Project – Marathon

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1 Introduction

A philosopher once said, "Some flowers... Some flowers don't grow in some soils. Such is life." A few days ago, I received such an e-mail from rambo.ocon@boun.edu.tr. He wrote in that e-mail, "As a traveling race man, I could not do anything when it came to coding. I'm not good enough to code and need help from Mustafa." So he asked me to create this project for you to help him. And now it's time to help him!

Esteban Ocon, a famous Formula 1 pilot, also known as Rambo Ocon, decides to participate in the 43rd Istanbul marathon, even though he has no previous running experience. Since he has a competitive personality, he wants to finish the race in first place. So he decides to cheat and complete the course in the shortest way possible.

In the meantime, he sees that at some points on the path, the opposing team's flags fly around. He wants to take down all these flags before the race starts. Because he doesn't want to get tired before the race, he wants to do it in the shortest possible way. Also, this will mean that the chances of him getting caught by the police will decrease; hence he will make it to the race.

Before the race, Rambo Ocon takes the map of Istanbul in front of him, marks the points where the flags are, and starts calculating the shortest route. Since there are many streets in Istanbul, and he is bad at math, he cannot calculate it. Besides, he doesn't know how to code, which is the icing on the cake. It's time to help Rambo!

2 Clarification

Let's say the race starts from Samandıra Tesisleri and finishes at Şükrü Saraçoğlu stadium. The flags are at 1st Istanbul Bridge and 2nd Istanbul Bridge.

Before the race, he must cut all the flags using the shortest possible path. There are no restrictions on the order in which he cuts the flags. He can start from the 1st Bridge, then go to the 2nd Bridge, or vice versa.

Thanks to public transportation, he can travel the same exact path as many times as he wants after traveling a path between two flags once, without getting tired. (More detailed explanation is given with the graphs in the More Examples section.)

During the race, he has to start from Samandıra Tesisleri and finish at Şükrü Saraçoğlu by running the shortest route.

- He has to cut all the flags, starting from any point with a flag.
- He can cut the flags in any order that will lead to the minimum distance path.
- There can be many different paths between any two flags.
- He can travel using the same point more than once. However, if he uses the same exact path between two flags, he can travel with public transportation (at no cost).
- Exact route: Let's say s1 and s4 contain flags. If Rambo Ocon uses the s1-s2-s3-s4 path without passing through any other points, then he can travel this same path with no cost (s1-s2-s3-s4 and s4-s3-s2-s1).
- He can use both directions of all point connections (e.g., graph is undirected).

3 Input & Output

3.1 Input

- The first line represents (V) the number of points in Istanbul (e.g., the number of all the nodes in the graph).

  $0 \leq E_i \leq 100$ *where* E_i *is the number of edge count for* V_i.

- The second line represents the total number of flags (M).

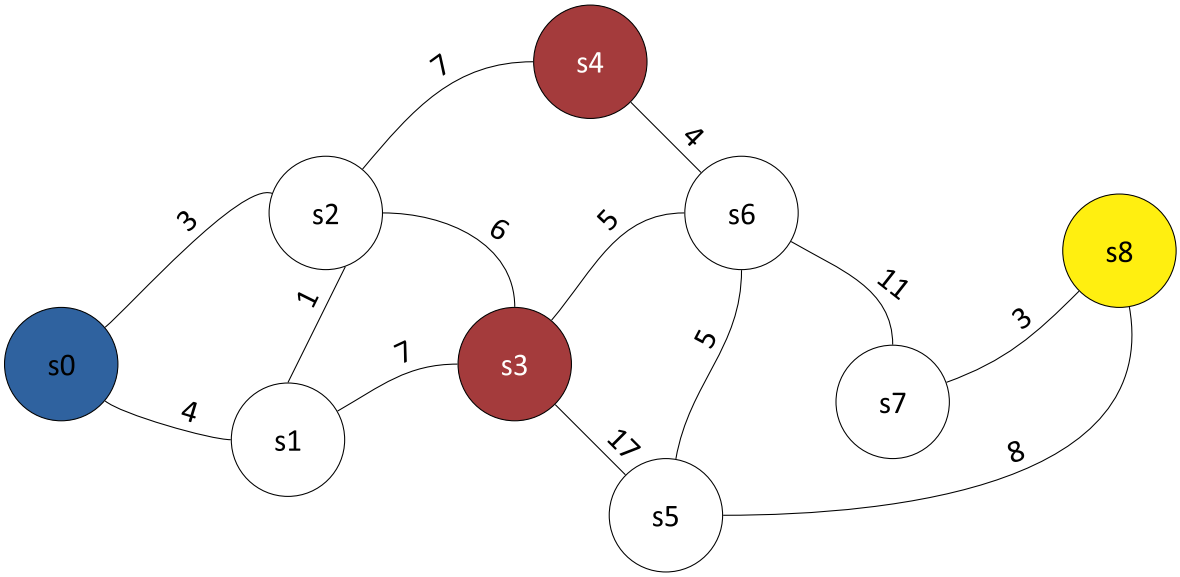
  $2 \leq V * M \leq 5.10^6$ and $2 \leq V \leq 5.10^6$

