Assignment 2

August 29, 2019

Question 1

You are given Balanced Binary Search Tree with n nodes. Given two nodes in the tree A and B, there is only one path form A to B in the BST. Design an efficient algorithm to find the maximum and minimum values of the nodes on the path form A to B in the BST.

Question 2

You are given a binary tree with integers as its keys. You need to test whether it is a correct binary search tree. Note that there can be duplicate integers in the tree, and this is allowed. The definition of the binary search tree in such case is the following: for any node of the tree, if its key is x, then for any node in its left subtree its key must be strictly less than x, and for any node in its right subtree its key must be greater than or equal to x. In other words, smaller elements are to the left, bigger elements are to the right, and duplicates are always to the right. You need to check whether the given binary tree structure satisfies this condition. You are guaranteed that the input contains a valid binary tree.

Question 3

Problem Description

Task. You are given a set of points on a line and a set of segments on a line. The goal is to compute, for each point, the number of segments that contain this point.

Input Format. The first line contains two non-negative integers s and p defining the number of segments and the number of points on a line, respectively. The next s lines contain two integers a_i, b_i defining the i-th segment $[a_i, b_i]$. The next line contains p integers defining points $x_1, x_2, \ldots, x_p$.

Constraints. $1 \le s, p \le 50000$; $-10^8 \le a_i \le b_i \le 10^8$ for all $0 \le i < s$; $-10^8 \le x_j \le 10^8$ for all $0 \le j < p$.

Output Format. Output p non-negative integers $k_0, k_1, \ldots, k_{p-1}$ where k_i is the number of segments which contain x_i. More formally,

$$k_i = |\{j : a_j \le x_i \le b_j\}| .$$

Sample 1.

Input:

```
2 3
0 5
7 10
1 6 11
```

Output:

```
1 0 0
```

Here, we have two segments and three points. The first point lies only in the first segment while the remaining two points are outside of all the given segments.

Question 4

Find k numbers closest to the median in O(n)

Question 5

You are given a hash table with n keys and m slots, with the simple uniform hashing assumption (each key is equally likely to be hashed into each slot). Collisions are resolved by chaining.

(a) What is the probability that the first slot ends up empty?

(b) What is the expected number of slots that end up not being empty?