CSCI-SHU 210 Data Structures

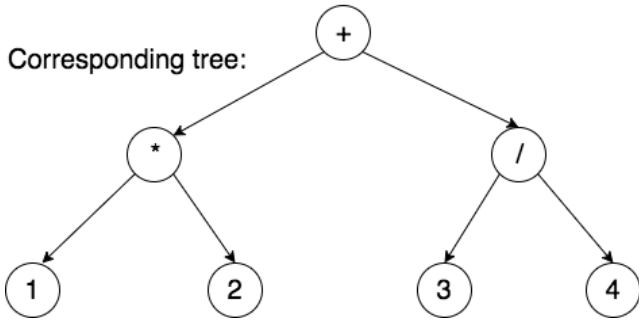
Recitation7 Worksheet Trees/Binary trees

In this recitation, we will practice **`Binary Tree`**.

Today's goals:

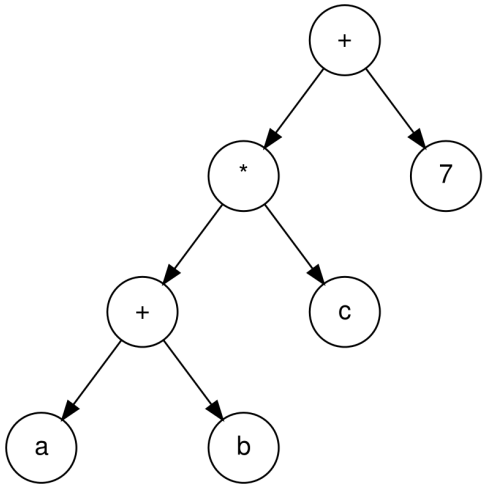
- Please keep in mind, what is a
  - **`General Tree`**
  - **`Binary Tree  (this recitation)`**
  - **`Binary Search Tree (next week)`**
  - **`AVL Tree  (next week)`**
- Binary tree's property: left child / right child only
- Binary tree traversal algorithms (Pre, in, post, level)
- Can perform recursion on Binary tree data structure.
- Arithmetic expression tree

Corresponding tree:



Preorder traversal: + * 1 2 / 3 4
Inorder traversal: 1 * 2 + 3 / 4
Postorder traversal: 1 2 * 3 4 / +

Warmup Exercise:

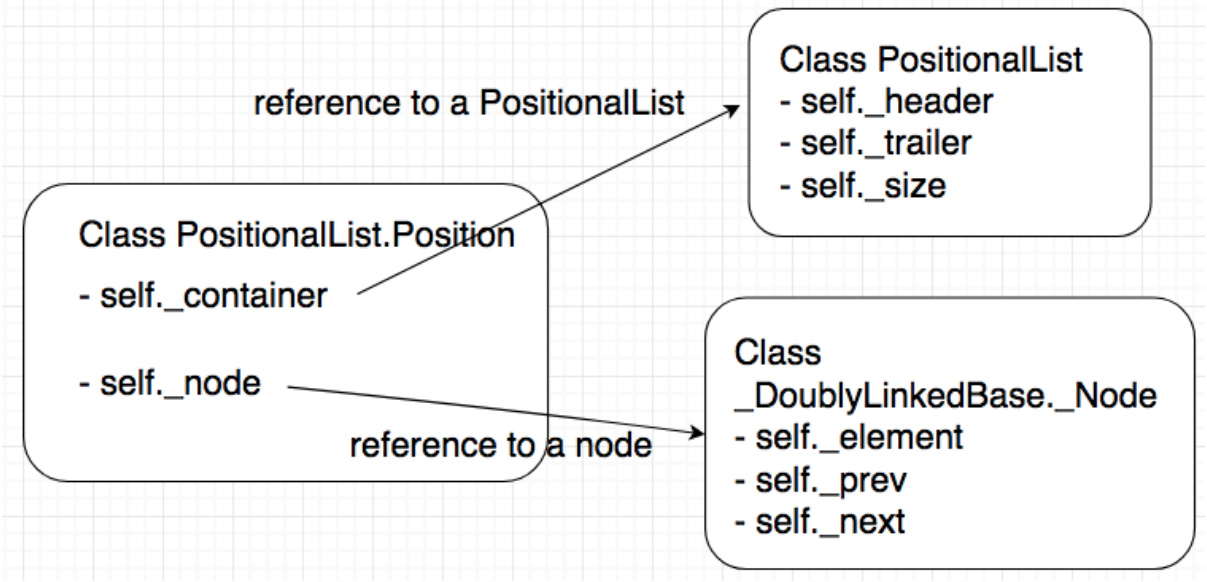


What is the preorder traversal result for the arithmetic expression tree above?

What is the inorder traversal result for the arithmetic expression tree above?

What is the postorder traversal result for the arithmetic expression tree above?

Part I: A quick look at Positional List:




```
def _validate(self, p):
    """Return position's node, or raise appropriate error if invalid."""
    if not isinstance(p, self.Position):
        raise TypeError('p must be proper Position type')
    if p._container is not self:
        raise ValueError('p does not belong to this container')
    if p._node._next is None: #convention for deprecated nodes
        raise ValueError('p is no longer valid')
    return p._node
```

Your task 1 (Optional): Take a look at class `PositionalList`. Try the test code, thentype some test code on your own. Try to understand this class' s tructure.

You don't need submit anything for task 1.

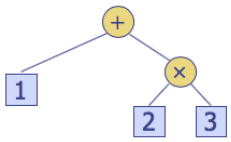
Part II: Simple Binary Tree (Just the Tree node class):

Your task 2: Let's continue from where we left off. Before we start OOP style, let's start from just the binary tree node.

Create a Simple tree for this infix expression: 3 * 2 + 5 - 2

Simple Binary Tree (w/o parent)

```
class TreeWithoutParent:
    def __init__(self,element,left=None,right=None):
        self._element = element
        self._left = left
        self._right = right
    def __str__(self):
        return str(self._element)
```



Your task 3: Implement function PreOrderTraversal(tree) in `simple_Tree_without_parent.py`.

This function should:

Prints all the elements with pre order traversal, the initial call parameter `tree` is the root node.

Your task 4: Implement function InOrderTraversal(tree) in `simple_Tree_without_parent.py`.

This function should:

Prints all the elements with in order traversal, the initial call parameter `tree` is the root node.

Your task 5: Implement function PostOrderTraversal(tree) in `simple_Tree_without_parent.py`.

This function should:

Prints all the elements with post order traversal, the initial call parameter `tree` is the root node.

Your task 6: Implement function LevelOrderTraversal(tree) in `simple_Tree_without_parent.py`.

This function should:

Prints all the elements with Level order traversal, the initial call parameter `tree` is the root node.

Part III: Binary Tree with OOP:

1. Getting familiar with 300 lines of code.

- `Class Tree`:
  - class TreeNode
    - self._element
    - self._parent
    - self._left
    - self._right
  - __len__(self)

---------- Traversal functions ----------

  - __iter__(self)
  - children(self, node)
  - preorder(self)
  - inorder(self)
  - postorder(self)
  - _subtree_preorder(self, node)
  - _subtree_inorder(self, node)
  - _subtree_postorder(self, node)
  - nodes(self)

---------- Boolean functions ----------

  - is_root(self, node)
  - is_leaf(self, node)
  - is_empty(self)

---------- Function accessors ----------

  - root(self)
  - parent(self, node)
  - left(self, node)
  - right(self, node)
  - sibling(self, node)
  - num_children(self, node)

---------- Public mutators ----------

  - add_root(self, e)
  - add_left(self, node, e)
  - add_right(self, node, e)
  - replace(self, node, e)
  - delete(self, node)
  - attach(self, node, t1, t2)

---------- Pretty printing ----------

  - pretty_print methods

---------- Today's tasks, starting at line 229 ----------

  - preorderPrint(self, node) # Task 1, optional
  - postorderPrint(self, node) # Task 2, optional
  - inorderPrint(self, node) # Task 3, optional
  - levelorderPrint(self, node) # Task 4
  - height(self, node = None) # Task 5
  - depth(self, node) # Task 6
  - return_max(self) # Task 7
  - flip_node(self, node) # Task 8
  - flip_subtree(self, node) # Task 9

Your task 1 (Optional): Implement function preorderPrint(self,node) in `BinaryTree.py`.

