Computational Problem Solving   CSCI-603
Track the TAs!   Lab 8

Problem

Colleen and Oliver are two TAs in the CS department who work together in the student center on the nights when CS1 assignments are due. There are lots of students in need of help on these nights! Colleen will always help the most confused student, while Oliver will always help students in the order in which they arrived (that is, he will help the student who has been waiting longest).

You will find out the order that students arrive and how confused they are, and when each TA gets free to help the next student. Your job is to figure out which students will get helped by which TA, in which order, and to do it as efficiently as possible.

Problem Solving

1.   Consider the following students, who arrived in the order listed:

> Ann: 3 units of confusion
> Ted: 1 units of confusion
> Ray: 5 units of confusion
> Jen: 2 unit of confusion

(a)   Who would Oliver help first?
(b)   Who would Colleen help first?
(c)   If Colleen helps two students before Oliver gets to the lab, who will Oliver start with?

2.   If Oliver was working alone, what data structure would we use to keep track of the students?

3.   If Colleen was working alone, what data structure would we use to keep track of the students?

4. Consider the case where Oliver is working alone, and one student decides to leave the lab. (From Oliver's point of view, this is essentially the same as when Colleen helps a student.)
   (a) Explain in English what happens to the data structure that you specified in question 2 when that student is removed.
   (b) Now consider that we would like to be able to write code that performs this operation in $O(1)$ time. What object will you need to have reference to? If this object is held in the variable `stu`, write code or pseudocode that repairs the overall data structure.

5. Now consider the opposite case: when Oliver helps a student, we have to also remove them from Colleen's data structure. What additional data should we store with each student so that we can find it efficiently in Colleen's data structure?

Implementation

A day in the lab will be represented by a data file such as the following:

```
Bob 3
Dan 6
Melissa 4
Oliver ready
Colleen ready
Nate 1
Gertrude 3
Colleen ready
Oliver ready
```

That is, each line is either a new student (name, confusion level), or exactly `Colleen ready` or `Oliver ready`. Your code should read this file one line at a time, printing out each student as they arrive, as well as which student each TA helps each time they are ready. For the above, your output should look something like:

```
Bob is looking for help!
Dan is looking for help!
Melissa is looking for help!
Oliver helping Bob
Colleen helping Dan
Nate is looking for help!
Gertrude is looking for help!
Colleen helping Melissa
Oliver helping Nate
Students left unhelped:
Gertrude
```

For full credit, each line of the file must be processed in $O(\log n)$ time, where n is the number of waiting students. One implication of this is that you may never iterate through the entire set of waiting students!

In addition, for this assignment **you may not use Python's sets or dictionaries**. You may use a list to keep data in a heap, and of course define your own classes as you see fit.

Finally, you should include a file with a comprehensive set of test cases.

Grading

- Problem solving and attendance: 20%
- Each TA helps the correct student at each time: 30%
- Student arrival and removal run in $O(\log n)$ time: 20%
- Main method reads file and creates and helps students correctly: 10%
- Test file: 10%
- Style and design: 10%

Submission

Transfer your program to the CS machines. Submit your program before the deadline using try:

```
try grd-603 lab8-1 tatracker.py
```

You may submit additional Python files if you have chosen to implement your solution across multiple files, but you must have your main method be in `tatracker.py`.