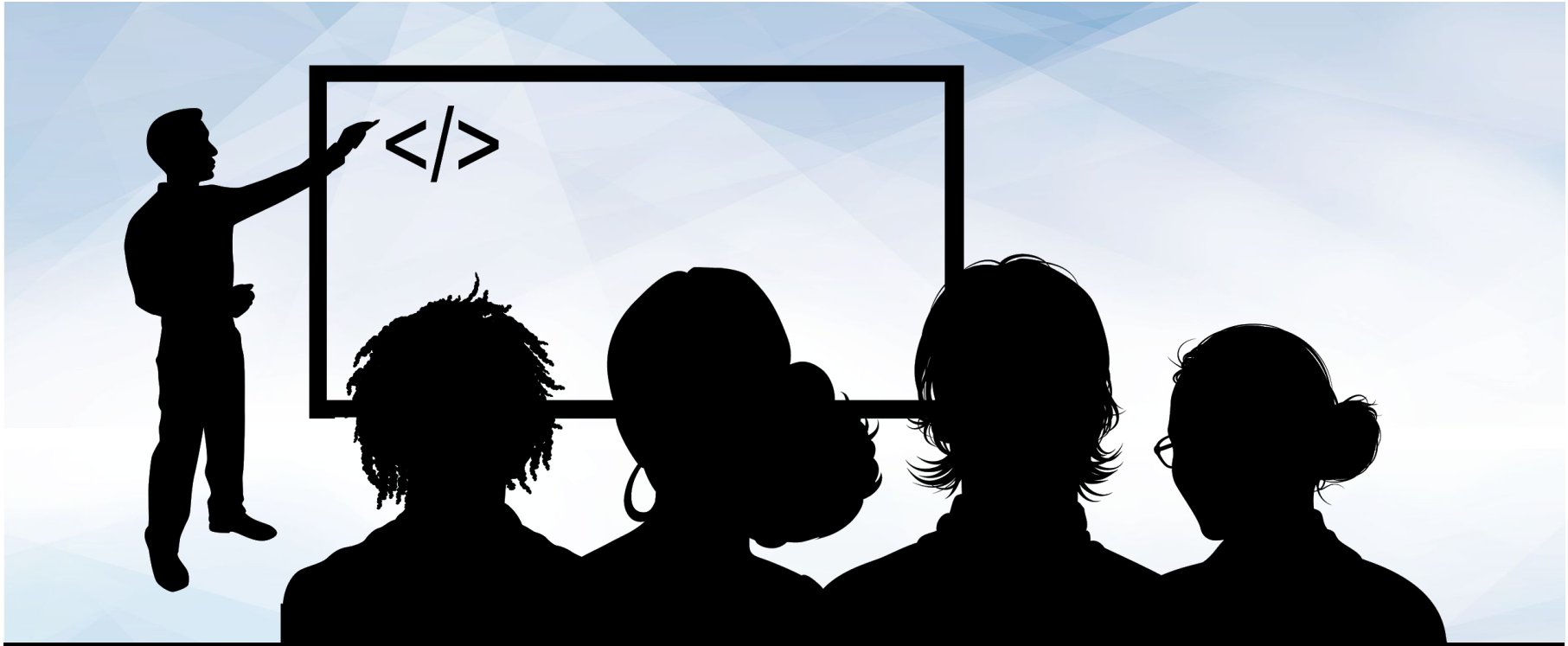
Using the provided starter code in your folders, recreate the figure as shown.

File:

```
Unsolved/py_bars.ipynb
```



Time’s Up! Let’s Review.

