

Data Structures

Homework #4

Due: Jan 04, 2022

1. The *size* of a tree T rooted at r is defined to be the total number of nodes in T , including r . Given a rooted tree T of size n , please devise an $O(n)$ algorithm to compute the size of the subtree rooted at each node. Assume that the degree of T is a constant.
2. (10 pts) Describe a generalization of the Euler tour traversal to trees such that each internal node has three children. Describe how you could use this traversal to compute the height of each node in such a tree.
3. (5 pts) Draw the binary tree representation of the following arithmetic expression:
 $((5+2)*(2-1))/((2+9)+((7-2)-1))*8$.
and compute the value of this expression.
4. A k -ary tree is a tree of which each node has at most k children. What is the maximum number of node is a k -ary tree of height h ? Prove your answer.
5. The *balance factor* of an internal node v of a proper binary tree is the difference between the heights of the right and left subtrees of v . Show how to specialize the Euler tour traversal to print the balance factors of all the internal nodes of a proper binary tree.

6. Programming (Binary Search Trees)

In this problem, you need to implement an *array-based binary search tree* T with the following associated operations(methods) using Python. We assume that each node is represented by a key value which is an integer. The operations include:

- (a) `insert(x)`: insert a node with key x into T .
- (b) `delete(x)`: delete a node with key x from T .
- (c) `searchkey(x)`: perform the search process from the root; if the search fails, print "NOT found"; otherwise, print "x is found".
- (d) `printProperty()`: print out the properties of tree T , including the height and size of T .
- (e) `preorderTraversal()`: list all the nodes using a preorder traversal.
- (f) `postorderTraversal()`: list all the nodes using a postorder traversal.
- (g) `inorderTraversal()`: list all the nodes using a inorder traversal.

The binary search tree will be built or defined as a class, `BinarySearchTree`, and the operations mentioned above are defined as the methods. Of course, you can have other auxiliary methods. Initially, the binary search tree is empty. Your program allows the user to search, insert, and delete a node with a key. Please run `T.preorderTraversal()`, `T.postorderTraversal()`, and `T.inorderTraversal()` for the same binary search tree to see what you can observe.

About submitting this homework

1. For problem 1, 2, 3, 4 and 5, Please
 - (1) write all of your solutions on the papers of **size A4**,
 - (2) leave you name and student ID on the first page, and
 - (3) hand in your solutions for problem 1, 2, 3, 4 and 5 to me in class
2. For problem 6, please upload the completed `.ipynb` file with the filename as `HW4_studentID.ipynb` to *ischool* platform (<http://www.ischool.ntut.edu.tw/>).
3. The **deadline** is the **midnight of January 4**, 2022 and **Late work** is not acceptable.
4. Honest Policy: We encourage students to discuss their work with the peer. However, each student should write the program or the problem solutions on her/his own. Those who copy others work will get 0 on the homework grade.