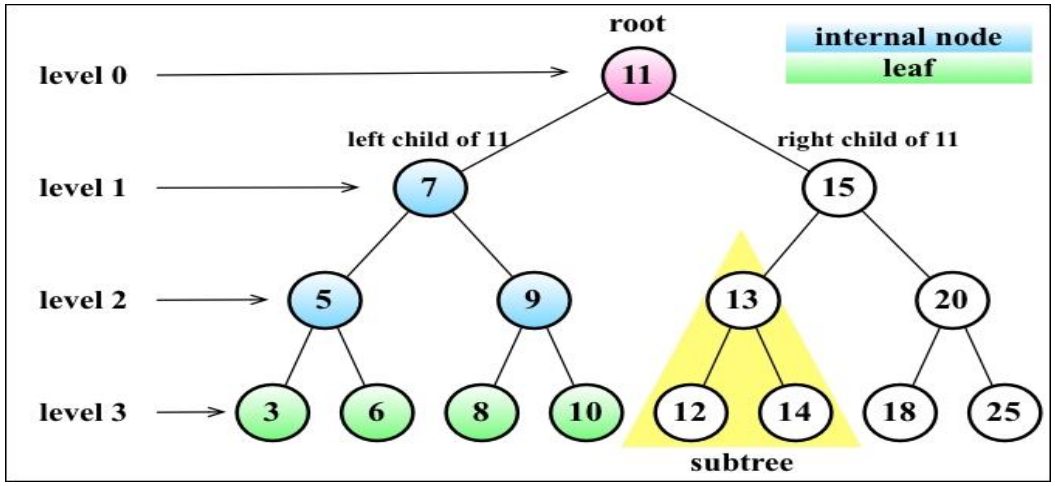
Tree Data Structure 3



by

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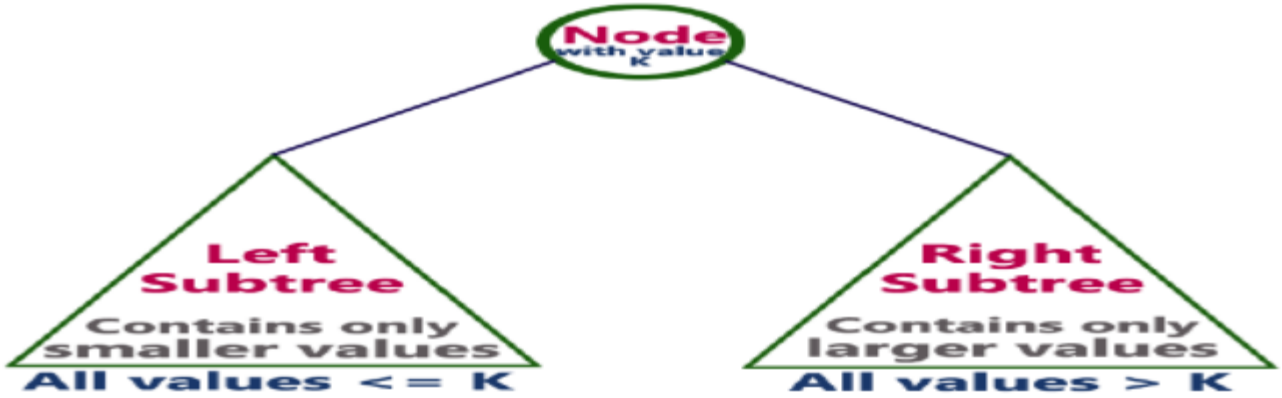
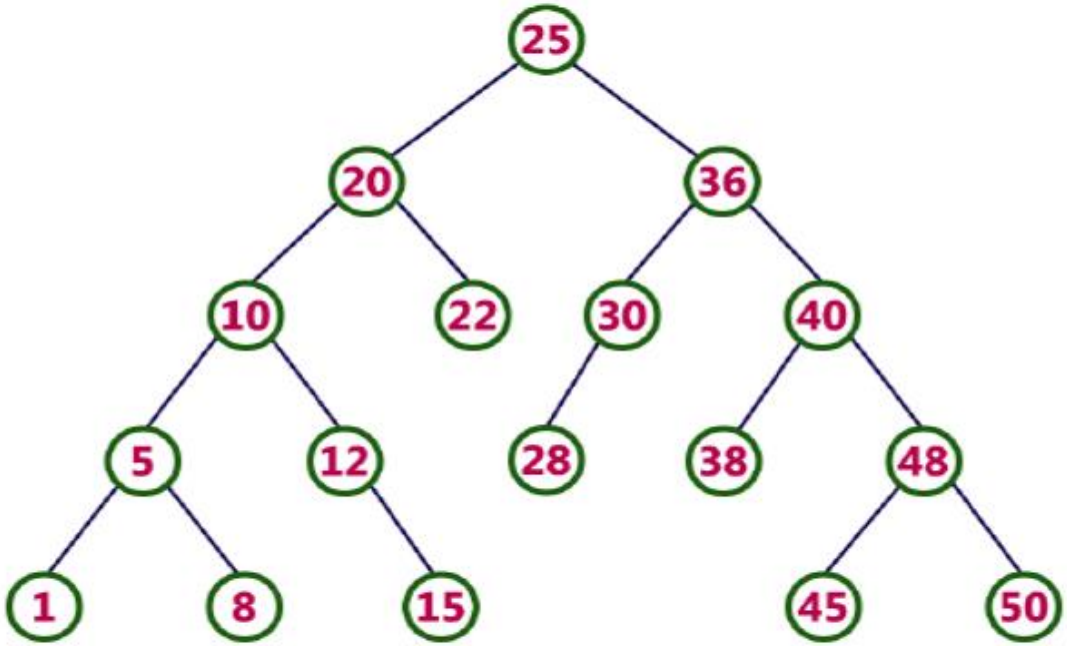
Binary Search Tree