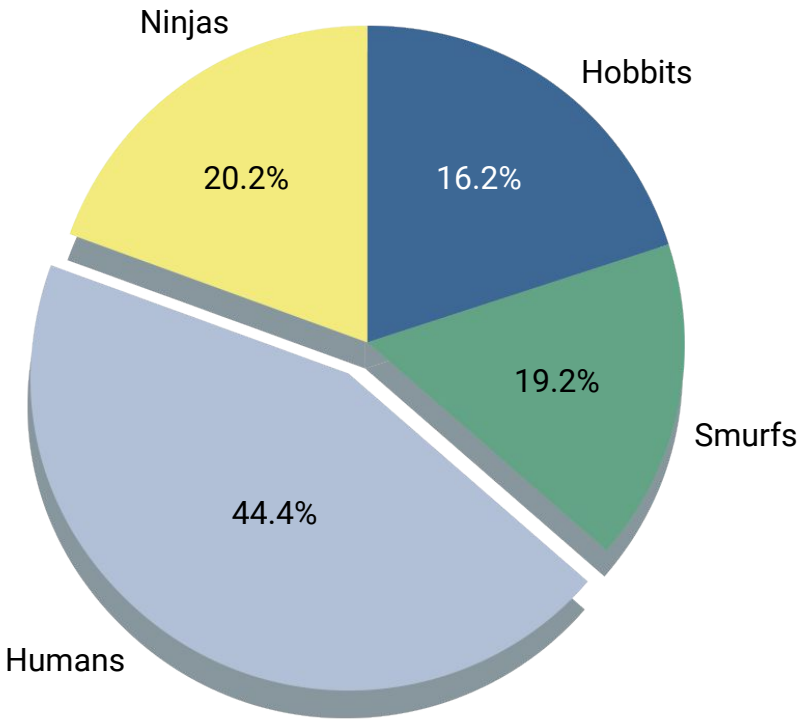


Instructor Demonstration

Pie Charts

Pie Charts Help Visualize Simple Categorical Data

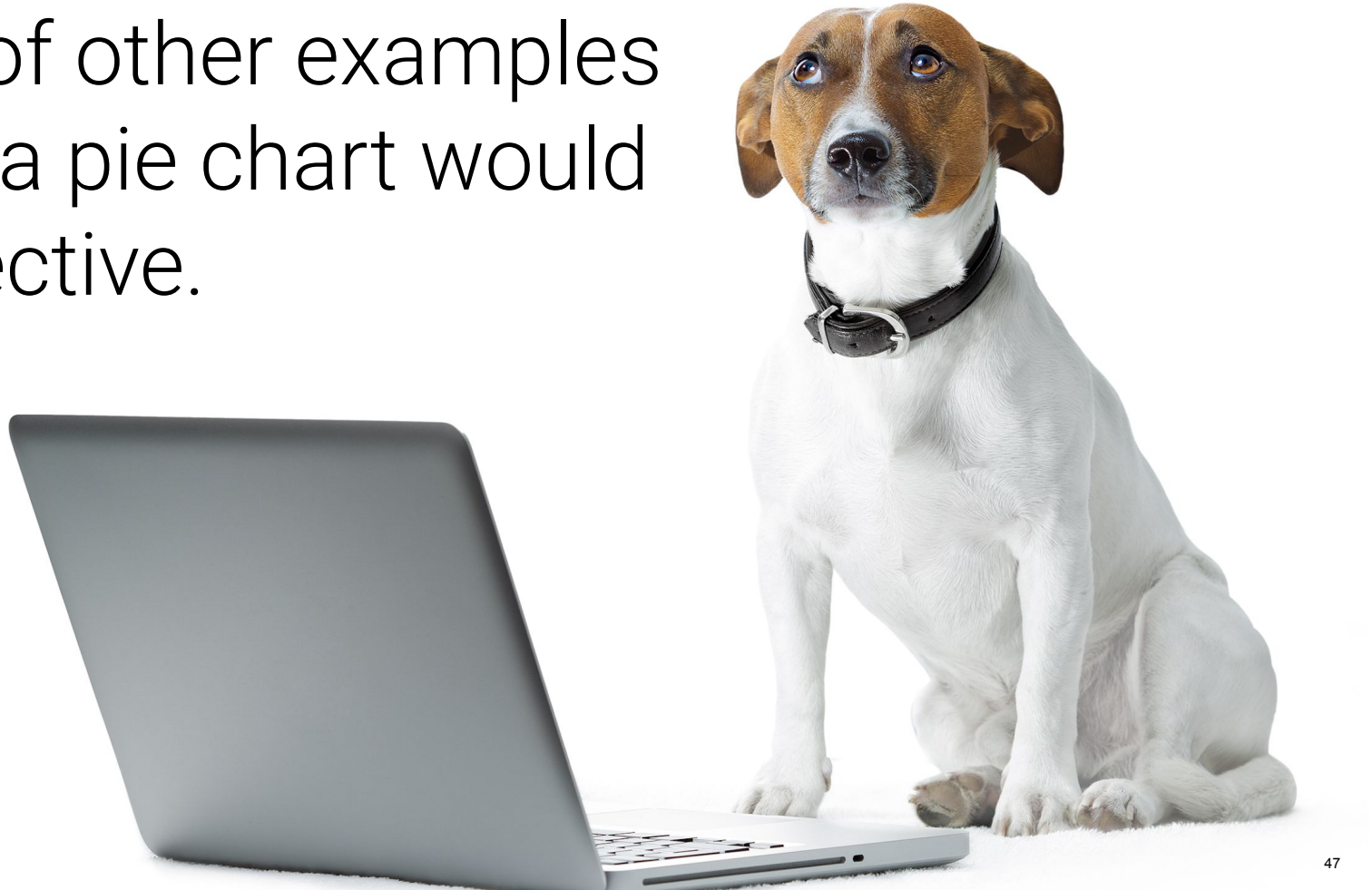
- Pie charts are great for visualizing data that is percentages, or proportions. Examples:
  - Proportion of Democrat versus Republican versus independent voters
  - Percentage of children's favorite story characters
  - Distribution of left-handed versus right-handed pitchers in baseball
- Fewer categories increase the effectiveness of a pie chart.



