

Name:

Roll Number:

ESO207: Data Structures and Algorithms

Programming Assignment 3

Due Date: 3rd April, 2022, 11:59 PM

Total Number of Pages: 4

Total Points 100

Note :

- All questions have to be answered through a contest in Hackerrank. The contest has 3 challenges, each corresponding to a part. You have to submit your code through the contest. Following is the link to the contest: <https://www.hackerrank.com/eso207-programming-assignment-3>
- Your code submissions may be thoroughly checked for any signs of plagiarism against other students' submissions and/or online resources. Any kind of malpractice or plagiarism detected would be severely penalised.
- Allowed Languages for challenge code submission : C, C++.
- Allowed libraries : `stdio.h` for C and `iostream`, `vector` for C++.
- Use the same hackerrank username for programming assignment 3 as you have used for programming assignment 1 and programming assignment 2.
- You will also need to upload all your program files (C/C++) on moodle.
- The teaching assistant in charge of Programming Assignment 3 is Aaryan Srivastava (aaryans@cse.iitk.ac.in).

Name:

Rollno:

Question 1. (30 points) **Cheenu and milkshakes**

Description:

Cheenu, the hamster, is roaming out on the streets of the city in search of his favorite milkshake at the well-known milkshake chain *Mio-Mama*. It has various shops all over the city, though his favorite milkshake costs a different amount of money at different shops of *Mio-Mama*.

The city can be modelled as an $n \times m$ 2-D Matrix (n rows, m columns) with s shops, with the i^{th} shop located at $(shopx_i, shopy_i)$ with c_i as the cost of his favorite milkshake.

He can move from (i, j) to one out of $(i + 1, j)$, $(i, j + 1)$, $(i - 1, j)$ or $(i, j - 1)$ (given they are inside the grid) in a single step.

Additionally, Cheenu knows of a single-use manhole which allows him to start his endeavour of having his milkshake at anyone out of k known cells, with the j^{th} start point located at $(startx_j, starty_j)$ in the city grid.

Cheenu wants to know the answer to q questions. Since Cheenu is an intelligent hamster, for the i^{th} question, he wants to what is the **lowest possible cost** of his favourite milkshake he can buy within t_i steps from a starting point of his choice? (Answer -1 if he is unable to buy his favorite milkshake at all).

Cheenu is very excited to have his favorite milkshake, but can you help him answer all his questions?

Input:

First line contains two integers n and m , the number of rows and columns.

The next line contains s , the number of shops.

The i^{th} of the next s lines contains 3 space separated integers: $shopx_i, shopy_i, c_i$

The next line contains k , the number of start points.

The j^{th} of the next k lines contains 2 space separated integers: $startx_j, starty_j$

The next line contains q , the number of questions.

The next line contains q integers, with t_r as the r^{th} integer.

Output:

Print one line with q integers with the r^{th} integer as the answer to the r^{th} question.

Constraints:

$$1 \leq n, m \leq 1000$$

$$1 \leq s, k \leq 10^5$$

$$1 \leq startx_j, shopx_i \leq n$$

$$1 \leq starty_j, shopy_i \leq m$$

$$1 \leq c_i \leq 10^9$$

$$1 \leq q \leq 10^5$$

$$0 \leq t_r < n + m$$

Example:

Sample Input:

```
3 3
2
1 3 10
3 2 20
2
1 1
3 1
2
1 2
```

Sample Output:

```
20 10
```

Explanation:

2^{nd} shop for first query, 1^{st} shop for second query.

Name:

Rollno:

Question 2. (40 points) **Riddle me this, Batman!**

Description:

Batman has been pursuing the Riddler for a long time and is closer than ever to the final clue to catching him.

For this problem, Gotham can be modelled as a graph with n nodes and m edges, with the i^{th} edge connecting the nodes u_i and v_i .

The Riddler doesn't want the Batman catching him, so he tries to disrupt the Batman from reaching the final clue by blocking **at most one** edge in the graph, restricting Batman's movement.

Find the number of ordered pairs (st, cl) such that Batman can reach cl after starting at st ($st \neq cl$), irrespective of the edge blocked by the Riddler.

Input:

The first line contains two space-separated integers: n (number of nodes) and m (number of edges).

The i^{th} of the next m lines contains 2 space separated integers: u_i and v_i , the endpoints of the i^{th} edge.

Output:

Print one integer, the answer to the problem.

Constraints:

$$1 \leq n, m \leq 10^5$$

$$1 \leq u_i, v_i \leq n$$

Example:

Sample Input:

4 4

1 2

2 3

1 3

1 4

Sample Output:

6

Explanation:

There are 6 valid pairs: $(1, 2), (1, 3), (2, 1), (2, 3), (3, 1), (3, 2)$

Name:

Rollno:

Question 3. (30 points) **cHeap and best?**

Description:

Joy, the football-loving baby shark, has a project about observing the recent trends and changes of products in the chocolate industry.

The changes in the market can be modelled as q events, where the i^{th} event can be one of the following three types:

- Type 1: A new product is launched into the market with price c_i .
- Type 2: As the competition increases, the most expensive product gets kicked off and is removed from the market. If there are no products in the market, it remains unchanged.
- Type 3 (query): Joy wants to know the range of prices of the products currently in the market, i.e., the difference between the prices of the most expensive and the least expensive items in the market at its present state. If there are no products in the market, the answer is -1 .

Help Joy complete his project so that he can cheer for his favorite football team in time!

Input:

First line contains q , the total number of events and queries.

i^{th} of the next q lines depicts the i^{th} event/query which is one of the following types:

- Type 1: Two space-separated integers: 1 and c_i (the price of the new product).
- Type 2: A single integer 2.
- Type 3: A single integer 3

Output:

For each query of type 3, print the answer to the query on a new line.

Constraints:

$$1 \leq q \leq 10^5$$

$$1 \leq c_i \leq 10^9$$

Example:

Sample Input:

```
6
1 53
1 11
3
2
1 24
3
```

Sample Output:

```
42
13
```

Explanation:

- For the 1st query of type 3, there are two products in the market with prices 53 and 11, respectively.
- For the 2nd query of type 3, there are two products in the market with prices 24 and 11, respectively.