Binary Search Tree is a binary tree in which every node contains only smaller values in its left subtree and only larger values in its right subtree.



Example

The following tree is a Binary Search Tree. In this tree, left subtree of every node contains nodes with smaller values and right subtree of every node contains larger values.



Every Binary Search Tree is a binary tree but all the Binary Trees need not to be binary search trees.

Operations on a Binary Search Tree

The following operations are performed on a binary search tree:

1. **Search.**
2. **Insertion.**
3. **Deletion.**

1. Search Operation in BST

The search operation is performed as follows:

Step 1: Read the search element from the user.

Step 2: Compare, the search element with the value of root node in the tree.

Step 3: If both are matching, then display "Given node found!!!" and terminate the function.

Step 4: If both are not matching, then check whether search element is smaller or larger than that node value.

Step 5: If search element is smaller, then continue the search process in left subtree.

1. Search Operation in BST

Step 6: If search element is larger, then continue the search process in right subtree.

Step 7: Repeat the same until we found exact element or we completed with a leaf node.

Step 8: If we reach to the node with search value, then display "Element is found" and terminate the function.

Step 9: If we reach to a leaf node and it is also not matching, then display "Element not found" and terminate the function.

2. Insertion Operation in BST

In binary search tree, new node is always inserted as a leaf node. The insertion operation is performed as follows:

Step 1: Create a newNode with given value and set its **left** and **right** to **NULL**.

Step 2: Check whether tree is Empty.

Step 3: If the tree is **Empty**, then set root to **newNode**.

Step 4: If the tree is **Not Empty**, then check whether value of newNode is **smaller** or **larger** than the node (here it is root node).

2. Insertion Operation in BST

Step 5: If newNode is **smaller** than **or equal** to the node, then move to its **left** child. If newNode is **larger** than the node, then move to its **right** child.

Step 6: Repeat the above step until we reach to a **leaf** node (e.i., reach to NULL).

