

Assignment 4

Deadline:-12/November/2020 11:55 PM IST

1 Theory

1. Given n integers in sorted order, give a simple way to generate a red black tree, which takes $O(n)$ time. 2
2. [Part 1] Given two red black trees with \sqrt{n} and n number of elements give a strategy to construct a new red-black tree, consisting of elements from both the trees in $o(n)$ time. 1
3. Given two BST's how do you check if they represent the same set of the elements? 2
4. Mr. Lazyrus feels that Red-black Trees deletion operation is complicated, so he suggests the following tweak. Each node has an additional boolean variable which denotes whether an element is active or deleted. Active elements are part of the input, while deleted elements are elements were part of the input at some point, but they were subsequently deleted.
While trying to delete an element, we do not remove the node from the tree. We simply set its additional boolean to zero, indicating deletion. While insertion of a node, we set its boolean to 1 indicating active node.
Explain the effectiveness/ineffectiveness of this tweak. Suggest additional tweaks if needed, in order to make this tweak work. Assume all elements are distinct. 4
5. How many rotations and color changes are needed to be performed per insertion/deletion in a red black tree? Explain your answer. 2
6. Given an element x , explain how to find the successor of x in a red black Tree which is built to store n elements in sorted order? (Assume all elements in that tree are distinct) 2

Additional simplifications and hints for question #4:-

Assume that the Red-black tree is first constructed by performing n insertions. After this point, we have any arbitrary sequence of search and insert, delete operations, but the number of active elements in the red-black tree at any point in time is at least \sqrt{n} .

Let X_{total} and X_{active} denote the total number of nodes and the number of active nodes in the modified red black tree? Try to compare the running time for each operation of this modified red black tree with that of a red black tree without this modification.

The Hint/Simplification comes at a price which is the following modification
Question #2 now has 2 parts.

First part is mentioned above and it is worth 1 mark.

Second part is worth 3 marks and is mentioned below.

Question 2 [Part 2]:- Given two red black trees each with $n/2$ and n number of elements, give a strategy to construct a new red-black tree, consisting of elements from both the trees in $o(n)$ time. 3