Mock Lab Test

COL106: Data Structures and Algorithms, Semester-I 2023–2024

Duration : 90 mins

1 Problem 1 (50 marks)

1.1 Statement

There are n cities and m bidirectional roads between them. Two cities a and b are said to be reachable if there exists a path between them using these roads. Your goal is to construct additional number of roads such that every pair of cities are reachable from one another. Find the **minimum number of roads** you need to construct for a given input. Note that we are not asking you to tell the cities between which roads need to be constructed, just the number of additional roads needed.

1.2 Constraints

- $1 \leq n \leq 10^5$
- $1 \leq m \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$

1.3 Coding guideline

Write your implementation in the function ***int solve(int n,vector<vector<int>> edges)*** of the file **q1.cpp**. Each $edges[i]$ would be of length 2, which denotes the edge between city $edges[i][0]$ and $edges[i][1]$.

2 Problem 2 (75 marks)

2.1 Statement

You are given an array ”words” of size n consisting of non-empty strings, (each string would consist of lowercase letters only : a-z). We can define score of each string in ”words” as follows -

Score(w) = number of strings s in array ”words” such that w is a prefix of s (note that a string is considered a prefix of itself)

Return an array ”answer” of size n, where answer[i] is the sum of scores of every non-empty prefix of words[i].

2.2 Constraints

- $words.length \leq 1000$
- $words[i].length \leq 1000$

2.3 Coding guideline

Write your implementation in the function ***vector<int> solve(vector<string> words)*** of the file **q2.cpp**.

3 Problem 3 (100 marks)

3.1 Statement

Your task is to find a minimum-price flight route from Delhi to Bombay. You have one discount coupon, using which you can halve the price of any single flight during the route. However, you can only use the coupon once.

When you use the discount coupon for a flight whose price is x, its price becomes $\lfloor \frac{x}{2} \rfloor$.

You are given two integers n, m : the number of cities and flight connections. The cities are numbered $1, 2, ..., n$. City 1 is Delhi, and City n is Bombay. After this there are m lines describing the flights. Each line has three integers a, b, and c: a flight begins at city a, ends at city b, and its price is c. Each flight is unidirectional. You can assume that it is always possible to go from Delhi to Bombay.

Hint: The min-cost of path from $u \rightarrow v$ would be same as the min-cost path of from $v \rightarrow u$ in the reversed graph (i.e graph formed by reversing the original edges)

3.2 Constraints

- $2 \leq n \leq 10^5$
- $1 \leq m \leq 2 \cdot 10^5$
- $1 \leq a, b \leq n$
- $1 \leq c \leq 10^9$

3.3 Coding guideline

Write your implementation in the function ***long long int solve(int n,vector<vector<int>> flights)*** of the file **q3.cpp**. Each $flights[i]$ would be of length 3, which denotes the flight from city $flights[i][0]$ to $flights[i][1]$, whose cost is $flights[i][2]$. The function should return the min cost to travel from Delhi (city 1) to Bombay (city n).
We have also given you a generic minheap to use if you want to, see the comments in the file for more details.

4 Starter Code relevant details

Starter Code can be downloaded from here.
To compile your program and run the test cases for the same run the following command from parent directory: *make part**x*** where x is the problem number (1,2 or 3), eg := make part1

To check the test cases details for any problem see the folder *tests*.
Important: Do not add or delete the headers given in .cpp files. Also do not make any changes to the "main" function.

5 Submission Instructions

Please submit the files *q1.cpp, q2.cpp and q3.cpp* on gradescope, and do not submit anything else.