Nicholas Bowman, Sonja Johnson-Yu, Kylie Jue **Section #7**
CS106AP **August 6, 2019**

Section Handout #7: Real-World Python

In this section, we are going to gain practice with list and dict comprehensions, lambda functions, custom sorting, built-in functions, and Jupyter notebooks, all of which are powerful real-world Python tools that will enable you to flex your Python skills to solve challenging problems!

1. Sorting with `lambdas`

Solve each of the following challenges in one line of Python, using the custom sorting with lambda functions discussed in class. You should practice solving these in the Python interpreter.

1. Given a list of strings **`strs`**, sort the list case-insensitively (i.e. ignoring whether the word is upper or lower case)
2. Given a list of strings **`strs`**, sort the list according to the last character of each string, case-insensitively.
3. Given a list of integers **`nums`**, sort the list according to the absolute difference between each number and 3.14. Python has an **`abs`** function, which takes as input a number and returns its absolute value, and which you might find helpful in this problem.
4. Given a list of tuples that represents houses for rent, the number of bedrooms and their prices, like so:
   ```
   [ ('main st.', 4, 4000), ('elm st.', 1, 1200), ('pine st.', 2, 1600)]
   ```
   Sort the list in the following ways:
   a. In ascending order by number of rooms
   b. In ascending order of price
   c. In ascending order of price-per-room

2. One Liners

In this problem, we'll go over how tools like list comprehensions, lambdas and builtin functions like **`sorted`**, **`sum`**, **`max`**, and **`min`** can be used to solve hard problems in satisfyingly few lines of code. You should practice solving these problems in the Python interpreter.

Comprehensions

Suppose we have a list of tuples representing statistics for how frequently a website is visited by particular browsers, as follows:

```
stats = [('foo.com', 'firefox', 23), ('bar.com', 'chrome', 47),
         ('foo.com', 'chrome', 3), ('bar.com', 'firefox', 16)]
```

In addition, note that the builtin **`sum`** function takes a list of numbers and returns the sum of those numbers, as follows:

```
>>> sum([1, 2, 3])
6
```

Armed with this list, **sum**, and your knowledge of list comprehensions, find one-line expressions for each of these values:

1. Get a list of the number of visits per browser to **'foo.com'**. For example, if applied to the list above, your expression should evaluate to **[23, 3]**.
2. Find the total number of visits to **'foo.com'**. For example, if applied to the list above, your expression should evaluate to 26.
3. Find the number of visits to any website from the browser **'firefox'**. For example, if applied to the list above, your expression should evaluate to 39.

More List Comprehensions

Given a list of numbers **lst**, write one-line list comprehensions to do the following:

1. Produce a list of the absolute difference between each of the numbers in **lst** and 10. Recall that the **abs** function returns the absolute value of a number.
2. Produce a list of the absolute difference between the numbers in **lst** that are between 10 and 15 inclusive, and 10. Recall that the **abs** function returns the absolute value of a number.

Now, suppose we have a list of pairs such as this one:

```
pairs = [('zzz', 3), ('bbb', 10), ('ccc', 4), ('aaa', 6)]
```

Write one-line list comprehensions to do the following:

3. Produce a list of the second elements of each tuple in **pairs**.
4. Produce a list of the second elements of each tuple in **pairs**, so long as the tuple's first element does not begin with a 'c'.
5. Produce a list of the first elements of each tuple in **pairs**, except that the first character of each of these elements is made uppercase. You can assume that each such element in the tuples has at least one character.

3. Data Analysis Using Jupyter Notebooks

In class this week, we explored the use of Jupyter notebooks as a means of more interactively engaging with the code we write by embedding it in a narrative that also includes textual commentary, images and graphs. In this problem, we'll be employing those same tools to aid us in solving a very real problem.

To get started, make sure you have the Jupyter notebook package installed. Instructions to do so can be found in the Jupyter Reference Guide.

Next, go ahead and download and unzip the section starter code here from the online version of this handout. There are two files in this starter code:

- **`heart_rates.ipynb`**: The Jupyter notebook you'll be doing all your work on.
- **`jumbled_heart_rates.csv`**: The dataset you'll be analyzing.