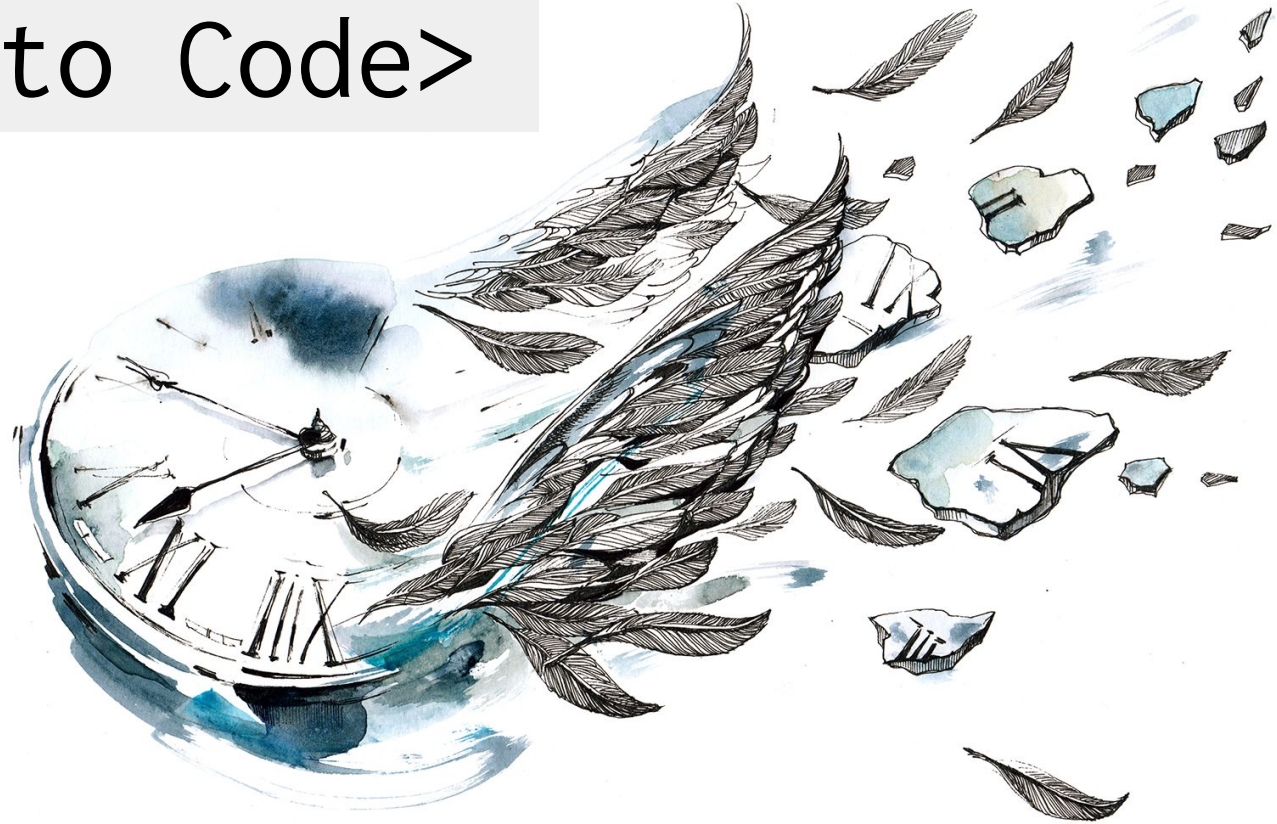
Pie charts are NOT effective for large or multivariate data.