Step 7: After reaching a leaf node, then insert the newNode as **left child** if newNode is **smaller or equal** to that leaf else insert it as **right child**.

3. Deletion Operation in BST

Deleting a node from Binary search tree has following **three cases**:

Case 1: Deleting a Leaf node (A node with no children).

Case 2: Deleting a node with one child.

Case 3: Deleting a node with two children.

Case 1: Deleting a leaf node

We use the following steps to delete a leaf node from BST:

Step 1: Find the node to be deleted using **search operation.**

Step 2: Delete the node using **free** function (If it is a leaf) and terminate the function.

Case 2: Deleting a node with one child

We use the following steps to delete a node with one child from BST:

Step 1: Find the node to be deleted using **search operation**.

Step 2: If it has only one child, then create a link between its parent and child nodes.

Step 3: Delete the node using **free** function and terminate the function.

Case 3: Deleting a node with two children

We use the following steps to delete a node with two children from BST:

Step 1: Find the node to be deleted using **search operation**.

Step 2: If it has two children, then find the **largest** node in its **left subtree** (OR) the **smallest** node in its **right subtree**.

Step 3: Swap both **deleting node** and node which found in above step.

Case 3: Deleting a node with two children

Step 4: Then, check whether deleting node came to **case 1** or **case 2** else goto steps 2.

Step 5: If it comes to **case 1**, then delete using case 1 logic.

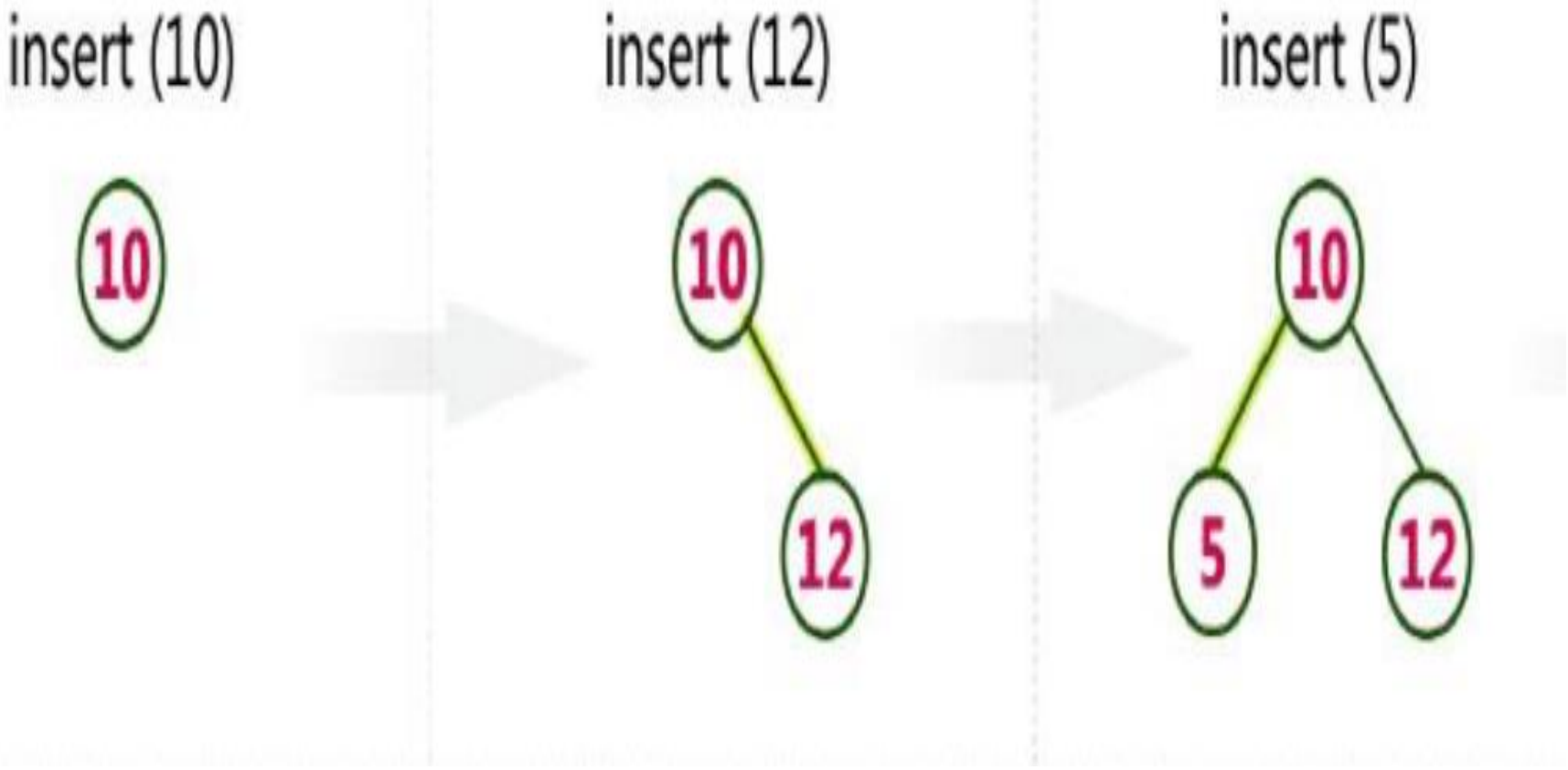
Step 6: If it comes to **case 2**, then delete using case 2 logic.

