Merging and Data Cleaning

Data Boot Camp

Lesson 4.3

Class Objectives

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

- Merge DataFrames and distinguish between inner, outer, left, and right merges.
- Slice data by using the `cut()` method, and create new values based on a series of bins.
- Fix Python/Pandas bugs within Jupyter Notebook.
- Use Google to explore additional Pandas functionality.

Instructor Demonstration

Merging DataFrames

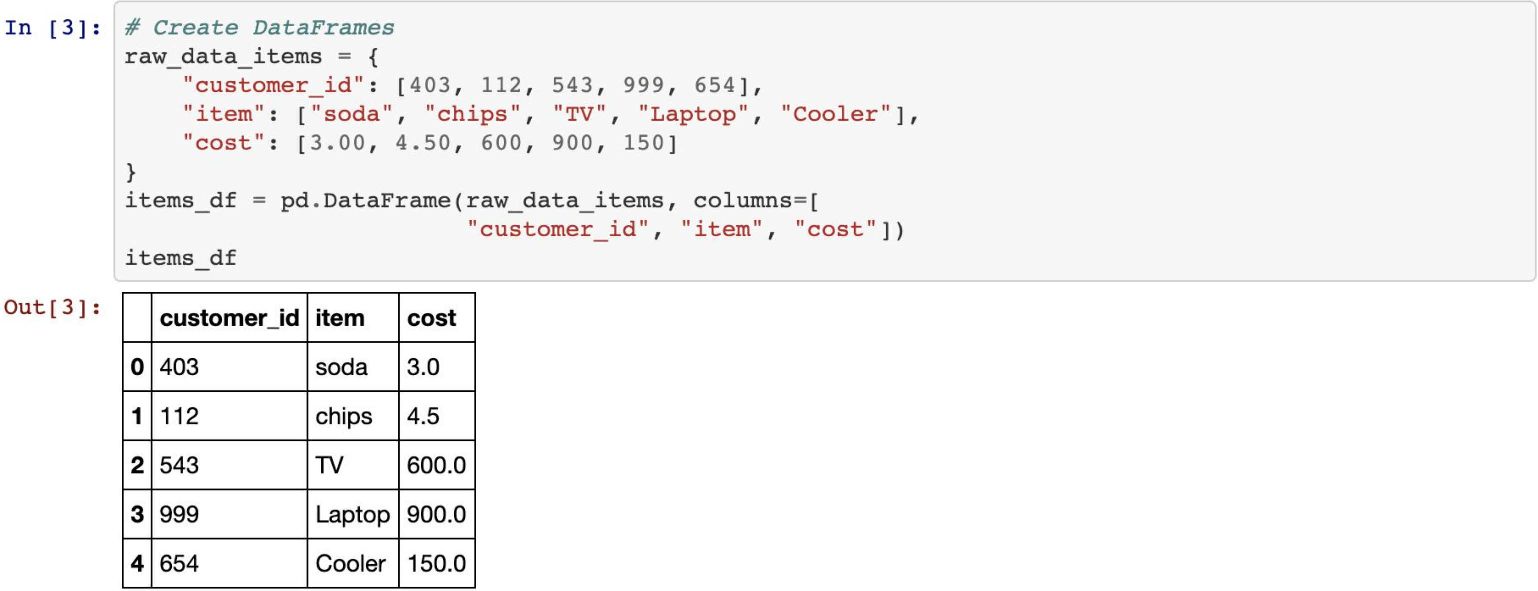
Merging DataFrames

What’s Merging?

- Sometimes, an analyst will receive data split across multiple tables and sources.
- Working across multiple tables is error-prone and confusing.
- **Merging** is the process of combining two tables based on shared data.
- Shared data can be an identical column in both tables or a shared index.
- In Pandas, we can merge separate DataFrames by using the `pd.merge()` method.

Merging DataFrames: Inner Joins

An inner join is the default method for combining DataFrames by using `pd.merge()`. It only returns data whose values match. Rows that do not include matching data will be dropped from the combined DataFrame.