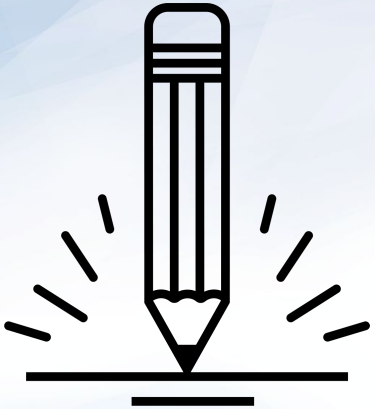
- With more than ~10 categories, pie charts become too crowded and lose effectiveness.
- Like bar charts, pie charts are only effective for visualizing univariate data.
- When in doubt, just use a bar chart.

Think of other examples where a pie chart would be effective.



<Time to Code>





Activity: Pies Pie Chart

In this activity, you will create a pie chart that visualizes favorite pies in the United States.

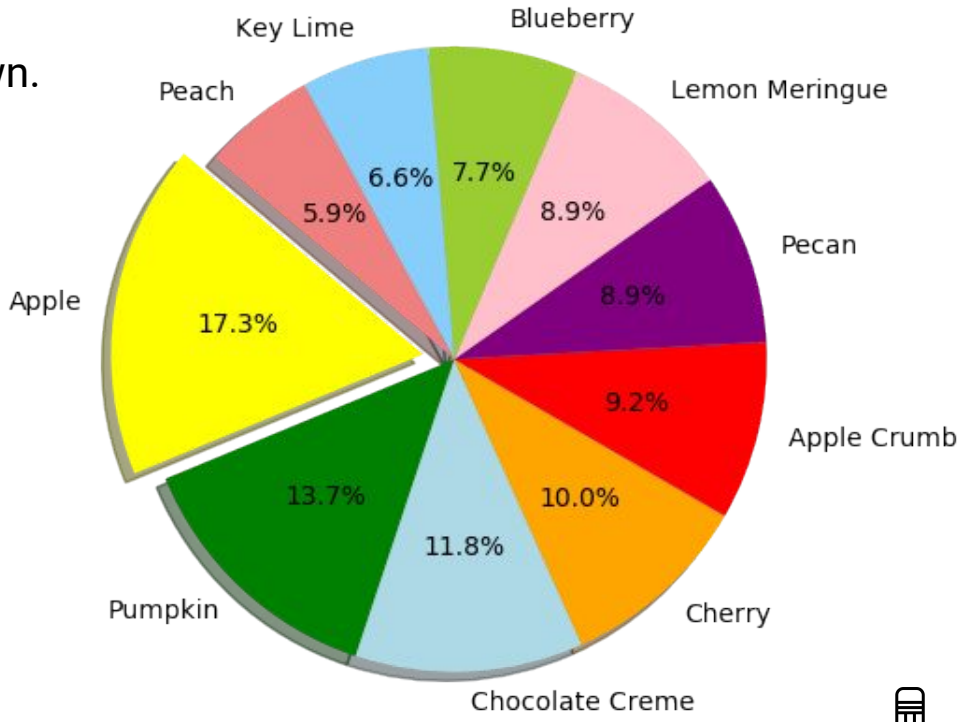
(Instructions sent via Slack.)