Now, you'll need to open this folder in your terminal. On a Mac, type **`cd`** into your terminal and (without pressing enter), drag the folder from Finder into the terminal window (you should see the full folder path show up) and then press enter. On a PC, open the directory containing the folder, right-click the folder and click 'Open Command Window here'.

You should now have a terminal window that is open in the **`Section7-Starter`** folder. Now, type **`jupyter notebook`** and press enter. This command should open up your web browser to the Jupyter Notebook explorer. Open **`heart_rates.ipynb`** to start the project!

4. Bonus: Experimenting with the Debugger!

Note: Use of the debugger is not something that is expected of you in this class, and nothing from this problem will show up on an exam. That being said, learning how to use the debugger is a really valuable tool for a programmer to have, and this problem offers a fun challenge and learning experience for those that are interested.

As you made your way through the assignments this quarter, you likely encountered bugs that required you to inspect the state of your program to assess exactly what was going wrong. Perhaps you strategically printed the values of variables at key points in the program's execution, or perhaps you traced through them by hand, or perhaps you just randomly perturbed parts of your code until it worked (as a teaching staff, we can't endorse that last strategy, but we've all been there).

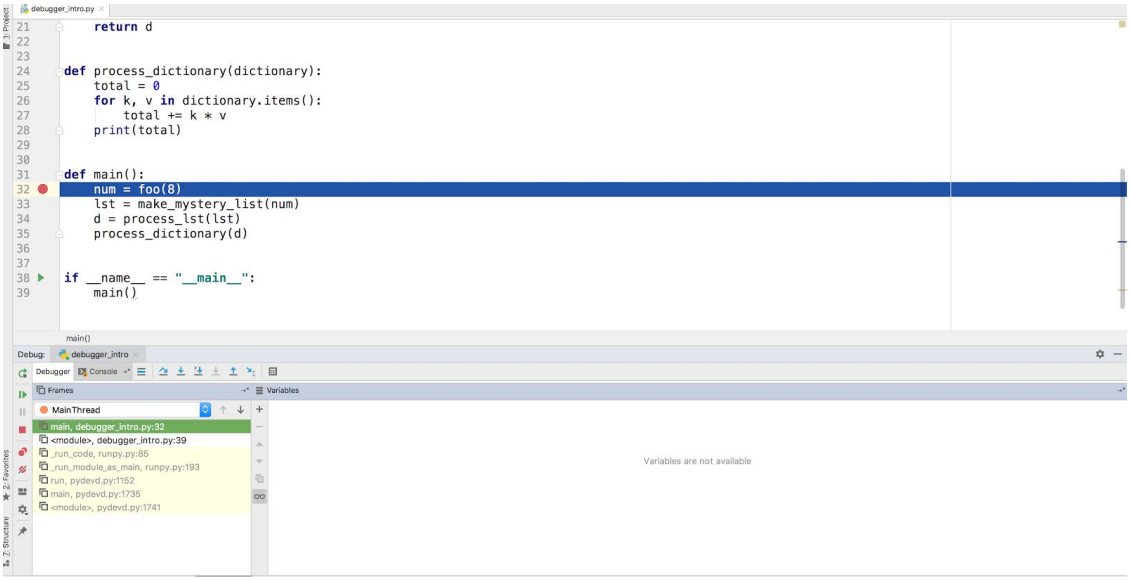
It's important to have a deep understanding of how to debug your programs by yourself, but it turns out that PyCharm comes with a feature called the *debugger*, which allows you to specify points at which you'd like to pause their program's execution and poke around to see the values of the variables. In this problem, we'll be exploring how to use the debugger. Begin by downloading the PyCharm project here , importing it into PyCharm and opening **`debugger_intro.py`**.

