CSE 231 **Summer 2023**

Computer Project #4

Assignment Overview

This assignment focuses on the implementation of Python programs to read files and process data by using lists and functions.

It is worth 85 points (8.5% of course grade) and must be completed no later than **11:59 PM on Tuesday, June 13 (due date)**. **After the due date, your score will be deducted by 2pt for every 1 hour late or a fraction of it. No submissions will be accepted after 24 hours from the due date (cut-off date).**

Assignment Deliverable

The deliverable for this assignment is the following file:

`proj04.py` – the source code for your Python program

Be sure to use the specified file name and to submit it for grading via the **Coding Rooms system** before the project deadline.

Assignment Background

One commonly hears reference to "the one percent" referring to the people whose income is in the top 1% of incomes. What is the data behind that number and where do others fall? Using the National Average Wage Index (AWI), an index used by the Social Security Administration to gauge an individual's earnings for the purpose of calculating their retirement benefit, we can answer such questions.

In this project, you will process AWI data. Example data for 2014 and 2015 is provided in the files `year2014.txt` and `year2015.txt`. The data is a table with the first row as the title and the second row defining the data fields; remaining rows are data. The URL for the data is: https://www.ssa.gov/cgi-bin/netcomp.cgi?year=2015

Here is the second line of data from the file followed by descriptions of the data. Notice that some data are ints and some are floats:

```
5,000.00 - 9,999.99  13,848,841  36,423,281  23.02549  102,586,913,092.61  7,407.62
```

Column 0 is bottom of this income range.
Column 1 is the hyphen separating the bottom of the range from the top.
Column 2 is the top of this income range.
Column 3 is the number of individuals in the income range.
Column 4 is the cumulative number of individuals in this income range and all lower ranges.
Column 5 is the Column 4 value represented as a cumulative percentage of all individuals.
Column 6 is the combined income of all the individuals in this range of income.
Column 7 is the average income of individuals in this range of income.

Assignment Specifications

1. The program must provide the following functions to extract some statistics. Note that the `data_list` parameter specified in these functions may be the same for all functions or different for different functions—that is your choice. A skeleton file is provided on the course website and in Coding Rooms.
   a) `open_file()` prompts the user to enter a year number for the data file. The program will check whether the year is between 1990 and 2023 (both inclusive). If `year` number is valid, the program will try to open data file with file name 'yearXXXX.txt', where XXXX is the year. An appropriate error message should be shown if the data file cannot be opened or if the year number is invalid. This function will loop until it receives proper input and successfully opens the file. It returns a file pointer and year. Note that your code should work with any file name 'yearXXXX.txt' not just the ones provided in this project.
      i. **Hint**: use string concatenation to construct the file name

   b) `read_file(fp)` has one parameter, a file pointer read. This function returns a list of your choosing containing data you need for other parts of this project.

   c) `find_average(data_list)` takes a list of data (of some organization of your choosing) and returns the average salary. The function does not print anything.

      Hints:
      i. This is NOT (!) the average of the last column of data. It is not mathematically valid to find an average by finding the average of averages—for example, in this case there are many more in the lowest category than in the highest category.
      ii. How many wage earners are considered in finding the average (denominator)? There are a couple of ways to determine this. I think the easiest uses the "cumulative number" column (Column 4), but using Column 3 is not hard and may make more sense to some students.
      iii. How does one find the total dollar value of income (numerator)? Notice that "Column 6 is the combined income of all the individuals in this range of income."
      iv. For testing your function notice that for the 2014 data the average should be $44,569.20. As a check, note that that value is listed on the web page referenced above.

   d) `find_median(data_list)` takes a list of data (of some organization of your choosing) and returns the median income. The function does not print anything. Unfortunately, this file of data is not sufficient to find the true median so we need to approximate it.
      i. Here is the rule we will use: *find the data line whose cumulative percentage (Column 5) is closest to 50% and return its average income (Column 7).* If both data lines are equally close, return either one.
      ii. **Hint**: Python's `abs()` function (absolute value) is potentially useful here.
      iii. **Hint:** your `get_range()` function should be useful here.
      iv. For testing your function, using our rule the median income for the 2014 data is $27,457.00

e) `get_range(data_list, percent)` takes a list of data (of some organization of your choosing) and a percent (`float`) and returns the salary range as a tuple (Columns 0 and 2) for the data line whose cumulative percentage (Column 5) is greater than or equal to the `percent` parameter, the cumulative percentage value (Column 5) and the average income (Column 7). Stated another way: `((col_0,col_2),col_5,col_7)` The function does not print anything.