In [3]:

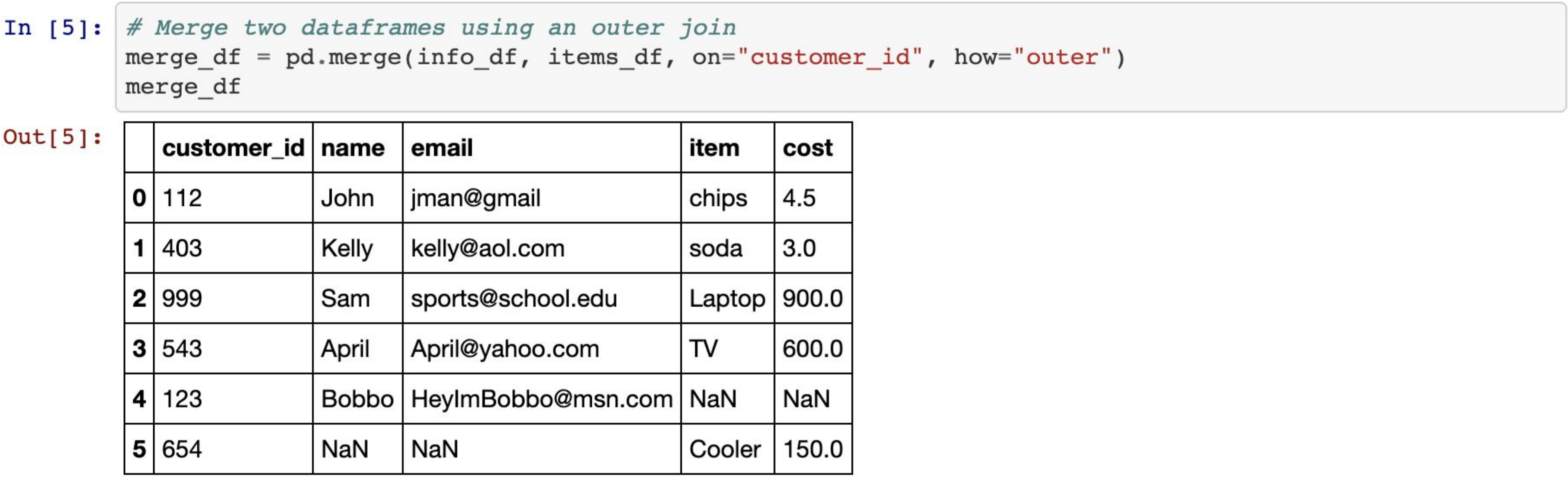
```
# Create DataFrames
raw_data_items = {
    "customer_id": [403, 112, 543, 999, 654],
    "item": ["soda", "chips", "TV", "Laptop", "Cooler"],
    "cost": [3.00, 4.50, 600, 900, 150]
}
items_df = pd.DataFrame(raw_data_items, columns=[
                        "customer_id", "item", "cost"])
items_df
```

Out[3]:

	customer_id	item	cost
0	403	soda	3.0
1	112	chips	4.5
2	543	TV	600.0
3	999	Laptop	900.0
4	654	Cooler	150.0

Merging DataFrames: Outer Joins

Outer joins combine the DataFrames whether or not any of the rows match. They must be declared as a parameter within the `pd.merge()` method by using the syntax `how="outer"`.



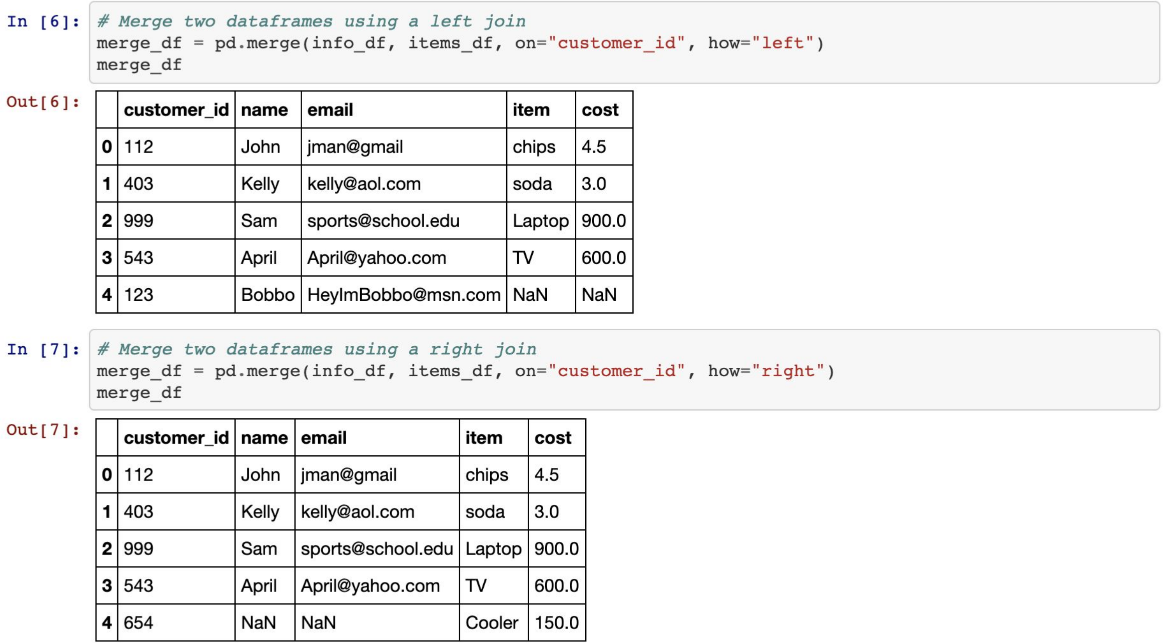
```
In [5]: # Merge two dataframes using an outer join
        merge_df = pd.merge(info_df, items_df, on="customer_id", how="outer")
        merge_df
```

