STAT 29000 Projects

Topics: python, R, SQL, and associated tools

Motivation: Practice, practice, practice. Continuing to learn about and use the tools we've addressed this semester will make you faster and more efficient. You will be able to break problems into logical parts, and will discover you get "stuck" less often.

Context: We've explored a wealth of tools in using python, R, & SQL. We are now going to use what you've learned to solve a variety of different problems.

Scope: The scope of this project encompasses all topics covered this semester, namely, python, R, SQL, and associated tools.

Important note:

> Please remember that we assigned 12 projects this semester, and students are able to *drop* their lowest two scores, so that only 10 projects are included in the overall grading. This is the same scheme as we had during the fall semester.
> Also (same as during the fall semester), we will not have a final exam. Instead, we've provided 4 "optional" projects (below), which can be use as substitutes for any of the 10 required projects. You do not need to do any of these optional make-up projects, if you are happy with your grades from 10 out of the regular 12 projects, but you are welcome to do as many of them as you like. (A make-up project is simply used for a grade replacement.)

Important note: For any of the following projects that require Python, please use the `project11` kernel on https://notebook.scholar.rcac.purdue.edu. We cannot guarantee that any other setup will work.

——— Optional Project 1 ———

#python #scraping

Question 1: goodreads

1a. In project 8, we had an `R` function called `guess_id` that, given a space separated query, returned a *guess* at what the imdb id is. We could then use that id to pull up a webpage with information about the respective movie or tv show. The same company (Amazon) owns both imdb.com and goodreads.com, so, unsurprisingly you can do the same sort of thing. Write a function called `guess_id` which accepts a space-separated query and returns a "guess" of the goodreads id as an `int` (use the function `int` to convert to an `int`).

Hints:

1. https://www.goodreads.com/search?q=SEARCH+QUERY is the link to get search results on goodreads.com. If, for example, you wanted to search for "The Eye of the World", you'd need to `GET` the page using https://www.goodreads.com/search?q=the+eye+of+the+world.
2. Similarly to what was done before, assume the search is accurate and the first result is what you are looking for.

3. The number directly following the /show/ part of the url is the id. Any non-numeric text following that number should be discarded. For example, this is the result for "The Eye of the World": https://goodreads.com/book/show/228665.The_Eye_of_the_World?from_search=true&qid=iAY1shIWAs&rank=1. In this case, "228665" is the id. In fact, the following link will work just as well: https://goodreads.com/book/show/228665.

```
guess_id("the eye of the world") # 228665
guess_id("the book thief") # 19063
guess_id("the book theif") # 19063
```

Item(s) to submit:

- A cell in a Jupyter notebook with your function `guess_id`. Include the import commands for the libraries/modules/functions that you used.

1b. It's fun to take advantage of systems that goodreads already has in place. For example, when you visit a books webpage https://www.goodreads.com/book/show/228665 it has a list to the right that shows books that "readers also enjoyed". If you click the link "See similar books…", you will see a list of similar books. Write a function called `suggest` that, given a search query, utilizes our `guess_id` function from (1a), and returns a `pandas` dataframe of the similar books with the following columns: `goodreads_id` (same type of id from (1a)), `title`, `author`, `average_rating`, `number_of_ratings`, and `summary`. The first row should be the book that our function "guessed".

Hints:

1. Similar to how we find a page for an individual book, there appears to be a "similar" id, that finds books that are similar to a certain book. For example, the similar id for "The Eye of the World" is "2008238". To use that id, place it in the url: https://goodreads.com/book/similar/SIMILAR_ID which ends up as https://goodreads.com/book/similar/2008238.