- The third line represents the name of the starting and ending points, respectively.
- The fourth line represents the name of the points where the flags are located.
- Each next line will give the name of a point in Istanbul and the names and lengths of the points that can be reached from that point in pairs. For example:
  There are ways from s1 point to s2, s3, and s4 points of length 1, 2, and 3, respectively.

  Then input line will be s1 s2 1 s3 2 s4 3 If there is no way from s2, input line for s2 will be s2

Input	Explanation
9 2 s0 s8 s3 s4 s0 s1 4 s2 3 s1 s2 1 s3 7 s2 s3 6 s4 7 s3 s6 5 s5 17 s4 s6 4 s5 s6 5 s8 8 s6 s7 11 s7 s8 3 s8	The race path has 9 points. There are 2 flags in the path. The race will start from s0 point and end at s8 point. The flags are located at s3 and s4 The point with ID s0 has a way to s1 and s2 with length of 4 and 3 respectively. This also means that s1 has a way to s0 with length of 4.

Table 1: Sample Input with Explanations



3.2 Output

- An integer, the length of the path during the race day. (If finishing the race is not possible, then there must be something wrong with the map so print -1.)
- An integer, the length of the path to cut the flags. (If cutting all the flags is not possible, then there must be something wrong with the map so print -1.)

Output	Explanation
27	The length (cost) of the path that Rambo used during the race. ($s0 \rightarrow s2 \rightarrow s4 \rightarrow s6 \rightarrow s5 \rightarrow s8$)
9	The length of the path that Rambo used to cut the flags. ($s3 \rightarrow s6 \rightarrow s4$)