Suggested Time:
10 Minutes

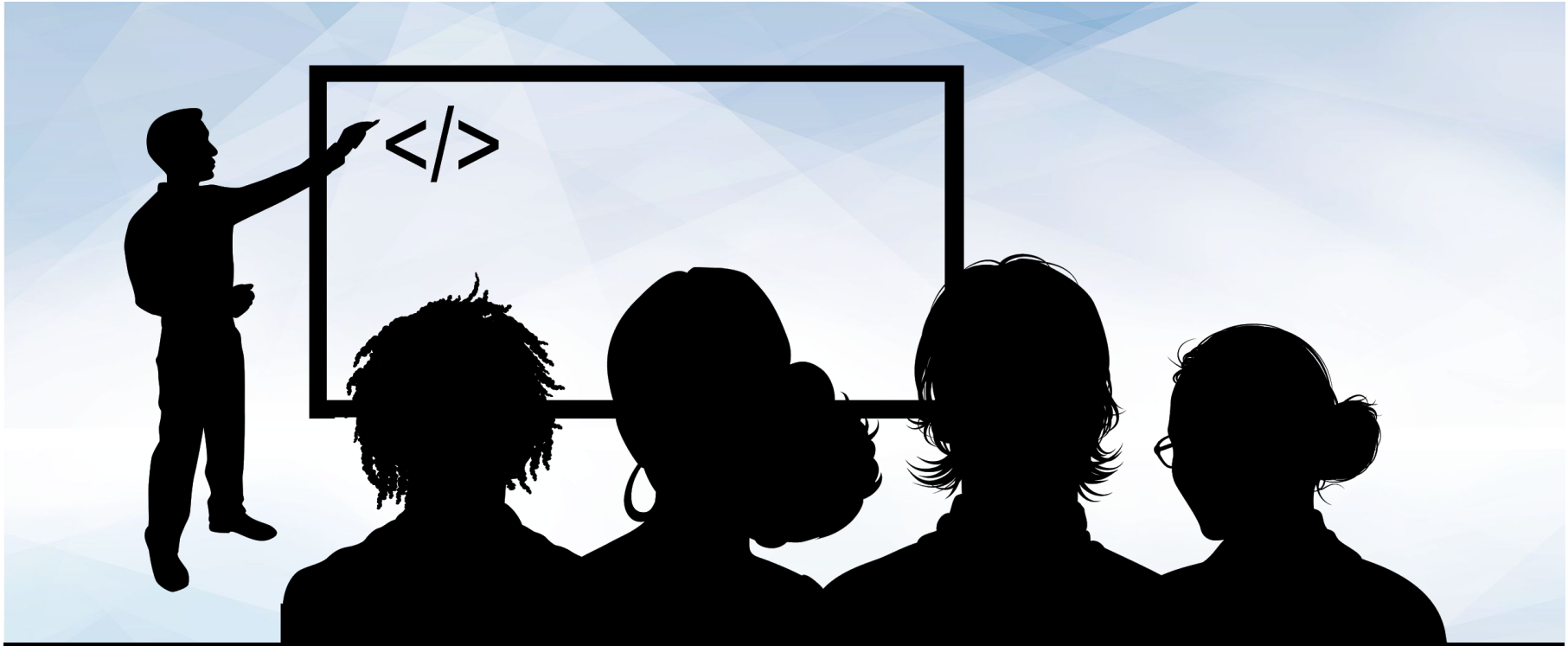
Pies Pie Chart Instructions

- Using the provided starter code in your folders, recreate the figure as shown.

- File:
  `10_Stu_PyPies/Unsolved/py_pie.ipynb`



Time’s Up! Let’s Review.

