## Binary Expression Tree (BXT)

A BXT is binary tree in which the leaves are numbers and the nonleaves are arithmetic operators. As you might expect, we will build a binary expression tree, display it, and evaluate it. Unlike TreeLab, we will encapsulate the behavior in a BXT class so that all the methods are instance methods. The teacher has written the driver class with the postfix expressions you are to use.

In order to allow decimals and negative numbers, we require that the tokens in the input string be separated by a space. You may assume that the input postfix expression is well-formed.

**Sample Run**

|  |  |  |
| --- | --- | --- |
| Postfix Exp: 14 -5 /   -5 /  14 Infix order: 14 / -5  Prefix order: / 14 -5  Evaluates to -2.8 ---------------------- | Postfix Exp: 20.0 3.0 -4 + \*   -4  +  3.0 \*  20.0 Infix order: 20.0 \* 3.0 + -4  Prefix order:\* 20.0 + 3.0 -4  Evaluates to -20.0 ------------------------  **Infix ignores order of operations** | Postfix Exp: 2 3 + 5 / 4 5 - \*  5  -  4 \*  5  /  3  +  2 Infix order: 2 + 3 / 5 \* 4 - 5  Prefix order: \* / + 2 3 5 - 4 5  Evaluates to -1.0 ------------------------ |

**Build a BXT**

You need to process the postfix expression String so it forms a binary expression tree stored at root.

Hint 1: The input is a string with spaces. Use str.split(" "); and a for-each loop.

Hint 2: Start with the operators + - \* / %. In postfix notation these operators are **preceded** by two operands (numbers). This suggests a **stack of TreeNodes** would be useful.

Hint 3: Each non-operator is a number. What two things do you do with it?

Hint 4: Each operator needs to be placed in a TreeNode that links to its two children, also in TreeNodes. Hint 5: Then what do you do with the TreeNode-with-operator?

Hint 6: A postfix string that has only one item is a special case.

**Display Infix and Prefix orders**

You don't need help with this. Each one needs, as usual, a public no-argument method which calls a private recursive method with arguments.

## Evaluating the Expression

Do this recursively. If the node is an operator, recursively evaluate the left child and the right child, and return the result. Else the node is a number, so it’s value can be converted into a double, and returned.

**Extensions**

1. Process the operators ^ and !.
2. Create a method inorderTraverseWithParentheses to print the infix expression with minimal parentheses, for example:

20.0 \* ( 3.0 + -4 ) needs parentheses

but 20.0 + 3.0 \* -4 does not.

**import** java.util.\*;  
/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  
Represents a binary expression tree. The BXT can build itself from a postorder expression. It can evaluate and print itself. It also prints an inorder string and a preorder string.   
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/  
**public class** BXT   
 {

**public** **static** **final** String operators = "+ - \* / % ^ !";  
 **private** TreeNode root;  
 **public** BXT()  
 {  
 root = null;  
 }  
 /\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  
 Builds a BXT from a postfix expression. Uses a helper stack of

TreeNodes.  
 \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/  
 **public void** buildTree(String str)  
 {

}  
 **public double** evaluateTree()  
 {  
 **return** evaluateNode(root);  
 }  
 **private double** evaluateNode(TreeNode root) //recursive  
 {

}  
 **private double** computeTerm(String s, **double** a, **double** b)  
 {

}  
 **private** boolean isOperator(String s) //   
 {

}  
 // display() from TreeLab  
 // inorder traverse  
 // preorder traverse  
}