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Effiziente Algorithmen und Datenstrukturen I

Aufgabe 1 (10 Punkte)

Given the key of an element x in an n-node binary search tree (choose a BST with suitable properties) and a natural number i, show how to augment the tree to find the i-th successor of x in the linear order of the tree in $O(\log n)$ time.

Aufgabe 2 (10 Punkte)

Suppose that we wish to keep track of a *point of maximum overlap* in a set of itervals - a point that has the largest number of intervals in the set of intervals overlapping it.

1. Show that there will always be a point of maximum overlap which is an endpoint of one of the segments.
2. Design a data structure that efficiently supports the operations INSERT, DELETE, and FIND_POM which are defined as follows:
   (a) INSERT(i, j): Inserts the interval $[i, j]$ in the set of intervals.
   (b) DELETE(i, j): Deletes the interval $[i, j]$ from the set of intervals.
   (c) FIND_POM: Returns a point of maximum overlap.

   (*Hint:* Keep a red-black tree of all the endpoints. Associate a value of $+1$ with each left endpoint, and associate a value of -1 with each right endpoint. Augment each node of the tree with some extra information to maintain the point of maximum overlap.)

Aufgabe 3 (10 Punkte)

Suggest how to use a skip list so that given a pointer to a node with key x, we can return a pointer to a node with key $y < x$ in $O(\log k)$ expected time where k is the distance between the nodes with values y and x in L_0.