Indian Statistical Institute

Semester-I 2024–2025

M.Tech.(CS) - First Year

Lab Test 3 (02 December, 2024)

Subject: Computing Laboratory

Total: 60 marks Duration: 4 hrs.

INSTRUCTIONS

1. You may consult or use slides / programs provided to you as course material, or programs that you have written yourself as part of classwork / homework for this course, but please **do not** consult or use material from other Internet sources, your classmates, or anyone else.
2. Unless otherwise specified, all programs should take the required inputs from stdin, and print the desired outputs to stdout. Please make sure that your programs adhere strictly to the specified input and output format. **Your program may not pass the test cases provided, if your program violates the input and output requirements.**
3. Submissions from different students having significant match will **not be evaluated**.
4. To avoid mismatches between your output and the provided output, please store all floating point numbers in `double` type variables.

You have to use a heap to implement a discrete event simulator for a hospital scenario involving m patients and n facilities (doctors in different departments, various medical test centres, administrative counters, e.g., billing and inquiries, etc.). For each patient P_i, you are given the patient's arrival time, a sequence of facilities that she needs to visit (in order), along with the service time required at each facility. Patients are serviced in first-come-first-served order. If multiple patients $P_{i_1}, P_{i_2}, \ldots$ arrive at a particular facility at the same time, they are served in increasing order of their serial numbers $(i_1, i_2, \ldots)$.

Input format: The two integers m and n, followed by one line for each of $P_0, P_1, P_2, \ldots, P_{m-1}$, in that order. The line for P_i will start with P_i's arrival time in HHMM format (e.g., 1430), followed by k, the number of services that P_i needs to avail, followed in turn by a list of k 2-tuples. Each of these tuples will specify the serial number of the facility that she needs to visit (between 0 and $n-1$), along with the service time required at that facility, in minutes. Note that a patient may need to visit the same facility multiple times, e.g., to consult a doctor before and after a blood test.

You may assume that all patients arrive between 5:00 AM and 11:59 PM on a single day.

Sample input 0:

```
3 3
0550 5 0 20 1 15 2 40 1 10 0 13
0602 5 1 35 0 12 2 30 0 14 2 27
0524 5 0 30 2 50 1 14 2 17 1 8
```

In the scenario given above, there are 3 patients, P_0, P_1 and P_2, and 3 facilities, F_0, F_1 and F_2. P_0, P_1 and P_2 arrive at 5:50 AM, 6:02 AM and 5:24 AM respectively. Each patient needs to avail 5 services.

For questions 1 and 2, assume that a facility can service any number of patients at a time.

Q1. (20 marks)

Write a program to print a log of the hospital's activities.

Output format: Each line should start with a timestamp in HHMM: format; the rest of the line should be of the form: `Facility i attends to Patient j for t minutes`

Sample output 0: For the scenario given in Sample input 0, your program should print the following.

```
0524: Facility 0 attends to Patient 2 for 30 minutes
0550: Facility 0 attends to Patient 0 for 20 minutes
0554: Facility 2 attends to Patient 2 for 50 minutes
0602: Facility 1 attends to Patient 1 for 35 minutes
0610: Facility 1 attends to Patient 0 for 15 minutes
0625: Facility 2 attends to Patient 0 for 40 minutes
0637: Facility 0 attends to Patient 1 for 12 minutes
0644: Facility 1 attends to Patient 2 for 14 minutes
0649: Facility 2 attends to Patient 1 for 30 minutes
0658: Facility 2 attends to Patient 2 for 17 minutes
0705: Facility 1 attends to Patient 0 for 10 minutes
0715: Facility 0 attends to Patient 0 for 13 minutes
0715: Facility 1 attends to Patient 2 for 8 minutes
0719: Facility 0 attends to Patient 1 for 14 minutes
0733: Facility 2 attends to Patient 1 for 27 minutes
```

Q2. (5 marks)

Write a program to print the departure time for each patient. Assume that a patient leaves as soon as all her service requirements are satisfied. Neglect the time spent transitioning between facilities.

Output format: The output should have one line per patient, printed in increasing order of serial number. Each line should contain 2 space-separated integers: the patient's serial number (between 0 and $m - 1$), and her departure time in HHMM format. Depending on her arrival time and total service time, a patient may not leave the hospital on the same day that she arrives. Your output simply needs to be in HHMM format; you do not need to keep track of the number of days elapsed.

Sample output 0: For the scenario given in Sample input 0, your program should print the following.

```
0 0728
1 0800
2 0723
```

Q3. (25 marks)

Next, consider a situation where each facility can cater to **only one patient** at a time. In this scenario, a patient may have to wait for a facility. Write a program to print a log of the hospital's activities.

Output format: The output format will be similar to that for Q1, except that the portion of the line after the time stamp may now be in one of the two following formats:

`Facility i attends to Patient j for t minutes`

or

`Patient i needs Facility j for t minutes, waits`

Sample output 0: For the scenario given in Sample input 0, your program should print the following.

```
0524: Facility 0 attends to Patient 2 for 30 minutes
0550: Patient 0 needs Facility 0 for 20 minutes, waits
0554: Facility 0 attends to Patient 0 for 20 minutes
0554: Facility 2 attends to Patient 2 for 50 minutes
0602: Facility 1 attends to Patient 1 for 35 minutes
0614: Patient 0 needs Facility 1 for 15 minutes, waits
0637: Facility 1 attends to Patient 0 for 15 minutes
0637: Facility 0 attends to Patient 1 for 12 minutes
0644: Patient 2 needs Facility 1 for 14 minutes, waits
0649: Facility 2 attends to Patient 1 for 30 minutes
0652: Patient 0 needs Facility 2 for 40 minutes, waits
0652: Facility 1 attends to Patient 2 for 14 minutes
0706: Patient 2 needs Facility 2 for 17 minutes, waits
0719: Facility 2 attends to Patient 0 for 40 minutes
0719: Facility 0 attends to Patient 1 for 14 minutes
0719: Patient 2 needs Facility 2 for 17 minutes, waits
0733: Patient 1 needs Facility 2 for 27 minutes, waits
0759: Facility 1 attends to Patient 0 for 10 minutes
0759: Facility 2 attends to Patient 1 for 27 minutes
0759: Patient 2 needs Facility 2 for 17 minutes, waits
0809: Facility 0 attends to Patient 0 for 13 minutes
0826: Facility 2 attends to Patient 2 for 17 minutes
0843: Facility 1 attends to Patient 2 for 8 minutes
```

Q4. (10 marks)

Write a program to print, for each patient, the total time in minutes that the patient spends **waiting** (for any service).

Output format: The output should have one line per patient. Each line should contain 2 space-separated integers: the patient's serial number (between 0 and $m - 1$), and her waiting time, in minutes.

Sample output 0: For the scenario given in Sample input 0, your program should print the following.

```
0 54
1 26
2 88
```