Mid-Term: ECS 342/442/642 Competitive Programming

10:00 am to noon on 22^{nd} Feb, 2025

Instructions

- You can upload your files only once. Please follow the instructions carefully.
- Suppose your roll number is `20001`.
  - Open Linux and create folder `mid-term-20001`.
  - The folder should contain files `mt-01-20001.cpp`, ..., `mt-06-20001.cpp` corresponding to the following **six questions**.
  - Zip the folder and upload it at http://172.28.153.65:5000
- Your output should use the following line of code.

```
int main()
{
   int final_output; // or other relevant declaration
   cout << ``20001\t'' << ``Donald Knuth\t'' << final_output << endl;
   //Replace '20001' by your roll number and 'Donald Knuth' by your name.
 }
```

Questions

1. (4 pts) You are given an array of n integers. You want to modify the array so that it is increasing, i.e., every element is at least as large as the previous element. On each move, you may increase the value of any element by one. What is the minimum number of moves required?

   Input: The first input line contains an integer n: the size of the array. Then, the second line contains n integers $x_1, x_2, \ldots, x_n$: the contents of the array.

   Output: Print the minimum number of moves.

2. (4 pts) A subsequence of a string is a new string that is formed from the original string by deleting some (can be none) of the characters without disturbing the relative positions of the remaining characters. (i.e., "ace" is a subsequence of "abcde" while "aec" is not).

   Input: Two lines containing strings s and t.

   Output: Print 1 if s is a subsequence of t, or print 0 otherwise.

3. (4 pts) You are given the arrival and leaving times of n customers in a restaurant. What was the maximum number of customers in the restaurant at any time?

   Input: The first input line has an integer n: the number of customers. After this, there are n lines that describe the customers. Each line has two integers a and b: the arrival and leaving times of a customer. You may assume that all arrival and leaving times are distinct.

   Output: The maximum number of customers at any given point.

4. (6 pts) There are n applicants and m free apartments. Your task is to distribute the apartments so that as many applicants as possible will get an apartment. Each applicant has a desired apartment size, and they will accept any apartment whose size is close enough to the desired size.

   Input: The first input line has three integers n, m, and k: the number of applicants, the number of apartments, and the maximum allowed difference. The next line contains n integers $a_1, a_2, \ldots, a_n$: the desired apartment size of each applicant. If the desired size of an applicant is x, they will accept any apartment whose size is between $x - k$ and $x + k$. The last line contains m integers $b_1, b_2, \ldots, b_m$: the size of each apartment.

   Output: The number of applicants who will get an apartment.

5. (6 pts) A game has n rooms and m tunnels between them. Each room has a certain number of coins. What is the maximum number of coins you can collect while moving through the tunnels when you can freely choose your starting and ending room?

   Input: The first input line has two integers n and m: the number of rooms and tunnels. The rooms are numbered $1, 2, \ldots, n$. Then, there are n integers $k_1, k_2, \ldots, k_n$: the number of coins in each room. Finally, there are m lines describing the tunnels. Each line has two integers a and b: there is a tunnel from room a to room b. Each tunnel is a one-way tunnel.

   Output: Print the maximum number of coins you can collect.

6. (6 pts) Write a code that will run for around 50 integers in less than 10 secs.

   Input: Collection of integers.

   Output: Print 1 if you can partition the integers into two subsets such that the sum of the elements in both subsets is equal. Otherwise print 0.

   Examples:

   (a) Input: 1 5 11 5 Output: 1

   (b) Input: 1 2 3 5 Output: 0

   Explanation: In the first example, the numbers can be partitioned as $\{1, 5, 5\}$ and $\{11\}$.