CptS355 - Assignment 3 (Python)

Spring 2024

Python Warm-up

Assigned: Wednesday, 21 Feb 2024

Due: Friday, 8 March 2024 by **10 pm**

Weight: This assignment will count for **6%** of your final grade.

This assignment is to be your own work. Refer to the course academic integrity statement in the syllabus.

Turning in your assignment

All the problem *solutions* should be placed in a single file named **`HW3.py`**. All of your test cases should be included in **`HW3tests.py`**. When you are done and certain that everything is working correctly, any *.txt files you might have used for your test cases, as well as HW3.py and HW3test.py files should be submitted via Canvas in a single submission (but multiple files). Do NOT zip the files. You may turn in your assignment up to 3 times. Only the last one submitted will be graded. Implement your code using Python3.

At the top of the file in a comment, please include your name and the **names of the students with whom you discussed any of the problems in this homework**. This is an individual assignment and the final coding in the submitted file should be *solely yours*. You may NOT copy another student's code or work together on writing code. You may not copy code from the web, or anything else that lets you avoid solving the problems for yourself.

Grading

The assignment will be marked for good programming style (appropriate algorithms, good indentation and appropriate comments -- refer to the Python style guide) -- as well as thoroughness of testing and clean and correct execution. You will lose points if you don't (1) provide test functions / additional test cases, (2) explain your code with appropriate comments, and (3) follow a good programming style. **For each problem below, at least 5% of the points will be reserved for the test functions and the programming style.**

- Good python style favors *`for-loops`* rather than *`while-loops`* (when possible).
- Turning in "final" code that produces debugging output is bad form, and points may be deducted if you have extensive debugging output. We suggest you do the following:
    - Near the top of your program write a debug function that can be turned on and off by changing a single variable. For example,

```
debugging = True
def debug(*s):
  if debugging:
    print(*s)
```

- Where you want to produce debugging output use the following instead of `print`.:

```
debug(”This is my debugging output”,x,y)
```

(How it works: Using * in front of the parameter of a function means that a variable number of arguments can be passed to that parameter. Then using *s as print's argument passes along those arguments to print.)

Problems:

1) (Dictionaries)

a) sprintLog(sprnt) – 15%

Assume a software development team follows an agile process model. During each sprint, developers keep track of the number of hours they spent on each task during the sprint. They store a weekly log of their hours in a Python dictionary. For example:

```
{'John': {'task1': 5}, 'Rae': {'task1': 10, 'task2': 4}, 'Kelly': {'task1': 8,
  'task3': 5}, 'Alex': {'task1': 11, 'task2': 2, 'task3': 1}, 'Aaron':
  {'task2': 15}, 'Ethan':{'task3': 12}, 'Helen': {'task3': 10}}
```

- The keys of the dictionary are the names of the developers and the values are the dictionaries which include the task names and the number of hours spent for each task. Please note that each developer may work on several tasks during a sprint and multiple developers may work on the same tasks.
- Define a function `sprintLog(sprnt)` which takes a dictionary of users as shown above and returns a dictionary of tasks, where each task is associated with the users who worked on that task during the sprint. For the above dictionary, `sprintLog` will return the following:

```
{'task1': {'John': 5, 'Rae': 10, 'Kelly': 8, 'Alex': 11}, 'task2': {'Rae': 4,
  'Alex': 2, 'Aaron': 15}, 'task3': {'Kelly': 5, 'Alex': 1, 'Ethan': 12,
  'Helen': 10}}
```

(*Important note*: Your function should not hardcode the developer and task names. It should simply iterate over the keys that appear in the given dictionary and should work on any dictionary with arbitrary names.)

(Important note: When we say a function *returns a value*, it doesn't mean that it prints the value. Please pay attention to the difference.)

