Lab 9: Project 8 (Stage 2)

In this lab, you'll learn to create simple plots, decode a secret message, and take your sorting to the next level. Have fun!

Package Installation

For this lab, you'll need to use two new packages: `matplotlib` and `pandas`. We'll eventually learn a lot about these, but for now you just need to install them and call some functions we provide. These and many other Python packages are available on the PyPI site.

Once you know the name of a Python package, installing it is easy. You just run the following in the terminal, substituting in the package name:

```
pip install ????
```

So in this case, you should run the following (in either the Mac Terminal or Windows PowerShell):

```
pip install matplotlib
pip install pandas
```

If you're on the lab machines, the above will fail because these will already be installed, and you are not allowed to make changes. You may also many "Requirement already satisfied" messages (e.g., if you already installed these by following the setup videos we provided at the beginning of the semester), so don't be surprised if your output looks something like this:

```
Requirement already satisfied: pandas in
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages
(0.23.4)
Requirement already satisfied: python-dateutil>=2.5.0 in
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages
(from pandas) (2.7.5)
Requirement already satisfied: numpy>=1.9.0 in
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages
(from pandas) (1.16.0)
Requirement already satisfied: pytz>=2011k in
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages
(from pandas) (2018.9)
Requirement already satisfied: six>=1.5 in
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages
(from python-dateutil>=2.5.0->pandas) (1.12.0)
You are using pip version 19.0.1, however version 19.0.3 is available.
You should consider upgrading via the 'pip install --upgrade pip' command.
```

Common issues:

- if you have both Python 2 and 3 installed, you may need to replace `pip` with `pip3`

- if neither pip command is found, you may need to replace `pip` with `python -m pip` or `python3 -m pip`. This just means pip, although installed, is not on the PATH (i.e., your computer doesn't know where to find it)

Plotting Dictionaries

Creating a dictionary will often be the first step towards creating a bar plot in Python. In particular, each dictionary key might correspond to a category (along the x-axis) and each value might correspond to an amount (along the y-axis). To setup plotting in Python, paste following into two separate cells (with no other code added):

```
%matplotlib inline
```

And in a second cell:

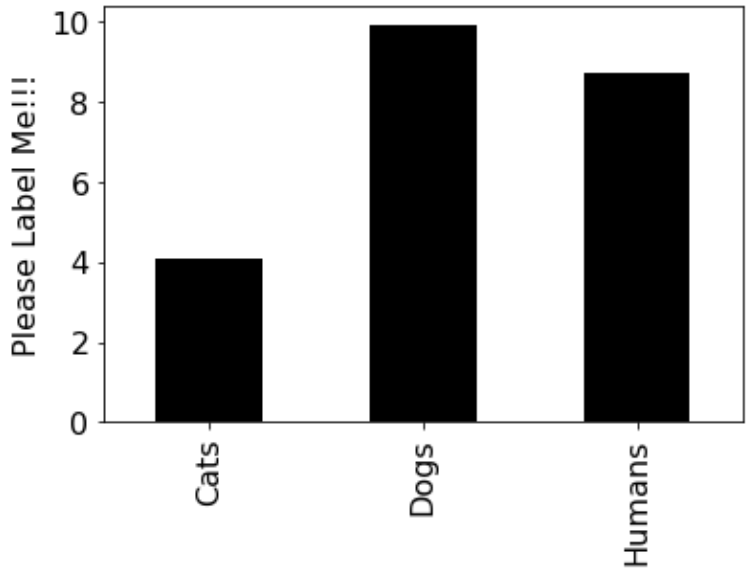
```
import matplotlib, pandas

def plot_dict(d, label="Please Label Me!!!"):
    ax = pandas.Series(d).sort_index().plot.bar(color="black", fontsize=16)
    ax.set_ylabel(label, fontsize=16)
```

Let's try creating a simple dictionary and using it to create a bar plot with the `plot_dict` function:

```
scores = {"Dogs": 9.9, "Cats": 4.1, "Humans": 8.7}
plot_dict(scores)
```