Table 2: Expected Output File

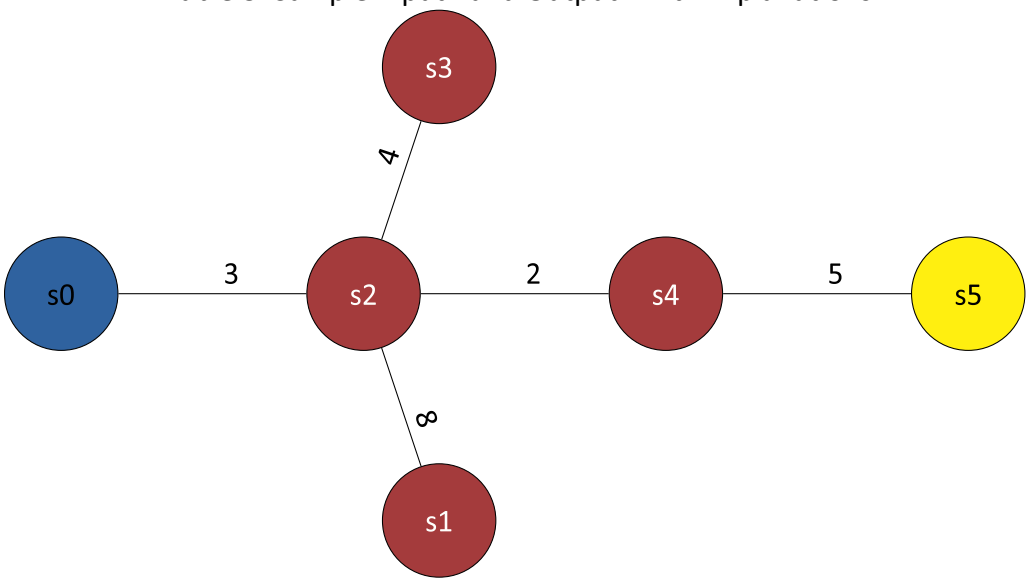
4 More Input & Output Examples

4.1 Example1

Input
6
4
s0 s5
s1 s2 s3 s4
s0 s2 3
s1 s2 8
s2 s3 4 s4 2
s3
s4 s5 5
s5

Output	Explanation
10	($s0 \rightarrow s2 \rightarrow s4 \rightarrow s5$)
14	($s1 \rightarrow s2 \rightarrow s3 \rightarrow s2 \rightarrow s4$)

Table 3: Sample Input2 and Output2 with Explanations



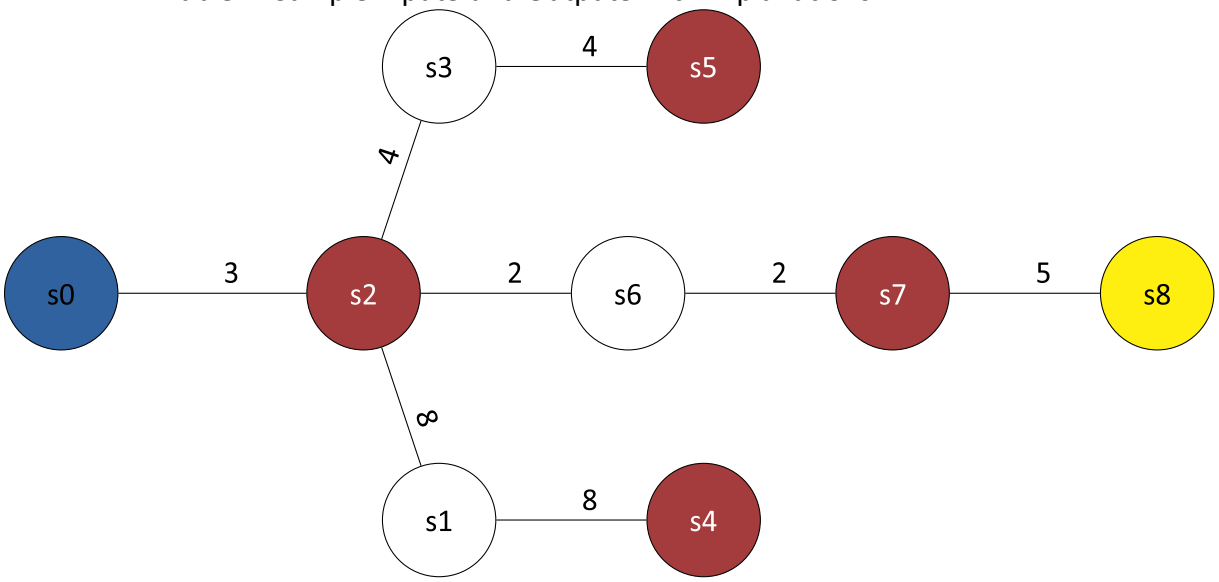
Explanation: While cutting the flags, Rambo starts from s1. Then he goes to s2. Then he goes to s3. He traveled 12 distances in total. Since he used exactly the same path between s2-s3 before, he uses public transport here and returns to s2 again. His total distance is still 12. Then he goes to s4 and finishes cutting the flags with a distance of 14.
Note that it is also okay to start from s2, s3, or s4. All of them will give the same result. But he can't start from s0 or s5.