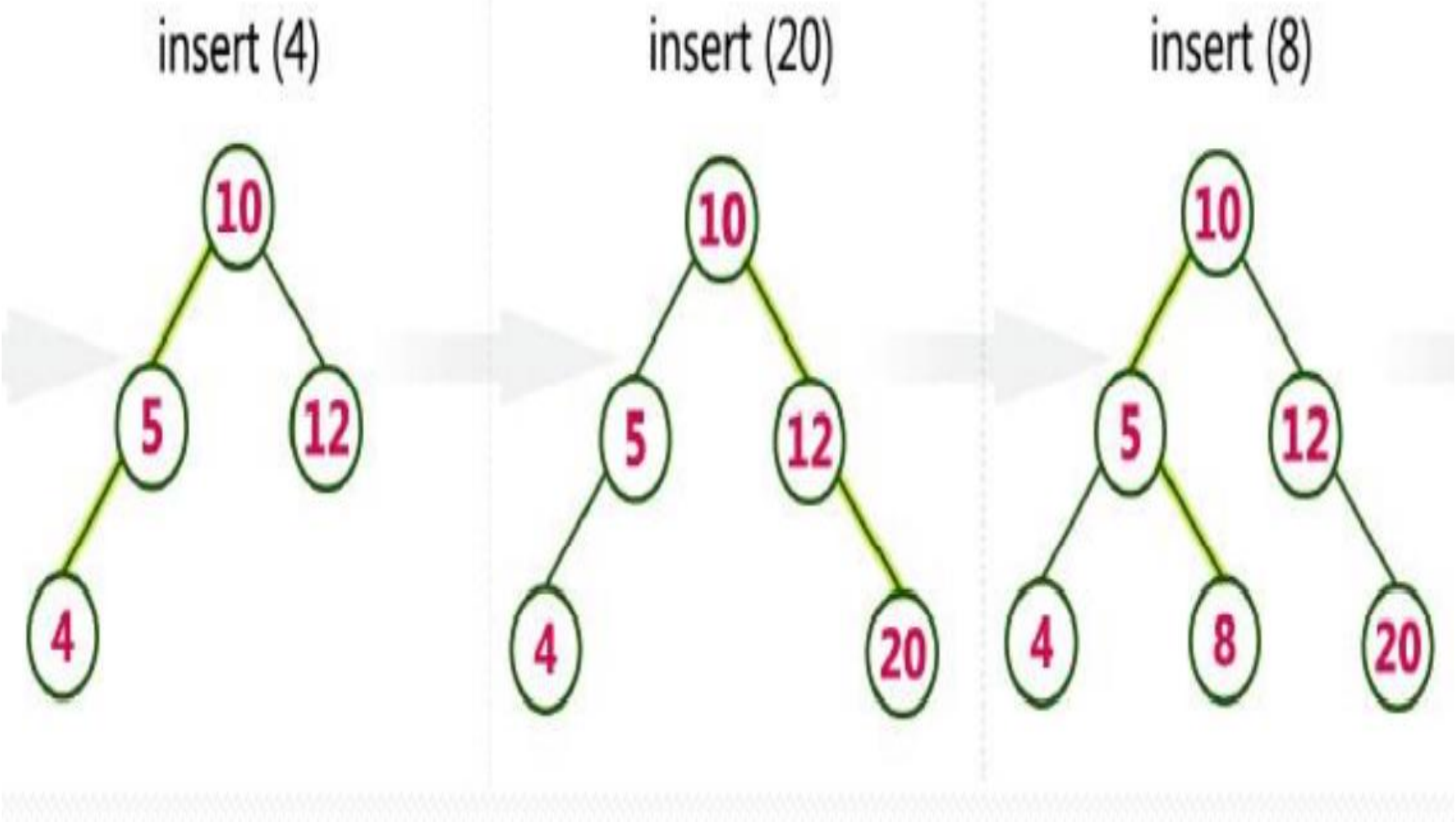
Step 7: Repeat the same process until node is deleted from the tree.