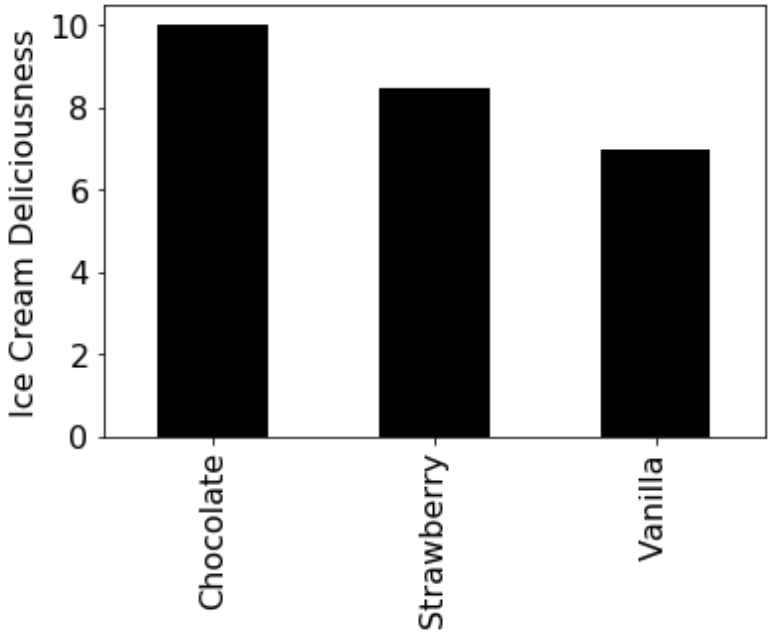
You should see something like the following:



Notice that the y-axis is missing a label; that can be specified with an optional second argument. Try specifying something descriptive, like this, and observe the result:

```
scores = {"Dogs": 9.9, "Cats": 4.1, "Humans": 8.7}
plot_dict(scores, "Likeability")
```

Now try writing a couple lines of code to produce a plot using `plot_dict` that looks roughly like the following (feel free to use different numbers to reflect your personal preferences):



The Gold Bug

The Gold Bug is a famous story by Edgar Allan Poe about cracking a secret message by counting how often different symbols occur. Take a moment to skim the Wikipedia article if you aren't familiar with the story: https://en.wikipedia.org/wiki/The_Gold-Bug

The secret message in the story is the following:

```
53‡‡†305))6*;4826)4‡.)4‡);806*;48†8
¶60))85;;]8*;:‡*8†83(88)5*†;46(;88*96
*?;8)*‡(;485);5*†2:*‡(;4956*2(5*–4)8
¶8*;4069285);)6†8)4‡‡;1(‡9;48081;8:8‡
1;48†85;4)485†528806*81(‡9;48;(88;4
(‡?34;48)4‡;161;:188;‡?;
```

Complete the following code to produce a plot that shows the frequency of each letter:

```
lines = [
    '53‡‡†305))6*;4826)4‡.)4‡);806*;48†8',
    '¶60))85;;]8*;:‡*8†83(88)5*†;46(;88*96',
    '*?;8)*‡(;485);5*†2:*‡(;4956*2(5*–4)8',
    '¶8*;4069285);)6†8)4‡‡;1(‡9;48081;8:8‡',
    '1;48†85;4)485†528806*81(‡9;48;(88;4',
    '(‡?34;48)4‡;161;:188;‡?;',
]

# key is the symbol, value is how many times it occurred
```

```
counts = {}

for line in ????:
    for symbol in line:
        if not symbol in counts:
            counts[????] = 0
        counts[????] += 1

plot_dict(????, "Occurrences")
```

The most common letter in English is "e". Based on your plot, can you guess which symbol represents the letter "e"?

Challenge: improve the above code so that the y-axis shows percentage of symbols rather than a raw count. For example, the plot should communicate that "8" represents 16% of the symbols rather merely reporting that "8" occurs 34 times.

Binning

Start by pasting the following code in a cell to setup the data:

```
names = ["Ada", "Caitlin", "Abe", "Bobby", "Alice", "Britney", "Cindy", "Caleb"]
```

Your job is to determine, for each letter, the average length of names starting with that letter. This is a two-part task: (1) bucketize the names based on the first letter, and (2) run a function over each bucket of data to get a summary.

