

## Assignment 9

R-3.11 Consider the following sequence of keys:

(5, 16, 22, 45, 2, 10, 18, 30, 50, 12, 1)

Consider the insertion of items with this set of keys, in the order given, into:

- an initially empty (2,4) tree  $T'$ .
- an initially empty red-black tree  $T''$ .

Draw  $T'$  and  $T''$  after each insertion.

R-3.14 For each of the following statements about red-black trees, determine whether it is true or false. If you think it is true, provide a justification. If you think it is false, give a counterexample.

- a subtree of a red-black tree is itself a red-black tree.
- the sibling of an external node is either external or it is red.
- given a red-black tree  $T$ , there is a unique (2,4) tree  $T'$  associated with  $T$ .
- given a (2,4) tree  $T$ , there is a unique red-black tree  $T'$  associated with  $T$ .

Design a pseudo code algorithm **isValidAVL(T)** that decides whether or not a binary tree is a valid AVL tree. For this problem, we define valid to mean that the height of the left and right sub-trees of every node do not differ by more than one.

What is the time complexity of your algorithm?

Design an algorithm, **isPermutation(A,B)** that takes two sequences A and B and determines whether or not they are permutations of each other, i.e., they contain same elements but possibly occurring in a different order. Assume the elements in A and B cannot be sorted. **Hint:** A and B may contain duplicates. Same problem as in previous homework, but this time use a dictionary to solve the problem.

What is the worst case time complexity of your algorithm? Justify your answer.

C-3.10 Let D be an ordered dictionary with n items implemented by means of an AVL tree (or a Red-Black tree). Show how to implement the following operation on D in time  $O(\log n + s)$ , where s is the size of the iterator returned:

FindAllInRange( $k_1, k_2$ ):

Return an iterator of all the elements in D with key k such that  $k_1 \leq k \leq k_2$ .