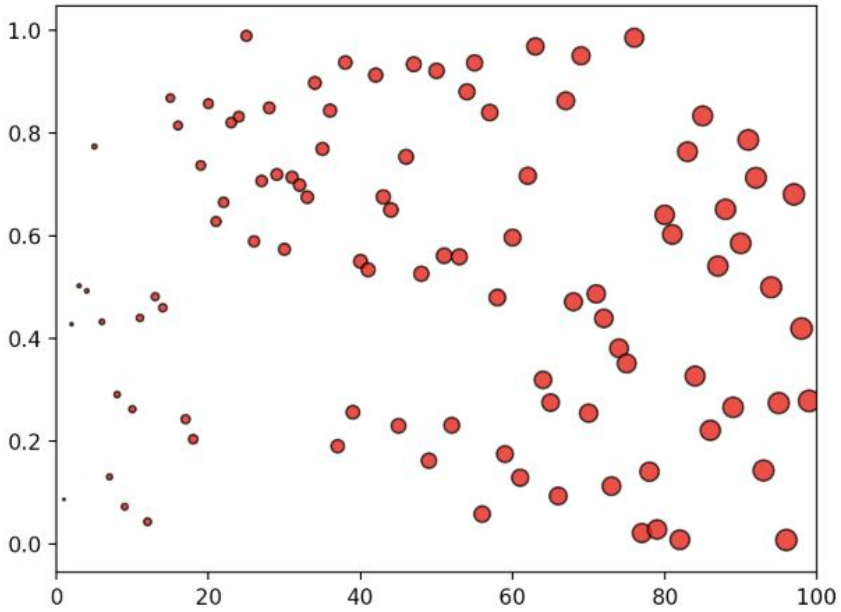


Instructor Demonstration

Scatter Plots

Scatter Plots = Powerful Visualizations for Bivariate Data

- Bivariate data refers to data with two variables.
  - Each data point is a combination of two variables.
  - Anything plotted on an *x*- and *y*-axis is bivariate data.
  - Example: The amount of ice cream sold per daily temperature
- Scatter plots can also be used for multi-variate data by altering the size of the points
- Scatter plots are helpful for visualizing large datasets (i.e., thousands of data points).
- Scatter plots are frequently used to visualize clustering in a dataset.