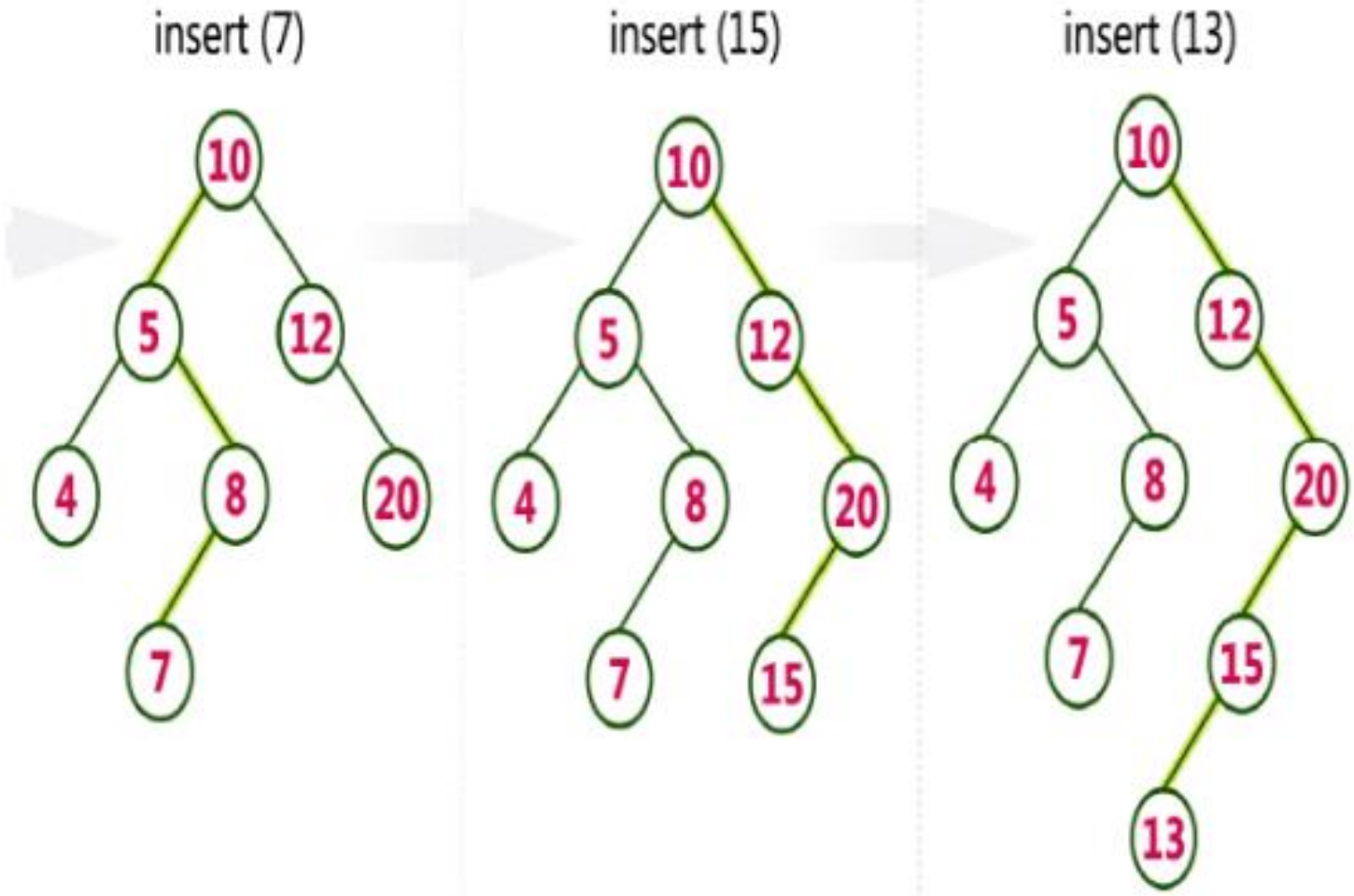
Example Construct a Binary Search Tree by inserting the following sequence of numbers...