This program is a nonsensical one designed entirely to allow us to explore the debugger, so begin by running the program as per normal to see what it does (it should print a number). Following that, verify to yourself that -- at a high level -- you understand what each of the functions does. Now, we're going to set a *breakpoint* on a line in our code, which indicates to PyCharm that when we run our program, we would like to pause the program *before* that line executes, and see what our variables look like at that point. To set a breakpoint, click on the editor's “gutter”, directly to the right of the line number, and note that a red dot shows up in that position. Set a breakpoint on line 32, which calls the foo function:

```
31  def main():
32      num = foo(8)
33      lst = make_mystery_list(num)
34      d = process_lst(lst)
35      process_dictionary(d)
```

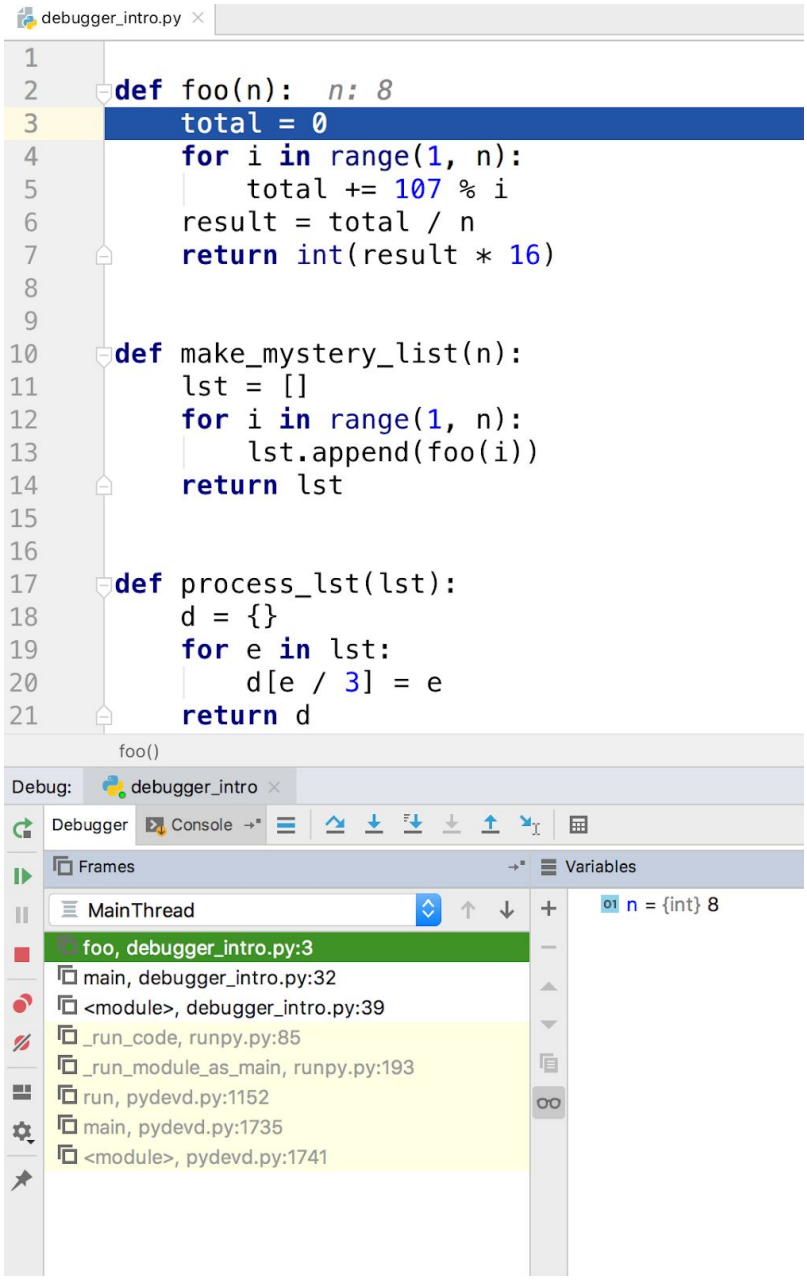
Now, click the bug button next to the run button in the top right corner to start the debugger:

After a brief pause, you should see line 32 highlighted, since the program is paused there, and the *debug pane* appear in the bottom of your PyCharm window:



The first portion of interest in this debugging pane is the *Stack Trace*, which shows all the functions that are currently running. Notice the top of this trace says **`main`**, since that is the function that most recently begun execution. That said, the key portion of this pane is the variables sub-pane, which displays the values of the program's variables. Right now, since we've paused our program before line 32 executes, no variables have been created and so the pane doesn't show us anything. In order to step our program forward, we turn our attention to the toolbar of buttons at the top of the debug pane:

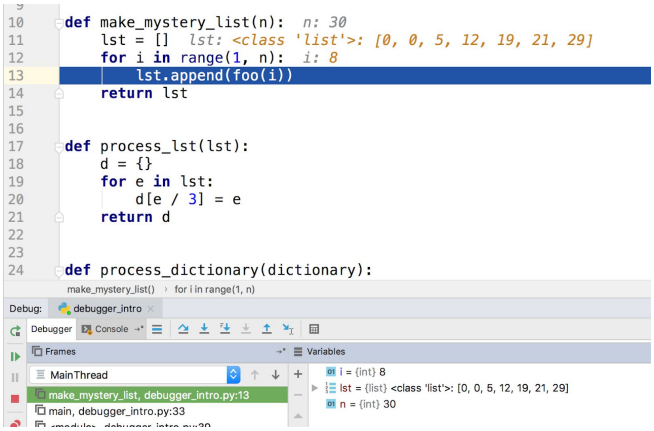
Far and away the most common buttons you'll be using are the leftmost two, which are called the *Step Over* and *Step Into* buttons, respectively. The *Step Over* button executes the current line of code in its entirety and moves on to the next one. If the current line of code contains a call to another function, the *Step Into* button jumps into the first function to be called on that line and pauses before it begins to execute. Click the *Step Into* button to step into the **`foo`** function.



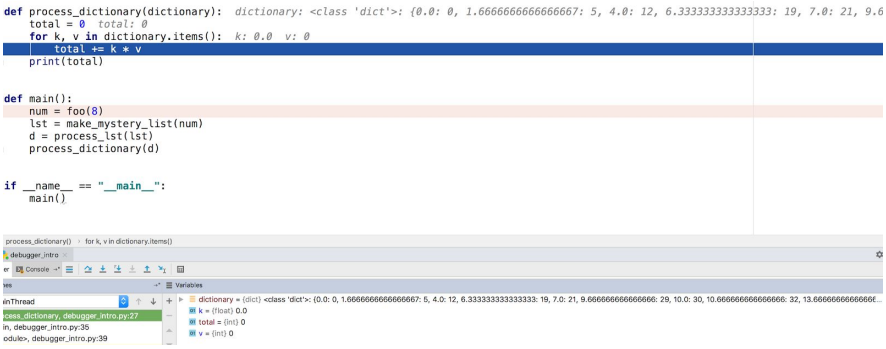
Notice that the Stack Trace has updated to show that **`foo`** has been begun (and **`main`** hasn't yet ended), and that the variables pane has been updated to show the current value of **`foo`**'s **`n`** parameter, which in this case is equal to 8, since we passed that value in when calling **`foo`**. Verify to yourself that this output makes sense, and then move the program forward a few lines by clicking the *Step Over* button a few times, noting that the program cycles through the **`for`** loop, and that entries for **`i`** and **`total`** are created and updated in the variables pane. As an added bonus, PyCharm displays the values for variables on the line at which they are declared.

Keep moving forward in the program (the *Step Over* button will automatically jump out of functions when they return) until you get to line 33, at which point you should step into the **`make_mystery_list`** function. At this point, keep stepping forward, but pay particular attention

to the value of **`lst`** in the variables pane. Notice that its members list gets updated as the function progresses:



As you keep stepping through the program, you'll notice the same is true for dictionaries:



Now that you have some familiarity with the debugger, open up **`broken_program.py`**, a simple program aimed at demonstrating the differences between how integers and lists are passed as parameters. Trace through the program, and then run it, verifying that it behaves as you expect it to. Now, armed with the debugger, step through the program, making sure that the values of the variables are what you expect them to be at key points in the program.