Out[5]:

	customer_id	name	email	item	cost
0	112	John	jman@gmail	chips	4.5
1	403	Kelly	kelly@aol.com	soda	3.0
2	999	Sam	sports@school.edu	Laptop	900.0
3	543	April	April@yahoo.com	TV	600.0
4	123	Bobbo	HeyImBobbo@msn.com	NaN	NaN
5	654	NaN	NaN	Cooler	150.0

Merging DataFrames: Right and Left Joins

These joins protect the data contained within one DataFrame, like an outer join does, while also dropping the rows with null data from the other DataFrame.



In [6]:
```
# Merge two dataframes using a left join
merge_df = pd.merge(info_df, items_df, on="customer_id", how="left")
merge_df
```

Out[6]:

	customer_id	name	email	item	cost
0	112	John	jman@gmail	chips	4.5
1	403	Kelly	kelly@aol.com	soda	3.0
2	999	Sam	sports@school.edu	Laptop	900.0
3	543	April	April@yahoo.com	TV	600.0
4	123	Bobbo	HeyImBobbo@msn.com	NaN	NaN

In [7]:
```
# Merge two dataframes using a right join
merge_df = pd.merge(info_df, items_df, on="customer_id", how="right")
merge_df
```

Out[7]:

	customer_id	name	email	item	cost
0	112	John	jman@gmail	chips	4.5
1	403	Kelly	kelly@aol.com	soda	3.0
2	999	Sam	sports@school.edu	Laptop	900.0
3	543	April	April@yahoo.com	TV	600.0
4	654	NaN	NaN	Cooler	150.0

Activity: Census Merging

In this activity, you will merge the two Census datasets that we created in the last class, and then do a calculation and sort the values.

Suggested Time:

20 minutes

Activity: Census Merging

Instructions

Read in both of the CSV files, and print out their DataFrames.

Perform an inner merge that combines both DataFrames on the `Year` and `State` columns.

Create a DataFrame that filters the data on only 2019.

Add a new column that calculates the `Poverty Rate`.

Sort the data by `Poverty Rate` and `Average Per Capita Income` by `County`, highest to lowest, to find the `state` or `territory` with the highest poverty rate.

Print out the data for the `state` or `territory` with the highest poverty rate.

Bonus

Print out the data for the `state` or `territory` with the lowest poverty rate with one line of code.

Time’s Up! Let’s Review.