This function should:

Prints all the elements with pre order traversal, treating parameter node as the root Position.

Your task 2 (Optional): Implement function postorderPrint(self, node) in `BinaryTree.py`.

This function should:

Prints all the elements with post order traversal, treating parameter node asthe root Position.

Your task 3 (Optional): Implement function inorderPrint(self, node) in `BinaryTree.py`.

This function should:

Prints all the elements with in order traversal, treating parameter node as the root Position.

Your task 4 (Optional): Implement function levelorderPrint(self, node) in `BinaryTree.py`.

This function should:

Prints all the elements with level order traversal, treating parameter node as the root Position.

Your task 5: Implement function height(self, node = None) in `BinaryTree.py`.

This function should:

Return the height of the subtree rooted at a given node.

If node is None, return the height of the entire (self) tree.

Your task 6: Implement function depth(self, node) in `BinaryTree.py`.

This function should:

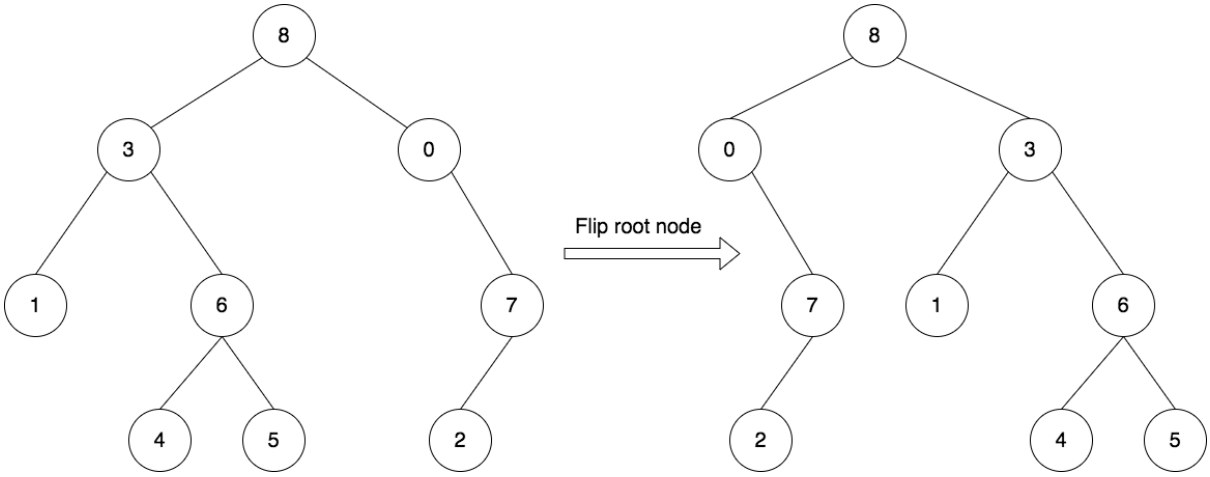
Return the depth of a given node, in the entire (self) tree.

Your task 7: Implement function return_max(self) in `BinaryTree.py`.

This function should:

Traverse the tree and return the maximum value stored within the tree.

Your task 8: Implement method flip(self, node) in `BinaryTree.py.` which flips the left and right children of a given node.



Your task 9: Implement method flip_subtree(self, node=None) in `BinaryTree.py` which flips the left and right children all nodes in the subtree of given node, and if p is omitted it flips the entire tree.

Your method must be recursive.