2. You can use the following snippet to extract the id from a url:

```
import re
id = re.search('\/([0-9]+)(?=[^\/]*$)', MY_URL).group(1)
```

3. The `summary` data will be messy. Use the `contents` instead of `string` to access the contents of the summary. Assume that the variable `contents` is the result of accessing the `contents` attribute:

```
# to "flatten" a list: https://stackoverflow.com/questions/2158395/flatten-an-irregular-list-of-lists
import collections
def flatten(l):
    for el in l:
        if isinstance(el, collections.Iterable) and not isinstance(el, (str, bytes)):
            yield from flatten(el)
        else:
            yield el

contents = soup.find(something).contents
summary = ' '.join(flatten(contents))

# the result, "summary", will be sufficient. No need for further cleaning.
```

```
suggest("harry potter and the sorcerer's stone")
# first 6 goodreads_id's: 3, 2767052, 5907, 41865, 17157681, 28187
```

Item(s) to submit:

- A cell in a Jupyter notebook with your function `suggest`. Include the import commands for the libraries/modules/functions that you used.

Question 2: create a question

2a. The entire internet is yours for the taking. Find a website with data you are interested in scraping. You have two options:

1. Write a question that asks the user to write a function to scrape info from the website given an id of some sort. Based on the id, the function will fetch a particular set of data.
2. Write a question that asks the user to scrape a set of data. Unlike option (1), this question should require the scraped data to be of a significant size – not merely a few factoids.

For each option, provide the answer to your question, including any code you used. You only need to do (1) or (2) not both.

Item(s) to submit:

- A markdown cell in a Jupyter notebook with your newly created question.
- A code cell in the same Jupyter notebook with the solution to your question.

2b. Create an interesting plot or graphic using the data you scraped in (2a). If option (1) was chosen, use your function to scrape info for at least 5 "ids", and use the resulting data to create your graphic.

Item(s) to submit:

- A `jpeg` or `png` image with your newly created graphic.
- As you are not limited on *how* you create your graphic, you are not required to submit any code for this question.

——— Optional Project 2 ———

#python #numpy #pandas

Question 1: bears, beets, battlestar galactica

We've provided you with a set of data here and on scholar:

`/class/datamine/data/spring2020/the_office_dialogue.csv`.

Load this data into a `pandas` dataframe called `office_data`.Take a look at the first 5 rows of the data. Each row in the dataframe corresponds to a character's line in an episode (and season). Can we predict if the an episode will be good based on how many lines loved characters have?

First, we need to define "good". Consider the episode good if it's `imdb_rating` is greater or equal to 8.5. Next, we must organize our data. In this question you will be guided through the steps.

1a. *(1 pt)* We want to create a dataframe where every row corresponds to a single, unique episode, and the columns contain information on that unique episode. Information should include `imdb_rating` and the number of lines certain characters have. To do so we will create two dataframes, `office_ratings` and `office_dialogue`, and will merge them.

First, aggregate `office_data` to a dataframe named `office_ratings`. This dataframe should contain the `imdb_rating` for every episode and season. Then, run the code below to reset the index of `office_rating`. The columns should be: `season`, `episode`, and `imdb_rating`.

```
import pandas as pd
import numpy as np

# your code here to obtain office_rating

office_rating = office_rating.reset_index()
```

You can test your dataframe by running the command below:

```
office_rating.shape # (should be (186, 3))
```