4.2 Example2

Input
9 4 s0 s8 s2 s4 s5 s7 s0 s2 3 s1 s2 8 s4 8 s2 s3 4 s6 2 s3 s5 4 s4 s5 s6 s7 2 s7 s8 5 s8

Output	Explanation
12	$(s0 \rightarrow s2 \rightarrow s6 \rightarrow s7 \rightarrow s8)$
28	$(s4 \rightarrow s1 \rightarrow s2 \rightarrow s3 \rightarrow s5 \rightarrow s3 \rightarrow s2 \rightarrow s6 \rightarrow s7)$

Table 4: Sample Input3 and Output3 with Explanations



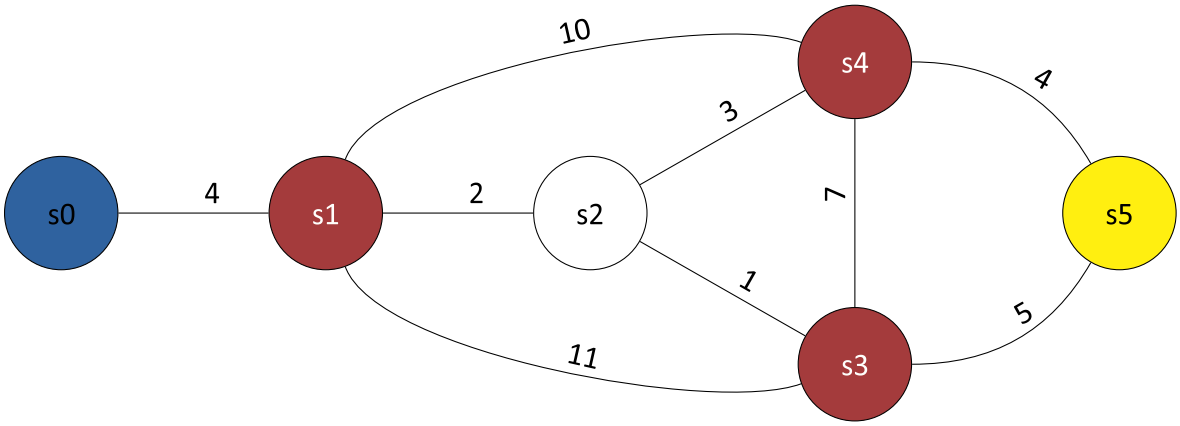
Explanation: While cutting the flags, Rambo starts from s4 and follows the path s1, s2, s3, s5 and the total distance is 24. Because he used the exact s5-s3-s2 path before, he goes to s2 at no cost. Then he goes to s6 and s7. The spanned total distance is 28.
Note that it is also okay to start from s7, s5 or s2. All of them will give the same result. However, he can't start from any other nodes without flags.

4.3 Example3

Input
6
3
s0 s5
s1 s3 s4
s0 s1 4
s1 s2 2 s3 11 s4 10
s2 s3 1 s4 3
s3 s4 7 s5 5
s4 s5 4
s5

Output	Explanation
12	$(s0 \rightarrow s1 \rightarrow s2 \rightarrow s3 \rightarrow s5)$
7	$(s1 \rightarrow s2 \rightarrow s3 \rightarrow s2 \rightarrow s4)$

Table 5: Sample Input4 and Output4 with Explanations



Explanation: While cutting the flags, Rambo starts from s1. Then follows the path s2-s3 with a total distance of 3. Now he has to go to s4 but because he never traveled the exact path s3-s2-s4, he can't use public transportation. He has to follow s2, s4 with a total distance of 3+4 = 7.

4.4 Example4

Input
6 3 s0 s5 s1 s3 s4 s0 s1 4 s1 s2 2 s3 20 s4 10 s2 s3 10 s4 3 s3 s4 20 s5 20 s4 s5 20 s5

Output	Explanation
29	$(s0 \rightarrow s1 \rightarrow s2 \rightarrow s4 \rightarrow s5)$
17	$(s1 \rightarrow s2 \rightarrow s3 \rightarrow s1 \rightarrow s2 \rightarrow s4)$

Table 6: Sample Input4 and Output4 with Explanations