You can start with the following code:

```
def sprintLog (sprnt):
    #write your code here
```

b) addSprints(sprint1, sprint2) – 10%

Now define a function, `addSprints(sprint1, sprint2)`, which takes the logs of two sprints as input and joins them. The result will be a joined dictionary including tasks from both dictionaries. The logs for the tasks that are common to both dictionaries will be merged. See below for an example.

```
sprint1 = {'task1': {'John': 5, 'Rae': 10, 'Kelly': 8, 'Alex': 11}, 'task2':
  {'Rae': 4, 'Alex': 2, 'Aaron': 15}, 'task3': {'Kelly': 5, 'Alex': 1,
  'Ethan': 12, 'Helen': 10}}
sprint2 = {'task1': {'Mark': 5, 'Kelly': 10, 'Alex': 15}, 'task2': {'Mark': 2,
  'Alex': 2, 'Rae': 10, 'Aaron': 10}, 'task4': {'Helen': 16}}
```

addSprints(sprint1,sprint2) will return:

```
{'task1': {'John': 5, 'Rae': 10, 'Kelly': 18, 'Alex': 26, 'Mark': 5}, 'task2':
  {'Rae': 14, 'Alex': 4, 'Aaron': 25, 'Mark': 2}, 'task3': {'Kelly': 5,
  'Alex': 1, 'Ethan': 12, 'Helen': 10}, 'task4': {'Helen': 16}}
```

c) addNLogs(logList) – 10%

Now assume that the team recorded the log data for several sprints as a list of dictionaries. This list includes a dictionary for each development sprint.

Define a function `addNLogs` which takes a list of developer sprint logs and returns a dictionary which includes the collection of all project tasks and the total number of hours each developer has worked on each task. **Your function definition should use the Python `map` and `reduce` functions as well as the `sprintLog` and `addSprints` functions you defined in part(a) and (b).**

Example: Assume that the project had 3 sprints.

```
logList = [{'John': {'task1':5}, 'Rae': {'task1':10, 'task2':4}, 'Kelly':
  {'task1':8, 'task3':5}, 'Alex': {'task1':11, 'task2':2, 'task3':1},
'Aaron': {'task2':15}, 'Ethan':{'task3':12}, 'Helen': {'task3':10}},
{'Mark': {'task1':5, 'task2':2}, 'Kelly': {'task1':10}, 'Alex': {'task1':15,
  'task2':2}, 'Rae': {'task2':10}, 'Aaron': {'task2':10}, 'Helen':
  {'task4':16}},
{'Alex': {'task3':10, 'task2':5, 'task4':6}, 'Rae': {'task3':5, 'task5':16},
  'Mark': {'task4':20}, 'Kelly': {'task2':5, 'task3':10, 'task4':12}, 'Helen':
  {'task5':10, 'task4':8}}]
```

For the above list `addNLogs` will return:

```
{ 'task1': {'John': 5, 'Rae': 10, 'Kelly': 18, 'Alex': 26, 'Mark': 5},
  'task2': {'Rae': 14, 'Alex': 9, 'Aaron': 25, 'Mark': 2, 'Kelly': 5},
  'task3': {'Kelly': 15, 'Alex': 11, 'Ethan': 12, 'Helen': 10, 'Rae': 5},
  'task4': {'Helen': 24, 'Alex': 6, 'Mark': 20, 'Kelly': 12},
  'task5': {'Rae': 16, 'Helen': 10}}
```

(The items in the dictionary can have arbitrary order.)

You can start with the following code:

```
def addNLogs (logList):
   #write your code here
```

2) Dictionaries and lists

a) lookupVal(L,k)– 5%

Write a function `lookupVal` that takes a list of dictionaries `L` and a key `k` as input and checks each dictionary in `L` starting from the end of the list. If `k` appears in a dictionary, `lookupVal` returns the value for key `k`. If `k` appears in more than one dictionary, it will return the one that it finds first (closer to the end of the list).