i. For testing using the 2014 data and a percent value of 90 your function will return `((90000.0, 94999.99), 90.80624, 92420.5)`

f) `get_percent(data_list, income)` takes a list of data (of some organization of your choosing) and an income (`float`) and returns the cumulative percentage (Column 5) for the data line that the specified income is in the income range (Columns 0 and 2), and income range (Columns 0 and 2) . Stated another way: `((col_0,col_2),col_5)` The function does not print anything.

i. For testing using the 2014 data and an income value of 150,000 your function will return `((150000.0, 154999.99), 96.87301)`

g) `do_plot(x_vals,y_vals,year)` provided by us takes two equal-length lists of numbers and plots them. Note that if you plot the whole file of data, the income ranges are so skewed that the result is a nearly vertical plot at the leftmost edge so close to the edge that you cannot see it in the plot—it looks like nothing was plotted. Plotting the lowest 40 income ranges results in a more easily readable plot.

2. `main()`

a) Open the data file
b) Read the data file (using the file pointer from the opened file).
c) Print the year, the average income, and the median income (and a header). Here is the output format that I used: `"{:<6d}${:<14,.2f}${:<14,.2f}"`
d) Prompt whether to plot the data and if "yes", plot the data: cumulative percentage (Column 5) vs. income (Column 0) – only the lowest 40 income ranges.
e) Loop, prompting for either "r" for range , "p" for percent, or nothing

i. r: prompt for a percent (float) and output the income that is below that percent. Print an error message, if an invalid number is entered (a percent must be between 0 and 100). Here is the output format that I used:
`"{:4.2f}% of incomes are below ${:<13,.2f}."`

ii. p: prompt for an income (float) and output the percent that earn more. Print an error message, if an invalid income is entered (income must be positive). Here is the output format that I used:
`"An income of ${:<13,.2f} is in the top {:4.2f}% of incomes."`

iii. if only a carriage-return is entered, halt the program.

3. Call `main()` using

```
if __name__ == "__main__":
    main()
```

Assignment Notes

1. Items 1-9 of the Coding Standard will be enforced for this project.

2. Files for `year2014.txt` and `year2015.txt` are provided so that you can test your program. We will also test you on the year 2000 data, but are not sharing that file with you.
3. Note that most data has commas. I wrote functions that converted a string with commas into a number without commas. I wrote separate functions for `int` and `float`, but you may find that one combined function suits your needs. I used a `try-except` statement in case the string wasn't really a number.
4. For output you need to insert commas. There is a format specification, e.g. if you might have formatted a floating-point value without commas as `{:<12.2f}` you can simply insert a comma before the dot as in `{:<12,.2f}`.
5. There are multiple ways to handle the "`and over`" wording in the last line of the input files. One way you might not have thought of uses the special value `float("inf")` which represents infinity in the sense of a value bigger than all others.

Suggested Procedure

- *Solve the problem using pencil and paper first.* You cannot write a program until you have figured out how to solve the problem. This first step may be done collaboratively with another student. However, once the discussion turns to Python specifics and the subsequent writing of Python statements, you must work on your own.

- Construct the program one function at a time—testing before moving on.

- Use the **Coding Rooms system** to turn in the first version of your solution.
  Cycle through the steps to incrementally develop your program:

  - Edit your program to add new capabilities.
  - Run the program and fix any errors.
  - Use the **Coding Rooms system** to submit the current version of your solution.

- Be sure to log out when you leave the room, if you're working in a public lab.

Tests

There are unit tests for functions: `find_average, find_median, get_range,` and `get_percent.` The tests all call your `read_file` function to get your data structure to pass to those functions. The file read for these unit tests is the 2014 data.