Step 1: Bucketize

Try completing the following:

```
buckets = {}

for name in names:
    first = name[????]
    if not first in ????:
        buckets[first] = [] # empty list
    buckets[????].append(????)

buckets
```

If you complete the above correctly, `buckets` will contain the following dict of lists:

```
{'A': ['Ada', 'Abe', 'Alice'],
 'C': ['Caitlin', 'Cindy', 'Caleb'],
 'B': ['Bobby', 'Britney']}
```

Step 2: Stats per Bucket

Now complete the following:

```
def avg_len(names):
    total = 0
    for name in names:
        ???? += len(name)
    return total / len(????)

summary = {}
for k in buckets:
    summary[k] = avg_len(buckets[????])

summary
```

Your goal is for `summary` to be a dictionary where a key is the first letter of a name, and the corresponding value is the average length of the names starting with that letter, like this:

```
{'A': 3.6666666666666665, 'C': 5.666666666666667, 'B': 6.0}
```

Try visualizing your result:

```
plot_dict(summary, "Avg Name Length")
```

Function References

Note, if you're working ahead on this lab because you're bored during spring break, you may wish to leave these last sections until we've covered function references in class.

Try running the following code and see what happens (try running in Python Tutor too, if that helps):

```
def hello():
    print("hola")

def bye():
    print("chao")

f = hello # look carefully!  We're not calling hello, because there are no parentheses
f()
f = bye
f()
f()
f = hello
f()
f()
f()
```

Now try filling in the blanks in the following code:

```
def hello():
    print("hola")
```

```
def bye():
    print("chao")

def good_afternoon():
    print("buenas tardes")

f = ????
for i in range(????):
    f()

f = ????
f()

f = ????
for i in range(????):
    f()
```

Your goal is to get the following output:

```
hola
hola
hola
hola
buenas tardes
chao
chao
```

Sorting

Given a list `L`, we've learned two ways to sort it:

- L.sort()
- L = sorted(L)

When a list contains simple values, the sorting is intuitive. For example, `sorted([3,1,2])` will return `[1,2,3]`, and `sorted(["C", "B", "A"])` will return `["A", "B", "C"]`. What when the list contains tuples? Try and find out:

```
tups = [
    (2, "A"),
    (2, "C"),
    (1, "A"),
    (1, "C"),
    (1, "B"),
    (2, "B"),
]
sorted(tups)
```

As you can see, Python sorts by the entries at index 0 first, breaking ties by looking at index 1, and so on. This behavior allows us to customize sorting. For example, suppose we have a list of two-digit numbers, and we want to sort based on the last digit (instead of using the usual sorting, which places biggest numbers first). Run this code to see how this can be done:

```
def get_sort_value(num):
    # extract the last digit
    return num % 10

def last_digit_sorted(nums):
    print("We want to sort these by the last digit:", nums)
    tups = []
    for num in nums:
        t = (get_sort_value(num), num)
        tups.append(t)
    print("We'll sort these tuples instead:", tups)
    tups.sort()
    print("We get these tuples:", tups)

    print("Let's extract the actual values from the tuples")
    rv = []
    for tup in tups:
        rv.append(tup[1])
    return rv

nums = [904, 703, 802, 901]
result = last_digit_sorted(nums)
print("Result:", result)
```

Try running the above code and playing with it until you understand it ("playing" means trying different numbers for `nums` and perhaps adding prints to see what is happening).

Observe two things in the above code:

1. most of the hard work was done in `last_digit_sorted`
2. the simple `get_sort_value` function was where we actually determined which numbers would get sorted earlier or later

Python's sort functions already provide an implementation similar to `last_digit_sorted`, and you can use it if you provide the equivalent of `get_sort_value`. This will require passing a reference to a function, which Python's sort logic will call to figure out what you want ranked first. Let's try it:

```
sorted(nums, key=get_sort_value)
```

This is the regular `sorted` function, but now we're passing a keyword argument (i.e., `key`). We're passing a reference to the `get_sort_value` function (note that we ARE NOT invoking this function ourselves, as there is no `()` after the function name).

Let's try another special sort. This time, we'll sort strings so that the shortest is first:

```
def sort_factor(s):
    return len(s)

vals = ["C", "AAA", "BB"]
print("Regular sorting:", sorted(vals))
print("Custom sorting:", sorted(vals, key=sort_factor))
```

Can you complete the following code so that strings containing the fewest words are ranked first?

```
def word_count(s):
    return ????

vals = ["A", "A A A A", "B B", "C C C"]
sorted(vals, key=????)
```

Project Hints

- you'll be creating a few plots for P8, so consider copying the `plot_dict` function
- you'll need to answer a few questions such as "what are the three genres in which movies receive the highest median rating?" The easiest way to approach such questions is with a custom sort.

Good luck!