Keywords: *pandas: groupby, agg, mean*

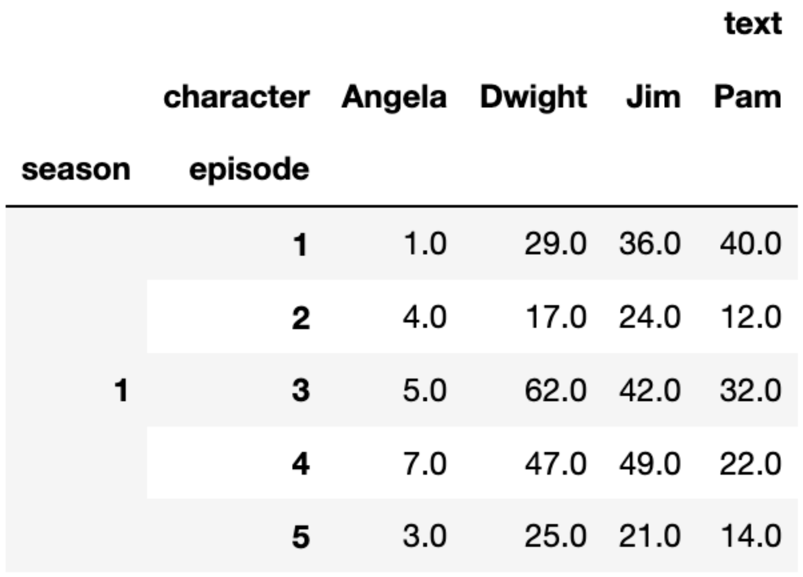
Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to create the `office_rating` dataframe.

1b. *(2 pts)* Create a new dataframe called `office_dialogue` with 6 columns: `season`, `episode`, `Jim`, `Pam`, `Dwight`, and `Angela`. For each `episode` and `season`, we want the corresponding number of lines for each character listed in the `characters_to_evaluate` list provided below:

```
characters_to_evaluate = ['Dwight', 'Jim', 'Pam', 'Angela']
```

Below is a snapshot of what your `office_dialogue` should look like:



		text			
	character	**Angela**	**Dwight**	**Jim**	**Pam**
season	**episode**				
1	**1**	1.0	29.0	36.0	40.0
	2	4.0	17.0	24.0	12.0
	3	5.0	62.0	42.0	32.0
	4	7.0	47.0	49.0	22.0
	5	3.0	25.0	21.0	14.0

Keywords: *pandas: groupby, agg, count, pivot_table, isin*

Hints:

1. Begin by selecting only rows where the character is in the `characters_to_evaluate` list.
2. Group by: `season`, `episode`, and `character`.
3. Aggregate the text by count (see the next **Hint**) to get the number of lines each character has.

4. Pivot the aggregated data using `season` and `episode` as indexes, `character` as column, and `text` (result of (3)) as values.*

Hint: To know how many lines a `character` has in a certain episode and season, count the number of rows with that character. For example, "Jim" has in total 6,268 lines during the 9 seasons:

```
office_data[office_data['character'].eq('Jim')]['text'].count()
```

Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to create `office_dialogue` dataframe.

1c. *(2 pts)* Merge the `office_dialogue` and the `office_rating` dataframes by `season` and `episode`. Call this new dataframe `combined_office_df`. Then, use the command below to rename some of the columns to be easier to understand AND creates a column called `is_good` that has value `True` if `imdb_rating` is equal or greater than 8.5, and `False` if not.

```
combined_office_df = combined_office_df.rename(columns={('text', 'Dwight'): "Dwight", ('text', 'Jim'):
combined_office_df['is_good'] = combined_office_df['imdb_rating'] >= 8.5
```

Separate `combined_office_df` into a train set called `train_df` and a test set called `test_df`. Place the data for seasons 1-7 into `train_df`, and leave the data from seasons 8-9 for the `test_df`.

We are going to build a classifier that classifies an episode to tell us if it is "good" or not. We will train our classifier using the data in `train_df` and test our classifier on the data in `test_df`.

Test your `train_df` and `test_df` by running:

```
train_df.shape # (Should be (115, 8))
test_df.shape # (Should be (71, 8))
```

Keywords: *pandas: merge, isin, range*

Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to create: `combined_office_df`, `train_df` and `test_df`.

1d. *(1 pt)* Separate `train_df` into 2 `numpy` arrays named `train_good` and `train_notGood`. `train_good` is for the "good" episodes and `train_notGood` is for episodes that are not "good". We based whether an episode is "good" or not on the column `is_good`. The `numpy` arrays should contain only the following columns: `Angela`, `Jim`, `Pam`, and `Dwight` (characters in `characters_to_evaluate`).