For example:

```
L1 = [{"x":1,"y":True,"z":"found"},{"x":2},{"y":False}]
lookupVal(L1,"x") #returns 2
lookupVal(L1,"y") #returns False
lookupVal(L1,"z") #returns "found"
lookupVal(L1,"t") #returns None
```

b) (b)lookupVal2(tL,k) – 10%

Write a function `lookupVal2` that takes a list of tuples (`tL`) and a key `k` as input. Each tuple in the input list includes an integer index value and a dictionary. The index in each tuple represent a link to another tuple in the list (e.g. index 3 refers to the 4th tuple, i.e., the tuple at index 3 in the list) `lookupVal2` checks the dictionary in each tuple in `tL` starting from the end of the list and following the indexes specified in the tuples.

For example, assume the following:

```
[(0,d0),(0,d1),(0,d2),(1,d3),(2,d4),(3,d5),(5,d6)]
   0       1      2      3      4      5      6
```

The `lookupVal2` function will check the dictionaries `d6`, `d5`, `d3`, `d1`, `d0` in order (it will skip over `d4` and `d2`). The tuple in the beginning of the list will always have index 0.

It will return the first value found for key `k`. If `k` is couldn't be found in any dictionary, then it will return `None`.

For example:

```
L2 = [(0,{"x":0,"y":True,"z":"zero"}),
      (0,{"x":1}),
      (1,{"y":False}),
      (1,{"x":3, "z":"three"}),
      (2,{})]
lookupVal2(L2,"x") #returns 1
```

```
lookupVal2(L2,"y") #returns False
lookupVal2(L2,"z") #returns "zero"
lookupVal2(L2,"t") #returns None
```

(*Note*: I suggest you to provide a recursive solution to this problem.
Hint: Define a helper function with an additional parameter that hold the list index which will be searched in the next recursive call.)

3) (Lists) `unzip` – 12%

Write a function `unzip` that calculates the reverse of the zip operation. `unzip` takes a list of 3-tuples, L, as input and returns a tuple of lists, where each list includes the first, second, or third element from each tuple, respectively. Give a solution using higher order functions (`map`, `reduce` or `filter`), without using loops.

For example:

```
unzip ([(1,"a",{1:"a"}),(2,"b",{2:"b"}),(3,"c",{3:"c"}),(4,"d",{4:"d"})])
```

returns

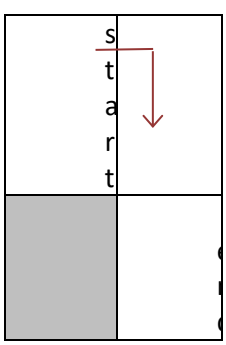
```
([1, 2, 3, 4], ['a', 'b', 'c', 'd'], [{1: 'a'}, {2: 'b'}, {3: 'c'}, {4: 'd'}])
```

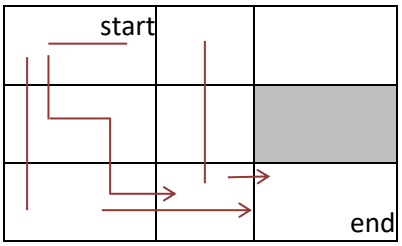
You can start with the following code:

```
def unzip(L):
    #write your code here
```

4) (Recursion) `numPaths(m,n,blocks)` – 10%

Consider a robot in a `mXn` grid who is only capable of moving right or down in the grid (can't move left, up or diagonal). The robot starts at the top left corner, (1,1), and is supposed to reach to the bottom right corner: `(m,n)`. Some of the cells in the grid are blocked and the robot is not allowed to visit those cells. Write a function `numPaths` that takes the grid length and width (i.e., `m`, `n`) and the list of the blocked cells (`blocks`) as argument and returns the number of different paths the robot can take from the start to the end. Give an answer using recursion. (A correct solution without recursion will be worth half the points.)





The blocked cells are represented as a list of `(x, y)` pairs where `x` is the row and `y` is column where the blocked cell is located.

For example, the 2x2 grid above has a blocked cell at (2,1). There is only one way for the robot to move from the start to the goal.