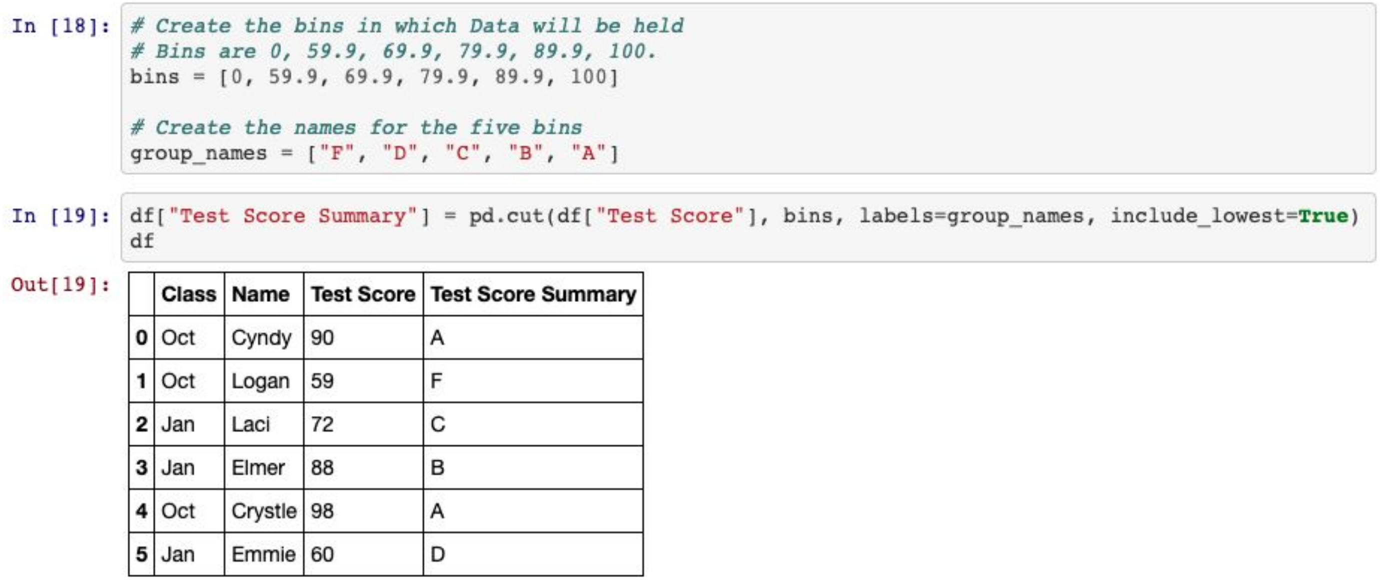
Instructor Demonstration

Binning Data

The binning method places values into groups to enable more vigorous dataset customization.

Binning Data: `pd.cut()`

Use `pd.cut()` when you need to segment and sort data values into bins. This function is also useful for going from a continuous variable to a categorical variable.



In [18]:
```
# Create the bins in which Data will be held
# Bins are 0, 59.9, 69.9, 79.9, 89.9, 100.
bins = [0, 59.9, 69.9, 79.9, 89.9, 100]

# Create the names for the five bins
group_names = ["F", "D", "C", "B", "A"]
```

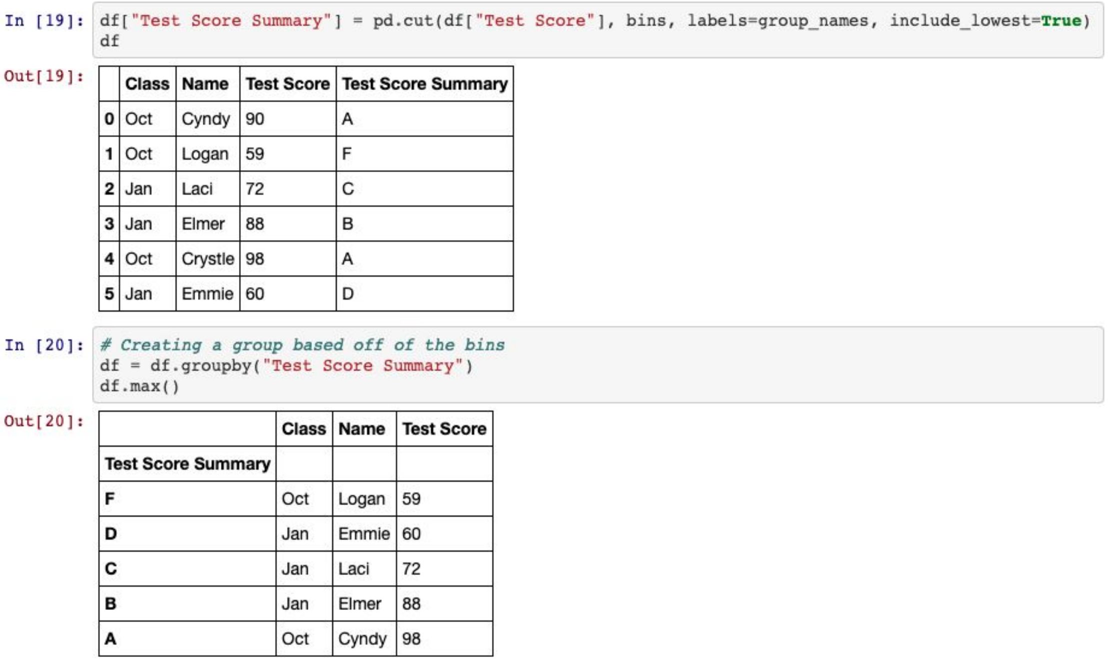
In [19]:
```
df["Test Score Summary"] = pd.cut(df["Test Score"], bins, labels=group_names, include_lowest=True)
df
```