Run the code below to calculate the mean and standard deviation for each column in `train_good` and `train_notGood`:

```
mean_good = np.nanmean(train_good, axis=0)
std_good = np.nanstd(train_good, axis=0)
mean_notGood = np.nanmean(train_notGood, axis=0)
std_notGood = np.nanstd(train_notGood, axis=0)
```

Hint: *You **may** want to first separate the `train_df` dataframe, and convert it to a numpy array.*

Keywords: *pandas: to_numpy, eq*

Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to create the two `numpy` arrays,
- The code provided to calculate mean and standard deviation for each column in `train_good` and `train_notGood`.

1e. *(2 pts)* The function `calculate_ind_probability` provided below calculates the probability of a vector named `lines_vector`, based on a `mean_vector` and a `std_vector`. The `lines_vector` contains information on the number of lines for each character in `characters_to_evaluate` in one episode.

```
import math
def calculate_ind_probability(lines_vector, mean_vector, std_vector):
    exponent_step = np.exp(-((lines_vector-mean_vector)**2 / (2 * std_vector**2 )))
    prob_array = (1 / (np.sqrt(2 * math.pi) * std_vector)) * exponent_step
    return np.prod(prob_array)
```

Test the function by running the command to calculate the probability for one "Good" episode in `train_good` under the distribution of "Good" episodes:

```
calculate_ind_probability(train_good[0,:], mean_good, std_good)
```

Note that we are making a big (and false) assumption to consider the character's number of lines as independent of each other.

Create a function called `classify_episode` that takes as an input `lines_vector`. The function should calculate two probabilities: 1. Given that an episode is "good", the probability we will see the lines from `lines_vector`. 2. Given that an episode is not "good", the probability we will see the lines from `lines_vector`.

Then, it should compare both probabilities, and based on the higher probability, classify the episode. To be consistent with our dataset, if the episode is classified as "good", your function should return `True`, and if it is classified as not "good", your function should return `False`.

To calculate (1) the probability of seeing the lines from `lines_vector` given the episode is "good", use the provided `calculate_ind_probability` function with the `mean_good` and `std_good` from (1d). Similarly, use `mean_notGood`, `std_notGood`, and `calculate_ind_probability` function to get the (2) second probability.

Keywords: *def*

Item(s) to submit:

- A cell in the Jupyter notebook containing your `classify_episode` function.

1f. *(2 pts)* Create a `numpy` array named `test` for the `test_df`. `test` should contain only the number of lines for each character in `characters_to_evaluate`. Create an array called `predicted` that uses your `classify_episode` function from (1e) to classify if the epsiode in `test` will be good or not. Be sure to use `np.apply_along_axis` function. Then, run the code below to compare the `predicted` class vs. the observed class, and get a percentage of how accurate our naive bayes classifier is.

keywords: *pandas: to_numpy, numpy:apply_along_axis*

```
test = # your code here to create numpy array test
predicted = # your code here to get predicted classes for the episodes in seasons 8 and 9
round(100*np.mean(predicted == test_df['is_good']),2)
```

Item(s) to submit:

- A cell in the Jupyter notebook containing the update Python code to obtain the predictions for episodes in seasons 8 and 9.

——— Optional Project 3 ———

#R #shiny

Recently you became familar Shiny, an R package for building interactive web apps straight from R. Shiny can be very useful to communicate the results of your analysis in an interactive manner. This is a valuable skill to anyone dealing with data.

We've provided you with the start to an app.

Your friends are planning their next vacation, you decided to create a Shiny app to provide some interesting information that could help them better plan their vacation. We've provided you with the start to the app here or on scholar:

`/class/datamine/data/spring2020/stat29000optionalproject03template.R`.

1. Complete the "Lead time" tab by including:

- A histogram of the `lead_time` from the `hotelSubset` data.
- A `summary()` of the `lead_time` from the `hotelSubset` data.

