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15-121 Fall 2019 Quiz 10

Up to 25 minutes. No calculators, no notes, no books, no computers. Show your work!

1. Binary Search Tree

Consider the following code for a binary search tree of integers. (There is nothing special here, the code is provided just in case you forgot how a binary tree is built.)

```
public class BinarySearchTree {
    private TreeNode root;

    private class TreeNode {
        private int data;
        private TreeNode left;
        private TreeNode right;

        private TreeNode(int data) {
            this.data = data;
        }
    }

    public BinarySearchTree() {
        root = null;
    }

    public void add(int item) {
        root = add(root, item);
    }

    private TreeNode add(TreeNode root, int item) {
        if (root == null) {
            return new TreeNode(item);
        }

        if (item < root.data) {
            root.left = add(root.left, item);
        } else {
            root.right = add(root.right, item);
        }

        return root;
    }
}
```

- (a) (5 points) Write the code for a new method in this class called `largest()`, which returns the value of the largest integer in the tree. Your method must be $O(\log N)$. If the tree is empty, return -1.

- (b) (7 points) Write the code for a new method in this class called `sum()`, which returns the sum of all the integers in the tree. You may also write any additional helper methods that you need. Your method must be $O(N)$. Hint: You should do this recursively.

- (c) (8 points) Write the code for a new method in this class called `height()`, which returns the height of the tree. You may also write any additional helper methods that you need. Your method must be $O(N)$. Hint: You should do this recursively. Also, this is the same as the homework.