CSE-2106

Data Structures and Algorithms Laboratory

LAB-02

Topic: Searching – Binary Search

Instructions for Submission:

1. Solve the problems provided below.
2. For each problem, submit your solution as a separate C++ file, naming them as **A.cpp**, **B.cpp**, and so on.
3. Create a **.zip** folder named **CSE_2106_LAB_02_2207*****.zip, ensuring that it only contains the corresponding **.cpp** solution files.
4. The class representative will create a Google Form to collect all submitted **.zip** files.
5. All submissions must be uploaded via the Google Form by **9th December 2024, 12:00 AM**.

Instructions for Lab Report:

1. Provide the pseudocode for the binary search algorithm.
2. For each problem, describe the logic step by step. Focus only on the logical process; implementation details are not necessary. Writing the actual code in the report is not required.

A. Binary Search

Implement a binary search algorithm.

Input

The first line of the input contains integers n and k ($1 \le n$, $k \le 10^5$), the length of the array and the number of queries. The second line contains n elements of the array, sorted in non-decreasing order. The third line contains k queries. All array elements and queries are integers, each of which does not exceed 10^9 in absolute value.

Output

For each of the k queries print YES in a separate line if this number occurs in the array, and NO otherwise.

Example

input `Copy`
```
10 10
1 61 126 217 2876 6127 39162 98126 712687 1000000000
100 6127 1 61 200 -10000 1 217 10000 1000000000
```

output `Copy`
```
NO
YES
YES
YES
NO
NO
YES
YES
NO
YES
```

B. Closest to the Left

Given an array of n numbers, sorted in non-decreasing order, and k queries. For each query, print the maximum index of an array element not greater than the given one.

Input

The first line of the input contains integers n and k ($0 < n$, $k \le 10^5$), the length of the array and the number of queries. The second line contains n elements of the array, sorted in non-decreasing order. The third line contains k queries. All array elements and queries are integers, each of which does not exceed $2 \cdot 10^9$ in absolute value.

Output

For each of the k queries, print the maximum index of an array element not greater than the given one. If there are none, print 0.

Example

input `Copy`
```
5 5
3 3 5 8 9
2 4 8 1 10
```

output `Copy`
```
0
2
4
0
5
```

C. Closest to the Right

time limit per test: 2 seconds
memory limit per test: 512 megabytes

Given an array of n numbers, sorted in non-decreasing order, and k queries. For each query, print the minimum index of an array element not less than the given one.

Input

The first line of the input contains integers n and k ($0 < n, k \leq 10^5$), the length of the array and the number of queries. The second line contains n elements of the array, sorted in non-decreasing order. The third line contains k queries. All array elements and queries are integers, each of which does not exceed $2 \cdot 10^9$ in absolute value.

Output

For each of the k queries, print the minimum index of an array element not less than the given one. If there are none, print $n + 1$.

Example

input	Copy

```
5 5
3 3 5 8 9
2 4 8 1 10
```

output	Copy

```
1
3
4
1
6
```

D. Fast search

time limit per test: 2 seconds
memory limit per test: 512 megabytes

You are given an array a of n integers $a_1, a_2, \ldots, a_n$.

Your task is to response to the queries like `"How many numbers' values are between l and r?"`.

Input

The first line of the input contains n — the length of the array ($1 \leq n \leq 10^5$).

The second line contains n integers $a_1, a_2, \ldots, a_n$ ($-10^9 \leq a_i \leq 10^9$).

The third line contains integer k — the number of queries ($1 \leq k \leq 10^5$).

The following k lines contain a pair of integers $l\ r$ — query, described above ($-10^9 \leq l \leq r \leq 10^9$).

Output

The output must consist of k integers — responses for the queries.

Example

input	Copy

```
5
10 1 10 3 4
4
1 10
2 9
3 4
2 2
```

output	Copy

```
5 2 2 0
```