CSE221: Algorithms
Fall 2024 Lab 02

Task 01

Your little brother, Alice, is very fond of playing with integers. One day, Alice was given a sorted list of **N** integers in ascending order by his school teacher. Now, your brother wants to play a game with you.

Alice will give you an integer, **S**. You have to find if it is possible to find two values from the list (at distinct positions) whose sum is equal to S.

Now you are feeling very tired. So you decided to write a code, so that it can give you the answer very quickly.

1) Can you write an $O(N^2)$ Solution to solve the problem?
2) Come up with an O(N)solution.

Input

The first line contains two integers N and S ($1 <= N <= 10^5$, $1 <= S <= 10^9$), denoting the length of the list, and the target Sum.

In the next line, there will be N integers $a_1, a_2, \ldots\ldots\ldots, a_N (1 \leq a_i \leq 10^9)$ separated by space.

Output

Print two integers: **the positions** of the values [**1 based indexing**]. If there are several solutions, you may print any of them. If there are no solutions, print "IMPOSSIBLE".

Sample Input 1	Sample Output 1
4 10 1 3 5 7	2 4
Sample Input 2	Sample Output 2

6 18 1 5 8 9 9 10	3 6 [4 5 is also a valid answer] [print only one output]
Sample Input 3	Sample Output 3
4 7 2 4 6 8	IMPOSSIBLE
Sample Input 4	Sample Output 4
4 10 1 5 6 8	IMPOSSIBLE

Task 02

Alice and Bob are two friends. Alice has a sorted list in ascending order of length **N.** On the other hand, Bob has a sorted list of length **M**. Now, they want to make a sorted list of **N+M** length in ascending order. However, they are not very good at algorithms. Hence, they asked for your help.

Since you are a computer science student, your task is to come up with an efficient algorithm. In the following, let n = N+M.

1) Find a solution which runs in O(nlogn).
2) Come up with a solution which runs in O(n).

Input

The first line contains an integer N ($1 <= N <= 10^5$), denoting the length of Alice's sorted list. In the next line, there will be N integers separated by space.

The third line contains another integer M ($1 <= M <= 10^5$), denoting the length of Bob's sorted list. In the next line, there will be M integers separated by space.

All the numbers given in the input will fit in a 32-bit signed integer.

It is guaranteed that the given lists will be in sorted order.

Output:

You have to make a sorted list in ascending order from the given lists in ascending order and show the output.

Sample Input/Output:

Sample Input 1	Sample Output 1
4 1 3 5 7 4 2 2 4 8	1 2 2 3 4 5 7 8
Sample Input 2	Sample Output 2
3 2 10 12 6 3 4 6 7 8 9	2 3 4 6 7 8 9 10 12
Sample Input 3	Sample Output 3
4 1 2 3 4 1 10	1 2 3 4 10
Sample Input 4	Sample Output 4
7 2 3 8 8 10 12 14 9 1 1 4 5 6 8 13 15 16	1 1 2 3 4 5 6 8 8 8 10 12 13 14 15 16

Task 3

You are a busy person with lots of tasks to do. You have a schedule of tasks represented by intervals of time, where each

interval represents a task that you need to complete. However, you can only work on one task at a time, and you want to complete as many tasks as possible.

Given a list of N intervals of time, your task is to determine the maximum number of tasks you can complete and which tasks they are.

Come up with a solution that runs in O(NlogN)

Input

The input consists of a single integer N ($1 \leq N \leq 10^5$), the number of tasks, followed by N lines representing the tasks. Each task is represented by two integers S_i and E_i ($0 \leq S_i \leq E_i \leq 10^9$), the start and end times of the task, respectively.

Output

Output a single integer k, the maximum number of tasks you can complete, followed by a line with k intervals of the tasks you can complete.

If there are multiple solutions with the same maximum number of tasks, print any one of them.

Sample Input/Output:

Sample Input 1	Sample Output 1
6 1 3 2 5 3 7 4 6 6 8 7 9	3 1 3 4 6 6 8
Sample Input 2	Sample Output 2

5 1 4 2 5 6 7 4 8 3 6	2 1 4 6 7
Sample Input 3	Sample Output 3
7 0 4 3 4 1 5 9 10 6 9 2 3 1 2	5 1 2 2 3 3 4 6 9 9 10

Task 4

Given N tasks and M people, where each task has a start time and end time, implement a greedy algorithm to find the maximum number of tasks that can be completed by M people.

Each task can only be completed by one person and a person can only be assigned one task at a time. Two tasks cannot be completed simultaneously by the same person. In the following, let n = N+M.

1) Can you write an $O(n^2)$ Solution to solve the problem?
2) Come up with an O(nlogn)solution.

Input

The input consists of two integers N and M ($1 \leq N, M \leq 10^3$), the number of activities and the number of people, respectively. This is followed by N lines representing the activities. Each line contains two integers S_i and E_i ($0 \leq S_i \leq E_i \leq 10^9$), representing the start and end times of the activity, respectively.

Output

Output a single integer representing the maximum number of activities that can be completed.

Sample Input/Output:

Sample Input 1	Sample Output 1
5 2 1 5 3 6 2 5 8 10 6 9	4
Sample Input 2	Sample Output 2
5 2 1 4 2 5 6 7 4 8 3 6	4
Sample Input 3	Sample Output 3
6 2 1 5 4 10 8 17 12 15 9 11 14 18	5
Sample Input 4	Sample Output 4
5 2 1 10 2 10 6 7 4 8 3 6	3

Sample Input 5	Sample Output 5
8 3 5 7 2 4 6 8 8 10 1 3 7 9 3 5 2 6	8

Sample Input Explanation:

In sample input 2-

Person 1 will complete the tasks: 1-4, 4-8
Person 2 will complete the tasks: 2-5, 6-7