CMSC 341 Data Structures

Red-Black Tree Review

These questions will help test your understanding of the Red-Black tree material discussed in class and in the text. These questions are only a study guide. Questions found here may be on your exam, although perhaps in a different format. Questions NOT found here may also be on your exam. The rotation diagrams for red-black trees ***may*** be provided with your exam. Check with your instructor.

1. Define ***Red-Black tree***. List all Red-Black tree properties
2. Define the ***black height*** of a node, *x*.
3. What is the “Big-Oh” performance (in terms of the number of nodes in the tree) for the operations **find, insert** and **remove** for a red-black tree in the best, worst and averages cases?
4. What property of red-black trees is most significant in explaining the “Big-Oh” performance for the operations **find, insert** and **remove**?
5. Prove that in any red-black tree with root *x*, there are at least *n* = 2*bh*(*x*) – 1 internal nodes where *bh*(*x*) is the black-height of *x*.
6. Prove that in any red-black tree, at least half the nodes on any path from the root to a leaf must be black.
7. Prove that in any red-black tree, no path from any node, N, to a leaf is more than twice as long as any other path from N to any other leaf.
8. Prove that if a black node has just one child, that child must be red.
9. Show the tree that results from inserting the values **2, 1, 4, 5, 9, 3, 6, 7** into an initially empty red-black tree. Show the tree after each insertion.
10. Given the following Red-Black Tree, show the tree that results after deleting the node with value **40** using bottom-up deletion.

166

49

68

40

56

114

87

Represents a BLACK node

Represents a RED node