2. Complete the "Vacation length" tab by including:

- A side-by-side boxplot with the `totalstay` variable for the selected month (`months`), as well as the `totalstay` variable for the prior month and next month.
- Use `renderPrint` to display a small dataframe that shows names of the three months in one column, and the calculated average stay time in another.

3. Use the data provided here to add an additional tab to the app. Feel free to supplement that data with the airbnb data on scholar:

`/class/datamine/data/airbnb`

Your tab needs to include the following:

1. A title for your tab
2. An in-app description for the user that explains what your tab does
3. Your tab must accept the two variables (arrival month and country) as inputs, and display at least one new output.
4. The output must be clear and include an appropriate name and description so the user understands how to interpret the results.

These datasets are rich, and can be explored in many different ways. Be creative and have fun! Remember that the end goal is to provide an interface to help your friends plan their vacation.

——— Optional Project 4 ———

#python #plotting

Question 1: plotting with pygal

(5 pts)

First, we must install the `pygal` package. In scholar, open up a shell and type the following:

```
python3.6 -m pip install pygal --user
```

Load the data here into a `pandas` dataframe.

Explore the data. As you can see there is information on beer’s brewing material for all months between 2008 and 2017. There are two material types (`material_type`): “Grain Products”, and " Non-Grain Products“, which can be of different types (`type`), like”Hops (dry)“,”Sugar and syrups“, etc. Note that in `material_type` the total of grain products and non-grain products, as well as the overall total, have already been calculated per month and year, and can be found in rows that contain the word”Total" (“Total Grain products”, “Total Non-Grain products”, and “Total Used”) under the column `type`. Additionally, the current number of barrels for corresponding year/month/material can be found in `month_current`.

Create a basic pie chart to plot the brewing material type for a specific `month` and `year` – for example ‘August’ of ‘2017’. We want the pieces of the pie chart to show the percentage of barrels produced using the corresponding brewing material (grain products vs non-grain products) on the `month` of the given `year`. Make sure to calculate the percentage of barrels produced from the number of barrels (`month_current`).

Important note: It is not necessary for you to follow the hints in (1a) or (1b), however, they may be helpful as they are designed to walk you through what to do step-by-step.

Hint(1a): *Filter the data to include only the `month` and `year` you want. Filter the data to include only the `material_type` that contains the word “Total” in it. Use the values in `month_current` column to calculate the percentage of barrels produced per brewing material type (grain vs non-grain products) per year. You can calculate the percentage by “hand”.*

Keywords: *isin, str.contains*

Hint(1b): *Use the percentage information from (1a) to create a basic pie chart. Use the command below to show your plot. Make sure you name your pie chart `brewing_material_pie_chart`.*

```
from IPython.display import HTML
html_pygal = """
<!DOCTYPE html>
<html>
  <head>
    <script type="text/javascript" src="http://kozea.github.com/pygal.js/latest/pygal-tooltips.min.js">
    <!-- ... -->
  </head>
  <body>
    <figure>
      {pygal_render}
    </figure>
  </body>
</html>
"""

# your code to create the brewing_material_pie_chart here

HTML(html_pygal.format(pygal_render=brewing_material_pie_chart.render(is_unicode=True)))
```

Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to create the pie chart using pygal.

Question 2: race bar chart with matplotlib

Race bar charts have been gaining attention lately. Examples include urban population growth and Interbrand’s Top Global Brands. In this question, we will create our own race bar chart for beer production across some US states since 2008.

Load the data here into a `pandas` dataframe. As you can see there is information on the state, year, and the quantity and type of produced beer barrels.

2a. *(1 pt)* Organize the dataset. Filter the data to include only rows where `state` is in the list `states_to_select` provided below. In addition, include only rows where barrels are of `type` equal to "Bottles and Cans". Save this dataset to a variable named `beer`.

```
states_to_select = ['CA', 'OR', 'MI', 'CO', 'VT', 'OH', 'PA', 'MA', 'IL', 'WI', 'IN']
```

Keywords: *isin*

Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to obtain `beer` dataset.

