CIS 313 Introduction to Data Structures
Winter 2007

Assignment 3

due Wednesday, February 7, 2007

1. Draw the binary tree whose inorder traversal is *eproiuscmgdtO* and whose postorder traversal is *erpisuogdOtmc*. Give the level order traversal of that tree. [**5 points**]

2. The **balance factor** of an internal node v of a binary tree is the difference between the heights of the left and right subtrees of v. Write a recursive routine which will print the balance factors of all nodes in a binary tree. What is the running time of this routine? [**6 points**]

3. Consider an ordered tree T and a binary tree T' representing it, using the first-child next-sibling representation (section 10.4). An inorder traversal of T' is equivalent to what kind of traversal of T? [**4 points**]

4. In class we defined the internal path length I and the external path length E, both measures of a binary tree. If that tree has n (internal) nodes, show that $E = I + 2n$. (This is exercise B.5-5, p 1091.) [**8 points**]

5. Consider the tree of Figure 12.2 on p 257. How many different permutations of the values it contains, when inserted in that order, will yield this particular tree? [**8 points**]

6. How many permutations of $1, 2, \ldots, n$ yield a skew tree? (Since any one skew tree is generated by just one permutation, this question is asking for the number of skew trees of n nodes.) [**5 points**]

7. *(Search path splitting a BST)* Exercise 12.2-4, p 260. [**4 points**]

Total: 40 points

Notes:

- *(Q1)* The lower case and upper case of the letter 'o' are used so they can be distinguished.
- *(Q2)* Consider the following three formulas:
  - $height(null) = -1$
  - $height(p) = 1 + \max\{height(p.left), height(p.right)\}$
  - $balFac(p) = height(p.left) - height(p.right)$

  These suggest that you may want to compute the height and the balance factor at the same time. You may simply print out the balance factors, in any order.

- *(Q3)* To get T', imagine the first-child as a left pointer and the next-sibling as a right pointer.
- *(Q4)* We had $I = \sum_{v \in V} d(v)$, where V is the set of nodes and $d(v)$ is the depth of a node. E is defined similarly, over all external nodes. You will want to use induction.
- *(Q5)* Consider a tree where
  - the left subtree contains n nodes and is generated by r permutations
  - the right subtree contains m nodes and is generated by s permutations

  Then the whole tree contains $n+m+1$ nodes and is generated by $r \cdot s \cdot \binom{n+m}{n}$ permutations.