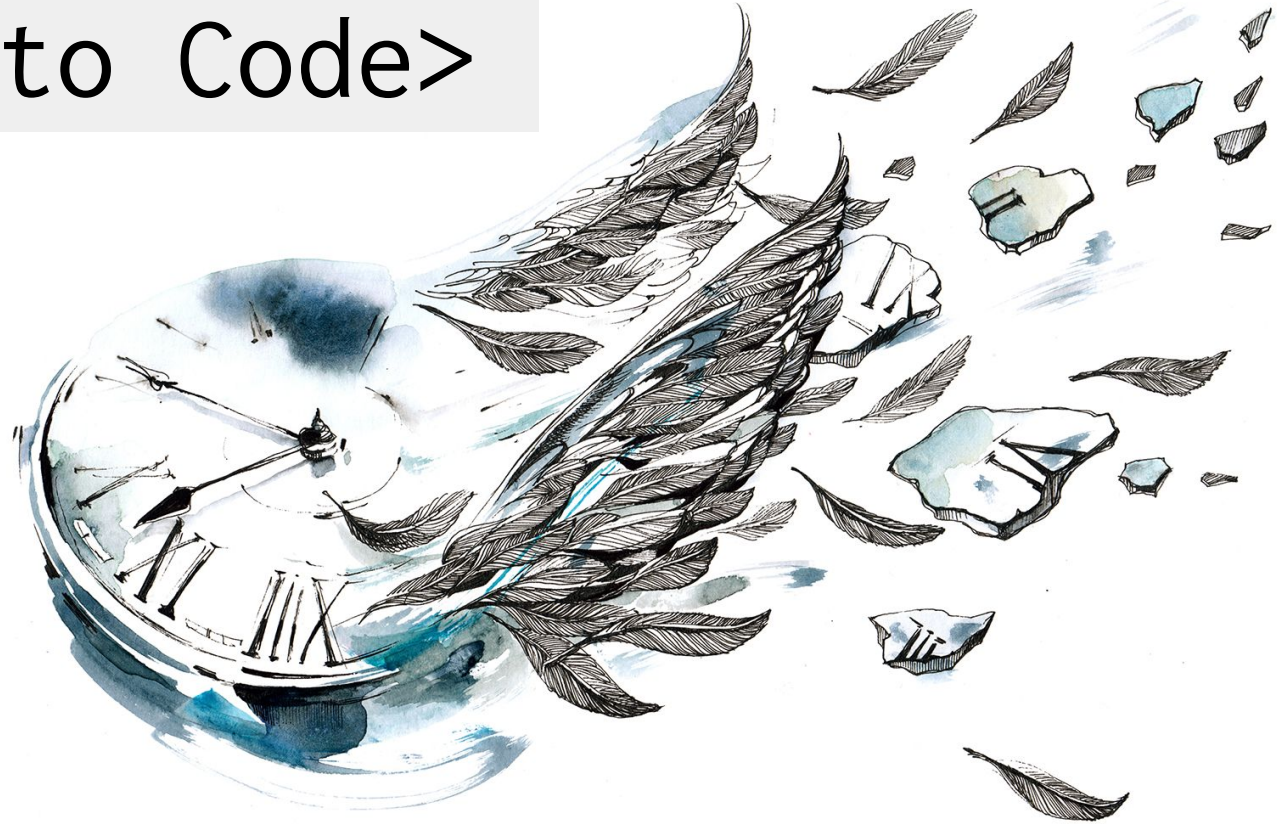


Scatter plots are NOT effective for continuous measurements.

- When data is continuous, we'll often want to interpolate between measurements.
  - The most common continuous data is time series.
- Scatter plots visualize "scattered" data, so interpolation is almost impossible.
- Line plots allow the audience to read between the data points.

Think of other examples where a scatter plot would be effective.

<Time to Code>



Activity: Scatter Py

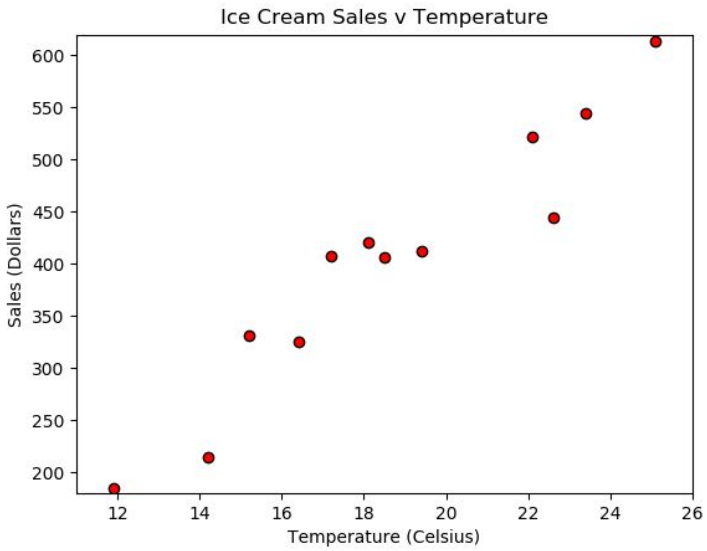
In this activity, you will create a scatter plot that visualizes ice cream sales in comparison to temperature increases.

(Instructions sent via Slack.)

Suggested Time:
10 Minutes

Scatter Py Instructions

- Using the provided starter code in your folders, recreate the figure as shown.
- File: `Unsolved/ice_cream_sales.ipynb`

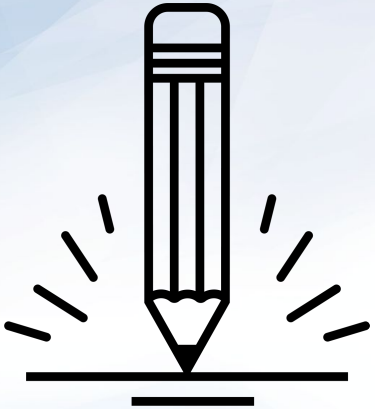


Bonus

Create a new list called `scoop_price`, fill it with values, and then set it so that the size of the dots are set according to those values.

Time’s Up! Let’s Review.

We're almost there!
Just one more activity!



Activity: Average Rainfall

In this activity, you will create a bar chart that shows the average rainfall in different states by importing data from a CSV file.

(Instructions sent via Slack.)

Suggested Time:
15 Minutes

Average Rainfall Instructions

- Look at the raw data in your Resources folder. This dataset contains the average rainfall per state in any given year.
  - File: `Resources/avg_rain_state.csv`
- Using the file provided as a starter, generate a plot that shows the average rainfall per state.
  - File: `Unsolved/avg_state_rain.ipynb`

Hints:

- Think critically about the different plots we discussed today. Ask yourself which type of plot summarizes the data most effectively.
- Be sure to add a title, axis labels, and any other aesthetics that may help make the visualization more effective.

Time’s Up! Let’s Review.

Questions?