Ben-Gurion University

Faculty of Engineering Sciences

Department of Electrical and Computer Engineering

Introduction to algorithms and data structures

Home assignment #3

Semester B / 2021

Instructions

These are the guidelines for submitting this home assignment:

1. The home assignment is submitted **only** through the moodle VPL!
2. Do not ask questions regarding the project through email, Use the moodle forum only.
3. You should submit a single **.c** or .**cpp** file in the C/C++ VPL component.
4. The template is a .c file and you may use it (not mandatory), even if you are writing your project in cpp language!!
5. There are three problems you have to provide solutions to.
6. You do not have to check the input. You can assume the input is correct.
7. The program will print the solution to the screen. For floating point answers, print only the first two digits after the point.
8. Each problem will be tested with 8 different inputs.
9. **If your solution is not correct, or your algorithm times-out (more than 1 second) you will get 0 for the test input. Otherwise, 1.**
10. For each question write as a comment in your code a tight upper bound to your solution including an explanation for it.
11. The assignment is **solo**! Each student must submit his own file with the name Assignment2.c or Assignment2.cpp. Deadline is in the moodle.
12. The inputs are entered by the user. You can use redirect values from a text file into your program from the command-line (Google it).
13. The first input will be the number of problem you want to solve.
14. A template file is attached, you are not allowed to add any other libraries,but you may implement by yourself in your file.
15. Don't use scanf_s! Make sure it compiles with gcc 9.3.0 , C++ 11- When submitting through the VPL you can check if your file compiled.
16. A few test cases have been entered into the VPL component, when submitting your file you must make sure your code complies with the given input and output.

Good Luck!

Problem 1

Iceland trip

Vik the puffin is planning a long road trip around the circle road in Iceland, during which he wants to visit all the landmarks along a path of length L. The tank of Vik's car can take up to F units of fuel and for every unit of distance covered, his car consumes a unit of fuel. Using Google maps, Vik knows how far each of the N gas stations are from the beginning of the path and the price per fuel unit each station offers. At the starting point he has T units of fuel in his car.

1 Task

Write a program that will accept the above information and will calculate the minimum amount of money Vik needs to spend on gas. If the journey is impossible to make, it should print -1.

2 Input

The first line contains four space separated integers:
N ($0 < N < 50001$): The total number of gas stations
F ($0 < F < 1000001$): The units of fuel Vik's car can take
T ($0 <= T <= F$): The units of fuel Vik's car has at the beginning of the trip
L ($0 < L < 1000000001$): The path length of the landmarks he plans to visit
Each of the following N lines will contain two integers: the first one, D_i ($0 <= D\_i <= L$) corresponds to the distance of the station from the starting point, and the second one, C_i ($1 <= C\_i <= 1{,}000{,}000$) represents the cost per fuel unit for that station.

Note: You may assume that the trip will be on a straight line where all gas stations are spread on this line at the positions specified by their D_i values.

3 Output

The minimum amount of money to be spent or with -1 in case the trip is not feasible.
Note: There is a newline character at the end of the last line of the output.

4 Sample input

```
4 20 6 34
4 40
18 15
10 7
20 12
```

5 Sample output

348

6 Explanation

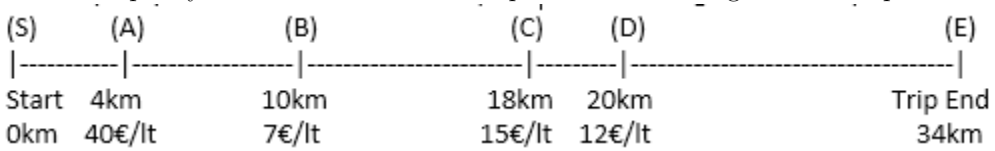
The first line of the input is 4 20 6 34 which means that:

a. There are in total N=4 gas stations on the route
b. The (max) fuel capacity of Vik's car is F=20 liters
c. The tank currently has T=6 liters of gas
d. Vik wants to travel L=34 kms in total

Then the details for the 4 gas stations are provided in the form Di Ci, where Di is the distance of this gas station from the starting point and Ci is the cost per liter of gas:

4 40
18 15
10 7
20 12

For simplicity assume that the whole trip is done in a straight line as depicted below:



Obviously Vik does not have enough fuel for all 34 kms, so he needs to refuel. The cheapest gas station is the one labeled (B) above, however Vik does not (initially) have enough fuel in his tank to reach (B), since B-S = 10 and he has T=6. So he needs to add an extra 4 liters from gas station A, so that he can the make it until gas station B to get as much (cheap) as he can in order to make his 34 km journey. Thus he pays (i) 4lt * 40€/lt = 160€ and now he can make it until (B). Since until this moment he has only traveled 10 kms, he needs gas for another 34-10=24kms. Normally he would want to refuel his car with 24 liters (since B is the cheapest gas station) but since his (max) fuel capacity is F=20 liters he will only take 20 liters and thus pay (ii) 20 lt * 7 €/lt = 140€. He knows however that up to point (B) he has only traveled 10kms and he needs to travel another 24kms to reach his goal, whereas he has gas for 20kms. So he would have to stop at a later gas station (after he has traveled at least 4kms) to refuel another 4 liters of gas so that he could complete the whole 34 kms journey. Since he now has quite some gas, he may decide whether he wants to refuel at (C) or at (D) and since (D) is cheaper, it is more than 4kms away from (B) and is within reach (based on his gas in the tank) he will choose to refuel another 4 liters at (D) and thus pay (iii) 4lt*12€/lt=48€). After that he can successfully reach the end point of his trip.

Problem 2

Farthest away from enemies

On the battlefield, the king must be present to manage the war. Therefore, the king is the most important and should be the farthest away possible from the enemies.

Assume the battlefield is a M by N grid, and each cell in the grid can be either 1 (a cell occupied by an enemy) or 0 (a cell occupied by friendly forces). The king will be positioned in the 0 cell that is farthest from all 1's.

1 Task

Given a Matrix of size N*M filled with 1‘s and 0‘s, the task is to find the maximum distance from a 0-cell to its nearest 1-cell.

Note: Only horizontal and vertical movements are allowed in the matrix.

Note: If the matrix is filled with only 0's or only 1's, return -1.

2 Input

The first line is a pair of space separated integers:

Number of rows N - $1 \leq N \leq 2000$.

Number of columns M - $1 \leq M \leq 2000$.

The following N lines will have M space separated values of 0 and 1.

3 Output

The farthest distance from a 0 to the closest 1. If the matrix is filled with only 0's or only 1's, return -1.

4 Sample input

3 3

1 0 0

0 0 0

0 0 0

5 Sample output

4

6 Sample explained

Cell number (2, 2) is at the farthest distance of 4 cells from the only 1-cell (0, 0).

Problem 3

Maze runner

1 Task

Thomas is a young adventurer who is curious about a maze he heard about from the wise old man. One day he decides to go on a mission to discover what lies at the end of the maze and asks for your help to do so.

The maze is an NxM dimension matrix, You need to help Thomas get from the starting location(0,0) to the end of the maze(N-1,M-1) fast enough to avoid starvation.

The maze walls are in the shape of toxic filled circles, hence each cell of the maze which engages a wall cannot be passed through. thanks to the advice of the wise old man, Thomas knows of their radiuses and center coordinates before starting the trip.

Thomas can move in any direction(including diagonal) and each movement takes one day,your task is to tell Thomas how many days it will take him to get to the end of the maze-if possible.

2 Input

The first line contains the size of the matrix as two integers: N and M.

$3 \leq N \leq 200$

$3 \leq M \leq 200$

The next line is the number of circles in the matrix: 0<K<=100.

Each of the next K lines are the radiuses and center coordinates of each corresponding circle: 0<Ri, 0<=Xi<=N-1, 0<=Yi<=M-1.

3 Output

The minimum number of steps required to get from the starting point(0,0) to the end of the maze(N-1,M-1). If there is no way to get to the end, -1 is returned.

4 Sample input

```
6 7
  2
  1 2 3
  1 3 1
```

5 Sample output

```
9
```

6 Sample explained

6x7 matrix with two circles of radius 1 centered in (2,3) and (3,1). The fastest way to reach the end is through the blue arrow in the picture below, which is 9 steps.