IT 427, Design and Analysis of Algorithms

Programming Assignment 1: Gale-Shapley Algorithm

Due date: Sep. 8, 2024, Sunday, 11:59 PM 30 points (25 on programs, 5 on report)

This is a warm-up assignment designed to help you become familiar with the format and requirements of programming assignments, such as submitting on the Linux server and through your Canvas account. Additionally, we will use this assignment to refresh your basics in Python and Unix commands.

You are asked to implement the Gale-Shapley algorithm in Python. You should name your program as `GaleShapley.py`. Preference lists will be prepared in a text file. Take `plitst1.txt` as an example, it contains 4 sets of preference lists as partially shown in the following. The first line of the file indicates the number of sets in the file. In this case, there are 4 sets.

```
4 sets of preference lists.

* Set 1 ***** |M|=|W|=5
5 men's preference list:
m1:[5, 2, 1, 4, 3]
m2:[5, 3, 4, 2, 1]
m3:[2, 1, 5, 3, 4]
m4:[3, 5, 1, 4, 2]
m5:[2, 4, 3, 5, 1]
5 women's preference list:
w1:[5, 2, 4, 1, 3]
w2:[2, 3, 1, 5, 4]
w3:[1, 3, 4, 2, 5]
w4:[4, 2, 5, 1, 3]
w5:[1, 3, 4, 5, 2]

* Set 2 ***** |M|=|W|=5
5 men's preference list:
......
```

Different sets may have difference sizes indicated by the first line of each set as `|M|=|W|=5`. For a list such as `m4:[5, 2, 1, 3, 4]` above, which means $m_4 : w_5 > w_2 > w_1 > w_3 > w_4$, i.e., m_4 prefers w_5 the most, then w_2 the second, then w_1 the third, and so on. Two consecutive sets are separated by a blank line. I will run your program from the command line and the program should print output as follows.

```
python GaleShapley.py plitst1.txt

Gale-Shapley Algorithm

** Set 1
(m, w):  (1, 5) (2, 4) (3, 2) (4, 3) (5, 1)
(w, m):  (1, 5) (2, 2) (3, 3) (4, 4) (5, 1)

** Set 2
......
......

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```

Your program should find two perfect matches for each set as above. The first match is $\{(m, best(m)|m \in$

$M\}$ and the second is $\{(w, best(w)|w \in W\}$, where $best(x)$ is the best valid partner for x as defined in the textbook. For example, $best(m_2) = w_4$ and $best(w_4) = m_4$. At the end of the output, your program should print your full name to indicate the author of the program.

Get ready and prepare your first program on Unix

1. Visit the web page of the class and check out Unix Notes and Install Python for necessary knowledge about your programming environment. To refresh or strengthen your algorithm background, you can review the class notes in IT179 and IT279 (there are many handouts and slides).

2. For your own convenience, you may want to setup a Python programming environment on your own computer, but you have to transfer your program files to our Linux Terminal Servers and Canvas. Read the information on IT Support, Tutorials and items listed under Linux box to learn how to connect your computer to our Linux server and transfer files between your computer and the server.

3. Make sure you have a working account in our Linux Terminal Server. If not, contact our system administrator to setup for you. Link to `https://login.it.ilstu.edu/` and click on the Terminal Service to login your Linux account. You have to use your ULID and password to login. From Linux Terminal Servers, you can select any of `Ash`, `Aspen`, and `Bur` (you may want to avoid their SSH alternatives unless you decide to open just one terminal). Once you login in, open one or more terminals and work from there. All operations will be done in a terminal using command line. Note: If you are using our Linux server, from the terminal window, you should call `python3` as:

   ```
   cli2@ash ~/IT427/asg1:  python3 GaleShapley.py plitst1.txt
   ```

4. Open a terminal and change your *present working directory* to your *home directory* (note that, your *home directory* is not your `Desktop` directory). Under your home directory, make a directory named `IT427`, then make a subdirectory under it, `IT427/asg1/`. From now on, I will use ~ to denotes your home directory (use Unix command `echo $HOME` to find out what is your home directory). All of your programs and needed files for this assignment should be saved under your `~/IT427/asg1` before submission. (Read next section for submission).

   Note that, the file system of Unix is case sensitive, e.g., `asg1` and `Asg1` are considered different. If the letter case of your file/directory names is not consistent with the requirements, my grading scripts will not be able to find your program, and you will get 0 on the assignment.

5. Check the contents of my `/home/ad.ilstu.edu/cli2/Public/IT427/`, which is the public directory for all assignments. All given files and data will be saved there in corresponding sub-directories. For now, you should be able to find a sub-directory, `asg1`, in which there are some text files that contains several preference lists for your program. Copy the files in my public `/IT427/asg1` to your own `~/IT427/asg1`.

Submission: There are two parts of submission: programs and reports. You programs should be submitted to Canvas and Linux server. For Linux server submission, you should login to the server and run a provided script program on the public directory. Your report and another copy of the programs should be submitted through Canvas. Two copies of your programs should be identical. **Important!! You will lose significant points if you fail to follow the instructions.**

1. The score of your program is based on the correctness, efficiency, appropriateness of data structures, and documentation. At the beginning of every program file, put a section of comments including (1) your full name, (2) student ID, (3) a pledge of honesty that you do not copy/modify from other's codes and (4) a declaration of your copyright that no one else should copy/modify the codes. Students who are involved in any plagiarism will be reported and receive 0 on the assignment.

   (a) Comment your program so I can understand the logic of your codes. You may follow the Java document convention to describe the parameters of each method.

   (b) Also, at the beginning of **every** method, class, or function that you developed on your own, put a few lines of comments with your name and date/time when you started and finished the code.

   (c) Do not declare any package for your programs. The grading script will fail to handle the user defined packages.

   (d) If everything is in place and you are ready to submit, select a secret name such as "`peekapoo`" (you should choose your own secret name, but no more than 8 characters and no space and special symbols.). This secret name will be used as the secret directory to hide your works from other students. The secret name should not be given to anyone except the instructor. To submit, run the following bash scripts:

   ```
   bash /home/ad.ilstu.edu/cli2/Public/IT427/submit427.sh peekapoo 1
   ```

   where `submit427.sh` is a bash script program, `peekapoo` is the secret name you just selected, and 1 is the number of the assignment you want to submit, in this case asg1, hence 1 is provided. If every thing goes well, all programs and data in your `/IT427/asg1/` will be copied to a place where your programs will be compiled and tested by the instructor/grader. If you want to modify your programs after submission and before the deadline, you have to run the script program again. Keep in mind that Unix is case sensitive. Don't copy the script program *submit427.sh* to your own directory, because I may modify it from time to time.

   The output of the program should be in the same format as shown above. Pay attention to the details, which will affect my grading program, and hence your score.

2. The report is graded based on the following items:

   (a) The cover page that contains assignment number, your names and ULID, not student ID, followed by the name of the secret directory. If you give me a wrong secret directory, I will not be able to grade your programs, and your program part will receive 0.

   (b) The program style including code arrangement, comments, and data structures. Since I will check and run your program on the server, do not include program code and output in the report.

   (c) The summary of the methods, algorithms and data structures, and efficiency analysis on time and space in details in terms of big-O notations. If there is any difficulties encountered in this assignment, you can report it.