For the 3x3 grid above , the robot has 3 different paths.

```
numPaths(2,2,[(2,1)]) #returns 1
numPaths(3,3,[(2,3)]) #returns 3
numPaths(4,3,[(2,2)]) #returns 4
numPaths(10,3,[(2,2),(7,1)]) #returns 27
```

You can start with the following code:

```
def numPaths(m,n,blocks):
#write your code here
```

5) Iterators

a) iterFile()– 25%

Create an iterator that represents the sequence of words read from a text file. The iterator is initialized with the name of the file and the iterator will return the next word from the file for each call to `__next__()`. The iterator should ignore all empty lines and end of line characters.

A sample input file (`"HW3testfile.txt"`) is attached.

For example:

```
mywords = iterFile("HW3testfile.txt")
mywords.__next__()   #returns CptS
mywords.__next__()   #returns 355
mywords.__next__()   #returns Assignment
for word in mywords:
    print(word)
# prints the rest of the words. See the Appendix for the output of the above
  print statement.
```

You can start with the following code:

```
class iterFile():
    #write your code here
```

Important note: Your `iterFile` implementation should read the lines (or words) from the input text file as needed. Note: this is meant to indicate that you will read a line from the file, then process that line word-by-word when requested, then read the next line (if one exists) and process it word-by-word, etc. An implementation that reads the complete file and dumps all words to a list all at once will be worth only 10 points.

b) wordHistogram(words)– 3%

Define a function `wordHistogram` that takes an iterator "`words`" (representing a sequence of words) and builds a histogram showing how many times each word appears in the file. `wordHistogram` should return a list of tuples, where each tuple includes a unique word and the number of times that word appears in the file.

For example:

```
wordHistogram(iterFile("HW3testfile.txt"))
```

returns

```
[('-', 5), ('CptS', 3), ('355', 3), ('Assignment', 3), ('3', 3), ('Python',
  3), ('Warmup', 3), ('text', 2), ('for', 2), ('This', 1), ('is', 1), ('a',
  1), ('test', 1), ('file', 1), ('With', 1), ('some', 1), ('repeated', 1),
  ('.', 1)]
```

You can start with the following code:

```
def wordHistogram(words):
    #write your code here
```

Testing your functions

We will be using the `unittest` Python testing framework in this assignment. See https://docs.python.org/3/library/unittest.html for additional documentation.

The file `HW3SampleTests.py` provides some sample test cases comparing the actual output with the expected (correct) output for some problems. This file imports the `HW3` module (`HW3.py` file) which will include your implementations of the given problems.

You are expected to add **at least 2 more test cases** for each problem. Make sure that your test inputs cover all boundary cases. Choose test input different than those provided in the assignment prompt.

In Python `unittest` framework, each test function has a "`test_`" prefix. To run all tests, execute the following command on the command line.

```
python -m unittest HW3SampleTests
```

You can run tests with more detail (higher verbosity) by passing in the -v flag:

```
python -m unittest -v HW3SampleTests
```

If you don't add new test cases you will be deducted 0.5% per missing test case in this homework, for a potential 2 tests/function * 9 functions * -0.5 %/function = -9% or 0.9 points. These new test cases must be included in your **`HW3tests.py`** file!

Main Program

In this assignment, we simply write some unit tests to verify and validate the functions. If you would like to execute the code, you need to write the code for the "main" program to include in your **HW3tests.py** file. Unlike in C or Java, this is not done by writing a function with a special name. Instead the following idiom is used. This code is to be written at the left margin of your input file (or at the same level as the `def` lines if you've indented those. You can see an example of this in the `HW3SampleTests.py` file provided with the assignment.

```
if __name__ == '__main__':
   # ...code to do whatever you want done...
```

Appendix

```
mywords = iterFile("HW3testfile.txt")
mywords.__next__()   #returns CptS
mywords.__next__()   #returns 355
mywords.__next__()   #returns Assignment
for word in mywords:
    print(word)
# prints the rest of the words
```

In problem 5, the above code will print the following:

```
3
-
Python
Warmup
This
is
a
text
test
file
for
CptS
355
-
Assignment
3
-
Python
Warmup
With
some
repeated
text
for
CptS
355
-
```

Assignment 3 - Python Warmup .