Test 1

```
Enter a year where 1990 <= year <= 2023: 2014

Year  Mean           Median
2014  $44,569.20     $27,457.00
```

```
Do you want to plot values (yes/no)? no
Enter a choice to get (r)ange, (p)ercent, or nothing to stop:
```

Test 2

```
Enter a year where 1990 <= year <= 2023: 2014

Year  Mean           Median
2014  $44,569.20     $27,457.00
Do you want to plot values (yes/no)? no
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: r
Enter a percent: 90

90.00% of incomes are below $90,000.00    .
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: p
Enter an income: 100000

An income of $100,000.00    is in the top 92.57% of incomes.
Enter a choice to get (r)ange, (p)ercent, or nothing to stop:
```

Test 3

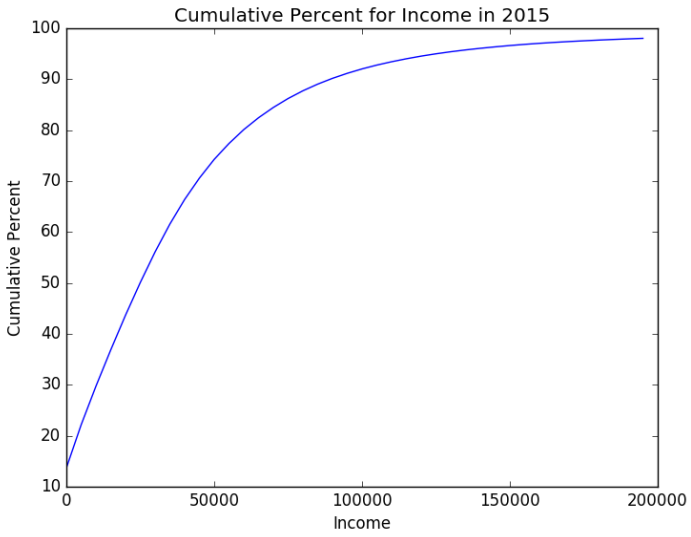
```
Enter a year where 1990 <= year <= 2023: xxxx
Error in year. Please try again.
Enter a year where 1990 <= year <= 2023: 1900
Error in year. Please try again.
Enter a year where 1990 <= year <= 2023: 1999
Error in file name: year1999.txt  Please try again.
Enter a year where 1990 <= year <= 2023: 2015

Year  Mean           Median
2015  $46,119.78     $27,459.59
Do you want to plot values (yes/no)? no
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: x
Error in selection.
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: r
Enter a percent: 104
Error in percent. Please try again
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: r
Enter a percent: -2
Error in percent. Please try again
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: r
Enter a percent: 90

90.00% of incomes are below $90,000.00    .
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: p
Enter an income: -20
Error: income must be positive
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: p
Enter an income: 100000

An income of $100,000.00    is in the top 92.03% of incomes.
Enter a choice to get (r)ange, (p)ercent, or nothing to stop:
```

Test 4

```
Enter a year where 1990 <= year <= 2023: 2000

Year  Mean           Median
2000  $30,846.09     $17,471.75
Do you want to plot values (yes/no)? no
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: r
Enter a percent: 40

40.00% of incomes are below $15,000.00    .
Enter a choice to get (r)ange, (p)ercent, or nothing to stop: p
Enter an income: 20000

An income of $20,000.00     is in the top 56.96% of incomes.
Enter a choice to get (r)ange, (p)ercent, or nothing to stop:
```

Test 5
(not on Coding Rooms because this tests the plot – TAs will run this test.)

```
Enter a year where 1990 <= year <= 2023: 2015

Year  Mean           Median
2015  $46,119.78     $27,459.59
Do you want to plot values (yes/no)? yes
```




```
Enter a choice to get (r)ange, (p)ercent, or nothing to stop:
```

Test 6: (using hidden file)

Grading Rubric

Computer Project #4 Scoring Summary

General Requirements

__0__ (5 pts) Coding standard

Program Implementation

__0__ (5 pts) Function (no Coding Rooms test): open_file

__0__ (5 pts) Function (no Coding Rooms test): read_file

__0__ (5 pts) Function Test: find_average

__0__ (5 pts) Function Test: find_median

__0__ (5 pts) Function Test: get_range

__0__ (5 pts) Function Test: get_percent

__0__ (8 pts) Test 1

__0__ (8 pts) Test 2

__0__ (8 pts) Test 3

__0__ (8 pts) Test 4

__0__ (10 pts) Plotting (Test 5 – no Coding Rooms test)

__0__ (8 pts) Test 6