Out[19]:

	Class	Name	Test Score	Test Score Summary
0	Oct	Cyndy	90	A
1	Oct	Logan	59	F
2	Jan	Laci	72	C
3	Jan	Elmer	88	B
4	Oct	Crystle	98	A
5	Jan	Emmie	60	D

Binning Data

Binning is so powerful because, after creating and applying these bins, we can group the DataFrame according to those values, and then conduct a higher-level analysis.



```
In [19]: df["Test Score Summary"] = pd.cut(df["Test Score"], bins, labels=group_names, include_lowest=True)
         df
```

Out[19]:

	Class	Name	Test Score	Test Score Summary
0	Oct	Cyndy	90	A
1	Oct	Logan	59	F
2	Jan	Laci	72	C
3	Jan	Elmer	88	B
4	Oct	Crystle	98	A
5	Jan	Emmie	60	D

```
In [20]: # Creating a group based off of the bins
         df = df.groupby("Test Score Summary")
         df.max()
```

Out[20]:

	Class	Name	Test Score
Test Score Summary			
F	Oct	Logan	59
D	Jan	Emmie	60
C	Jan	Laci	72
B	Jan	Elmer	88
A	Oct	Cyndy	98

Activity: Binning Movies

In this activity, you will test your binning skills by creating bins for movies based on their IMDb user vote count.

Suggested Time:

25 minutes

Activity: Binning Movies

Instructions

Read in the CSV file provided, and print it to the screen.

Find the minimum `"IMDB user vote count"` and maximum `"IMDB user vote count"`.

Using the minimum and maximum `"votes"` as a reference, create 9 bins to slice the data into.

Create a new column called `"IMDB User Votes Group"`, and fill it with the values collected through your slicing.

Group the DataFrame based on the values within `"IMDB User Votes Group"`.

Find out how many rows fall into each group before finding the averages for `"RottenTomatoes"`, `"RottenTomatoes_User"`, `"Metacritic"`, `"Metacritic_User"`, and `"IMDB"`.

Time’s Up! Let’s Review.

Instructor Demonstration

Mapping

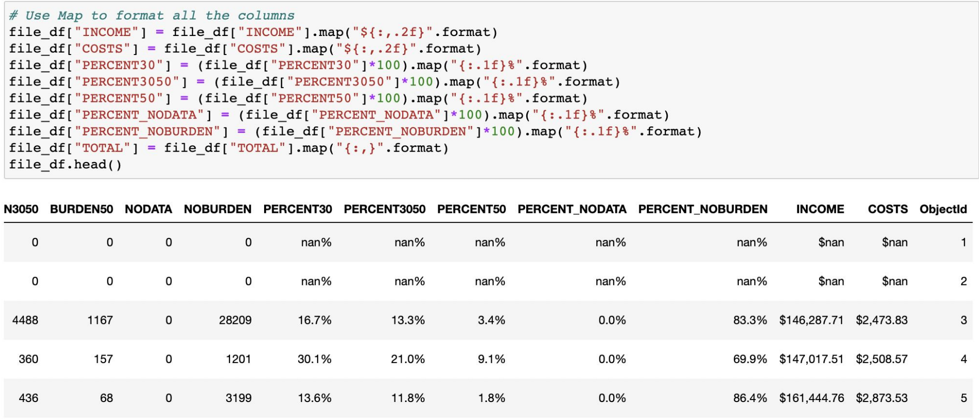
Similar to Excel’s number formats, Pandas unlocks the same functionality by using the `df.map()` method, which allows users to style entire columns at once.

Mapping

`df[<COLUMN>].map(<FORMAT STRING>.format)` enables users to modify the styling of an entire column.

To convert values into a typical dollar format, use `"${:.2f}"`. This places a dollar sign before the value, which has been rounded to two decimal places.

Using `"{:,}"` will split a number up so that it uses comma notation.



```
# Use Map to format all the columns
file_df["INCOME"] = file_df["INCOME"].map("${:,.2f}".format)
file_df["COSTS"] = file_df["COSTS"].map("${:,.2f}".format)
file_df["PERCENT30"] = (file_df["PERCENT30"]*100).map("{:.1f}%".format)
file_df["PERCENT3050"] = (file_df["PERCENT3050"]*100).map("{:.1f}%".format)
file_df["PERCENT50"] = (file_df["PERCENT50"]*100).map("{:.1f}%".format)
file_df["PERCENT_NODATA"] = (file_df["PERCENT_NODATA"]*100).map("{:.1f}%".format)
file_df["PERCENT_NOBURDEN"] = (file_df["PERCENT_NOBURDEN"]*100).map("{:.1f}%".format)
file_df["TOTAL"] = file_df["TOTAL"].map("{:,}".format)
file_df.head()
```