2b. *(1 pt)* Create a (default options) horizontal bar chart using `matplotlib` and our dataset, `beer`. Filter rows where the `year` is "2008". Specifically, finish the code below to plot the amount of produced beer (x-axis) by state (y-axis) for the year "2008".

```
import matplotlib.pyplot as plt
import matplotlib.animation as animation

fig, ax = plt.subplots()
# Code to create bar chart
```

Hint: *To get the bars organized by the beer production, make sure to sort the values prior to making the plot. To sort the* `beer` *dataframe by* `barrels`*, use the code:*

```
beer.sort_values(by='barrels', ascending=True)
```

Note that we want to sort the dataframe that contains data from only the year "2008" (not *all* of the data).

Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to create the horizontal bar chart.

2c. *(1 pt)* Let's give our bars some color. Make our horizontal bar graph colored based on the `colors_dict` provided below. Use the argument `color` from the plotting function, and note that it requires a list of colors.

```
purdue_colors = ['#5B6870', '#BAA892', '#6E99B4', '#A3D6D7',
     '#085C11', '#849E2A', '#B46012', '#29A592', '#AD1F65' ,
     '#B1810B', '#4D4038']

colors_dict = dict(zip(states_to_select,purdue_colors))
```

Hint: *We can get a list of colors from* `colors_dict` *for* `['IN', 'CO', 'MI']` *using the following command:*

```
[colors_dict[state] for state in ['IN', 'CO', 'MI']]
```

Item(s) to submit:

- A cell in the Jupyter notebook containing the python code used to create the colored horizontal bar chart.

2d. *(1 pt)* Complete the function called `make_beer_bar_chart`. The function accepts an argument called `year`, and makes a colored horizontal bar chart. The bar chart shows "Bottles and Cans" production per `states_to_select` for the given `year`. Use the code from (1b) and (1c). Test your function on the `year` "2008". It should equivalent to your bar chart from (1c).

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

def make_beer_bar_chart(year):
        ax.clear() # so positions can change
        # YOUR CODE HERE
        ax.text(1, 0.4, year, color='#5D8AA8', size=15, ha='right', weight=800) # text for year

make_beer_bar_chart(2008)
```

Item(s) to submit:

- A cell in the Jupyter notebook containing the modified python code with the complete `make_beer_bar_chart` function.

2e. *(1 pt)* Now let's make an animation using the completed function `make_beer_bar_chart` from (2d). Write 1-2 sentences about the resulting animation. Are the results expected? Is there anything you found interesting?

```python
from IPython.display import HTML

fig, ax = plt.subplots()
animator = animation.FuncAnimation(fig, make_beer_bar_chart, frames=range(2008, 2019))
# display on your jupyter notebook
HTML(animator.to_jshtml())

# You can save your animation as a gif. However, you must have the ffmpeg library or libav-tools instal
# animator.save('animator.gif', fps=0.5)
```

Item(s) to submit:

- A cell in the Jupyter notebook with the code above
- A cell in the Jupyter notebook with 1-2 sentences describing your conclusions based on the resulting animation.

Project(s) Submission:

Submit solutions for all projects using the instructions found in the GitHub Classroom instructions folder on Blackboard.

You do not need to do any of these make-up projects if you are happy with your grades on your top 10 projects. A make-up project would replace whatever your lowest score is (which could be a project you didn't do).

Submit make-up projects using the following links:

Optional Project 1: https://classroom.github.com/a/hU_7asC1

Optional Project 2: https://classroom.github.com/a/r35pVz5g

Optional Project 3: https://classroom.github.com/a/z5VbWrQR

Optional Project 4: https://classroom.github.com/a/y-75gfky