CS 124 Problem Set 8

Logged in as siddharthsingh@fas.harvard.edu

Due: Wednesday, April 22, 2015 11:59 pm EDT (**deadline passed**)

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Problems

Problem A

THIS PROBLEM IS EXTRA CREDIT

NO COLLABORATION IS ALLOWED

EXTRA CREDIT ONLY RECEIVED IF PROBLEM IS FULLY SOLVED

(100 POINTS ON PROGRAMMING SERVER)

SEE EMAIL FOR MORE DETAILS

"Can we pretend that airplanes in the night sky are like shooting stars,
'cause I could really use a wish right now."
Airplanes
2010

There are N cities in the United States that are connected by a network of flights. There is some set of flights, F, that run every hour. A given flight F_i takes t_i hours to transport l_i people from an origin city C_O to a destination city C_D. There is some subset of cities, V_e, that are East Coast cities and some subset of cities, V_w, that are West Coast cities. Initially, there are p_i people in city $C_i \in V_e$ and no people at any of the other cities. Each of these people want to get from their East Coast city to some West Coast city, although they don't care which one. Find the minimum time T needed for all the people to get from East Coast cities to West Coast cities.

You may assume that all flight times are integer values and it takes no time to transfer flights. An individual that lands in some city can immediately get onto a flight leaving that city, as long as the flight is not already at capacity. Also, the airplanes themselves are not limiting resources. A city with no incoming flights will still be able to have outgoing flights every hour.

CONSTRAINTS
$4 \leq N \leq 45$
$1 \leq |V_e| \leq 10$
$1 \leq |V_w| \leq 10$
$5 \leq p_i \leq 150$
$1 \leq t_i \leq 10$
$5 \leq l_i \leq 50$

TEST CASES & TIME LIMITS
Test cases 1 and 2 are the sample inputs. They are worth 0 points.

3-10 have one East Coast city and one West Coast city (and some number of intermediate cities). All of the people begin in the single East Coast city (e.g. Boston) and are trying to reach the single West Coast city (e.g. Seattle). Each flight takes exactly one hour.
300 ms

11-18 may have one East Coast city and one West Coast city. Again, all of the people begin in Boston and are trying to reach Seattle through a combination of transfers. In these test cases, however, each flight takes a positive integral amount of hours.
300 ms

19-27 may have multiple East Coast cities and multiple West Coast cities. People can begin at any East Coast city and are trying to reach any West Coast city. Flights takes a positive integral amount of hours.
350 ms

(3x for Java, 10x for Python)

INPUT FORMAT
First a space-delimited line containing N (the number of cities total), |V_e| (the number of East Coast cities), $|V_w|$ (the number of West Coast cities), and |F| (the number of connections between two cities).

Next a space-delimited line containing the indices of the East Coast cities.

Next a space-delimited line containing the populations of the corresponding East Coast cities listed in the previous line.

Next a space-delimited line containing the indices of the West Coast cities.

Next |F| space-delimited lines, each of which contains o d l t, where C_o is the origin of the flight, C_d is the destination city of the flight, l is the capacity, and t is the number of hours that the flight takes.

OUTPUT FORMAT
Print a single integer representing the minimum time, T, to get all people from the East Coast cities to the West Coast cities, with respect to the capacities of each flight, starting populations of the East Coast cities, and time lengths of each flight. If there is no possible way to get all the people from the East Coast to the West Coast then return -1.

SAMPLE INPUT
```
4 1 1 4
0
50
3
0 1 40 2
```

```
1 3 40 1
0 2 10 3
2 3 20 1

SAMPLE OUTPUT
4

DETAILS
Although the path 0-1-3 has a lower total time, the capacity along that path is
40. Because we are trying to move 50 people from the single East Coast city to
the single West Coast city, we have to use the other path 0-2-3 which has a
total time of 4. Because these paths are being traversed simulataneously, we
know our time to get all of the people across the country is 4 hours.

SAMPLE INPUT
5 2 2 5
0 1
10 10
2 3
0 4 5 1
0 2 5 2
4 2 5 5
1 2 2 4
1 3 8 4

SAMPLE OUTPUT
4

DETAILS
Path 0-4-2 will take 6 hours while path 0-2 takes only 2 hours. Therefore, we
send 5 people on the first flight from 0 to 2. We then let 5 people wait to
take the second flight from 0-2. The first flight will get in after 2 hours,
and the second flight will get in after 3 hours (1 hour delay between first
and second flights). From city 1, we send 2 people on the first flight to
city 2 and 8 people on the first flight to city 3. Each of these flights
take 4 hours.
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Based on the "Ultra Cool Programming Contest Control Centre" v1.7b by Sonny Chan
Modified for CS 124 by Neal Wu, with design help from Martin Camacho