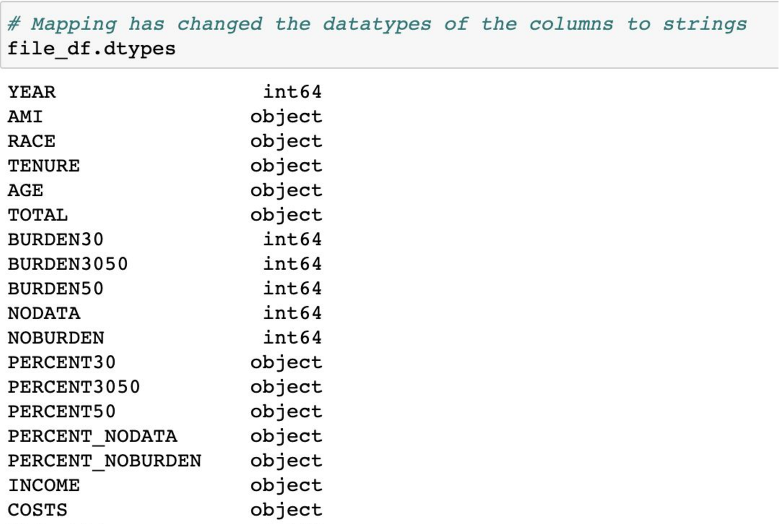
N3050	BURDEN50	NODATA	NOBURDEN	PERCENT30	PERCENT3050	PERCENT50	PERCENT_NODATA	PERCENT_NOBURDEN	INCOME	COSTS	ObjectId
0	0	0	0	nan%	nan%	nan%	nan%	nan%	$nan	$nan	1
0	0	0	0	nan%	nan%	nan%	nan%	nan%	$nan	$nan	2
4488	1167	0	28209	16.7%	13.3%	3.4%	0.0%	83.3%	$146,287.71	$2,473.83	3
360	157	0	1201	30.1%	21.0%	9.1%	0.0%	69.9%	$147,017.51	$2,508.57	4
436	68	0	3199	13.6%	11.8%	1.8%	0.0%	86.4%	$161,444.76	$2,873.53	5

Mapping

Format mapping only really works once. It will return errors if the same code is run multiple times without restarting the kernel. Therefore, formatting is usually applied near the end of an application.

It will also format NaN values, so it is a good idea to run a `.fillna()` or .`dropna()` to avoid formatting null values.

Format mapping also can change the data type of a column, so all calculations should be handled before modifying the formatting.



```
# Mapping has changed the datatypes of the columns to strings
file_df.dtypes
```

```
YEAR                  int64
AMI                  object
RACE                 object
TENURE               object
AGE                  object
TOTAL                object
BURDEN30              int64
BURDEN3050            int64
BURDEN50              int64
NODATA                int64
NOBURDEN              int64
PERCENT30            object
PERCENT3050          object
PERCENT50            object
PERCENT_NODATA       object
PERCENT_NOBURDEN     object
INCOME               object
COSTS                object
```

