Data Structures

Midterm, Nov. 17, 2000 (YEN)

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1. (20 pts) Explain each of the following in a *short* (no more than 3 lines) yet *precise* fashion:

    1. Abstract data type
    2. Linear homogeneous recurrence relation with constant coefficients
    3. $f(n) = \mathbf{W}(g(n))$
    4. Exclusive-or representation of linked lists
    5. Search tree
    6. Average-case running time of an algorithm
    7. AVL tree
    8. Post-order traversal of an ordered tree
    9. Red-black tree
    10. Lower bound of a problem

2. (10 pts) Draw the *expression tree* for the following expression:

    $$((-a)+(x+y))/(b*(c-a))$$

    where the `-` in -a is a unary operator. (Hint: The post-order traversal sequence of the tree is exactly its postfix expression.)

3 (10 pts) Use an array to store the following binary tree. Show the contents of the array.
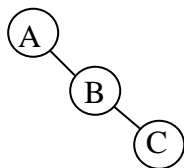

4 (8 pts) State the worst-case running time of the *search* operation for each of the following data structures (of size *n*):

    (1) sorted array, (2) sorted linked list, (3) skip list, (4) binary search tree,
    (5) AVL tree, (6) red-black tree, (7) splay tree, (8), B-tree.

5 (12 pts) Start with an empty *AVL search tree* and insert the following keys in the given order: **20, 10, 5, 30, 40, 3, 4, 25, 23, 27, 50**. Draw figures depicting your tree immediately after each insertion and following the rebalancing rotation (if any).

6   (10 pts) Given two sets A and B of *n* integers each, design a method to compute A-B (i.e., the set of those elements in A but not in B) efficiently. Explain your method in Chinese or English. What is the running time of your method? (Hint: use (balanced) binary search trees.)

7   (10 pts) *Splay* the following tree at node **1**. Show your derivation in sufficient detail.
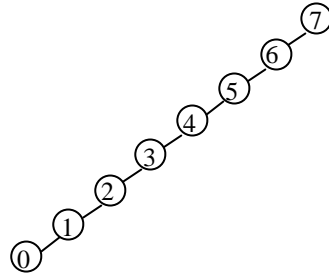
8   (10 pts) Convert the following tree into a *threaded tree*. Show the detailed structure for each cell in the tree.
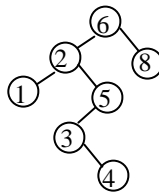
9   (10 pts) First *insert 62* then *delete 10* on the following *red-black tree*, in which dark nodes are black nodes and light nodes are red nodes. Show your derivation in detail.