Activity: Cleaning Crowdfunding

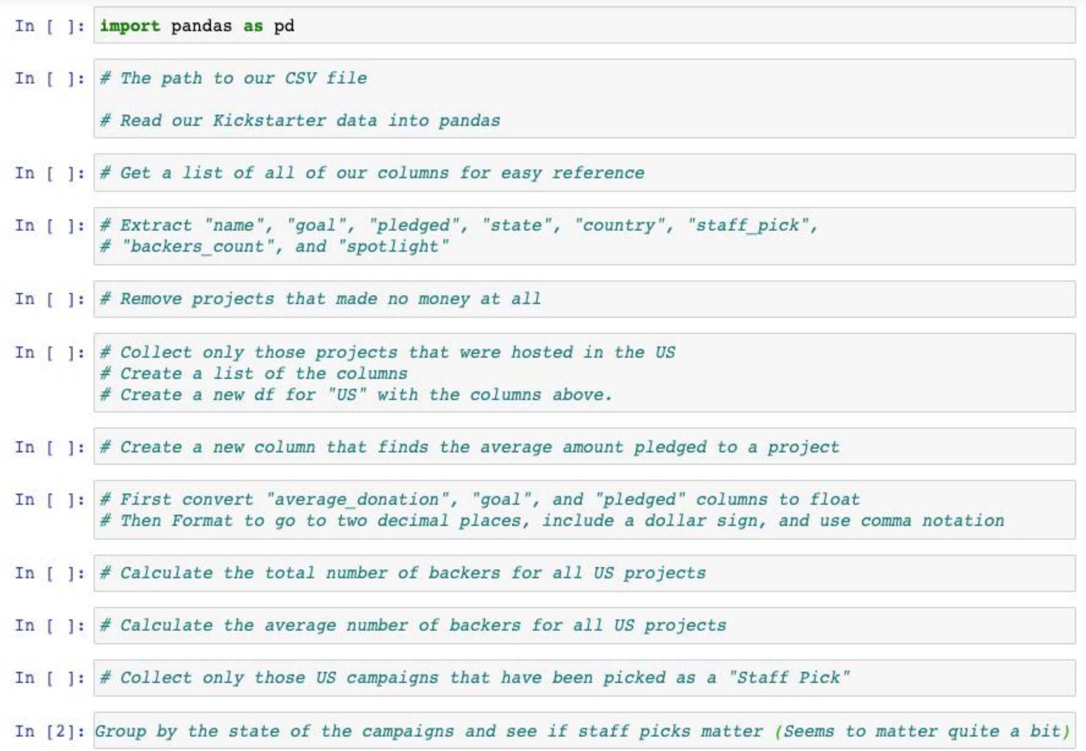
In this activity, you will take a dataset similar to your first homework, clean it up, and format it.

Suggested Time:

30 minutes

Activity: Cleaning Crowdfunding

The instructions for this activity are contained within the Jupyter Notebook.



```
In [ ]: import pandas as pd

In [ ]: # The path to our CSV file

        # Read our Kickstarter data into pandas

In [ ]: # Get a list of all of our columns for easy reference

In [ ]: # Extract "name", "goal", "pledged", "state", "country", "staff_pick",
        # "backers_count", and "spotlight"

In [ ]: # Remove projects that made no money at all

In [ ]: # Collect only those projects that were hosted in the US
        # Create a list of the columns
        # Create a new df for "US" with the columns above.

In [ ]: # Create a new column that finds the average amount pledged to a project

In [ ]: # First convert "average_donation", "goal", and "pledged" columns to float
        # Then Format to go to two decimal places, include a dollar sign, and use comma notation

In [ ]: # Calculate the total number of backers for all US projects

In [ ]: # Calculate the average number of backers for all US projects

In [ ]: # Collect only those US campaigns that have been picked as a "Staff Pick"

In [2]: Group by the state of the campaigns and see if staff picks matter (Seems to matter quite a bit)
```

Time’s Up! Let’s Review.

Countdown timer

40:00

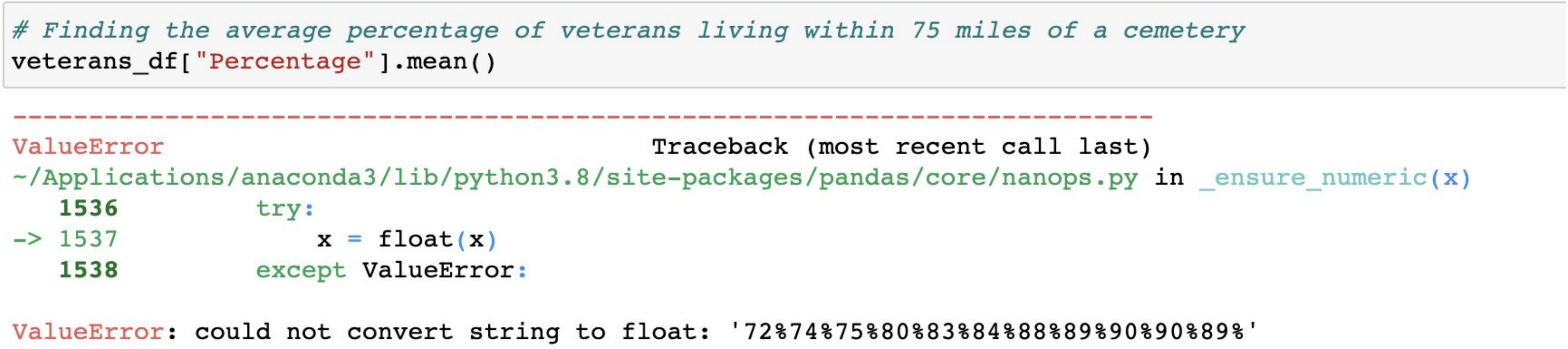
(with alarm)

Instructor Demonstration

Introduction to Bug Fixing

Bug-Fixing Bonanza

An error is returned as the application attempts to collect the average value within the `Percentage` column.



```python
# Finding the average percentage of veterans living within 75 miles of a cemetery
veterans_df["Percentage"].mean()
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
~/Applications/anaconda3/lib/python3.8/site-packages/pandas/core/nanops.py in _ensure_numeric(x)
   1536         try:
-> 1537             x = float(x)
   1538         except ValueError:

ValueError: could not convert string to float: '72%74%75%80%83%84%88%89%90%90%89%'
```

Bug-Fixing Bonanza

The first step: Keep calm.

Bugs happen all the time, and they are rarely the end of the world. In fact, most bugs that you’ll encounter are simple enough to solve as long as you know how and where to look for the solution.

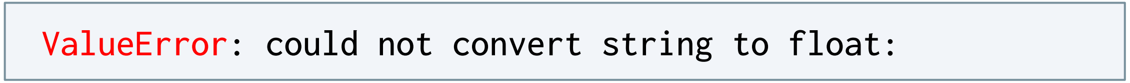
Bug-Fixing Bonanza

The second step: Figure out what the bug is and where it's located.

- Jupyter Notebook makes it easy to find the erroneous block of code because the error will always be returned in the space following the erroneous cell.

- Unfortunately, Pandas is not known for returning clearly understandable error text. In fact, it often returns large blocks of text that can easily confuse those who do not know the library's underlying code. The line following `KeyError:` is generally a good starting point.

- For example, the text following `ValueError:` within the current code lets the programmer know that Pandas cannot convert the string values in the `Percentage` column to floats.



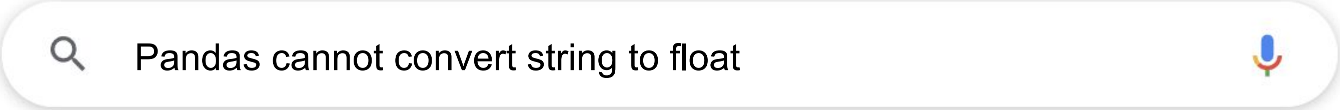
```
ValueError: could not convert string to float:
```

- If the error text isn't entirely clear, it can be helpful to print out variables/columns to the console to uncover the bug's location. For example, printing out the `Percentage` series lets the programmer know that the data type of this Series is an object and not a float.

Bug-Fixing Bonanza

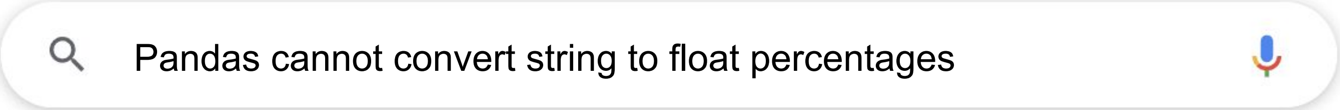
The third step: Research the error online to find solutions.

- The key part to this step is coming up with an accurate way to describe the bug, which can take multiple attempts, but it is a skill that will develop over time.
- Google is the programmer's best friend, as typing in a description of the bug will often bring up links to possible solutions. If not, simply alter the search a bit until a solution is discovered.



Pandas cannot convert string to float

- This particular problem requires the code to drop the percentages within the `Percentage` column, so the search could be more specific and add that information.



Pandas cannot convert string to float percentages

Activity: Bug-Fixing Bonanza

In this activity, you will be provided with a Pandas project containing TONS of bugs. Your job is to take the application and fix it up so that it works properly.

Suggested Time:

35 minutes

Activity: Bug-Fixing Bonanza

Instructions	Search the provided Jupyter notebook, and attempt to fix as many bugs as possible. There are a lot, and the bugs get harder to resolve as the code progresses.
	Once you have finished bug fixing, perform some additional analysis on the provided dataset. What interesting theories and/or conclusions can you draw about bedbugs in New York City? As long as you challenge yourself, bugs will pop up and you'll get more bug-fixing practice.
Hints	After fixing the bugs in each block of code, make sure to run the cell below for an updated error.
	A few new concepts are covered within this Jupyter notebook. The most complex of these concepts is multi-indexing, and it is very likely that this is where many will get held up. Don't worry: Multi-indexing is not in the homework, and it is not required outside of this activity. It is simply an interesting, powerful feature of Pandas.

Time’s Up! Let’s Review.

Questions?