- ***10,12,5,4,20,8,7,15 and 13***

Above elements are inserted into a Binary Search Tree as follows.

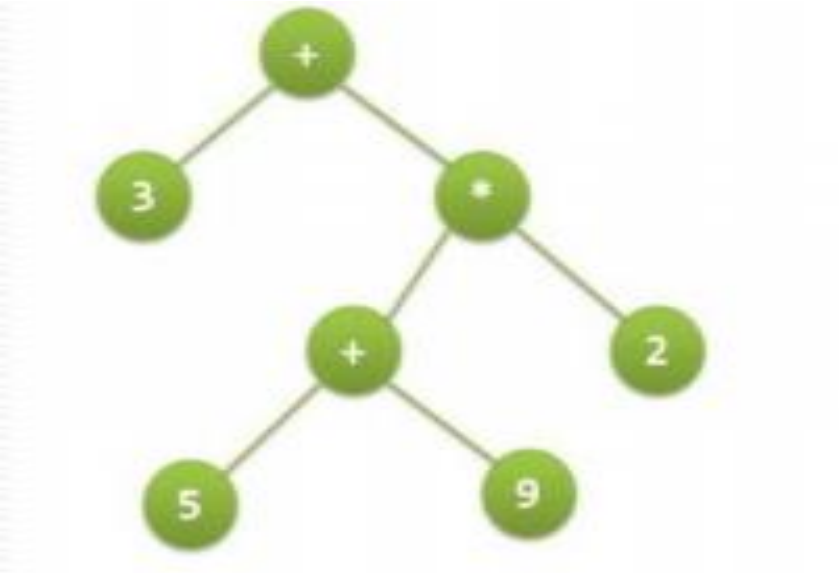

insert (10)
10
insert (12)
10
12
insert (5)
10
5
12


insert (4)
10
5
12
4
insert (20)
10
5
12
4
20
insert (8)
10
5
12
4
8
20


insert (7)
10
5
12
4
8
20
7
insert (15)
10
5
12
4
8
20
7
15
insert (13)
10
5
12
4
8
20
7
15
13

Expression Tree

Expression tree is a binary tree in which each internal node corresponds to **operator** and each leaf node corresponds to **operand.**



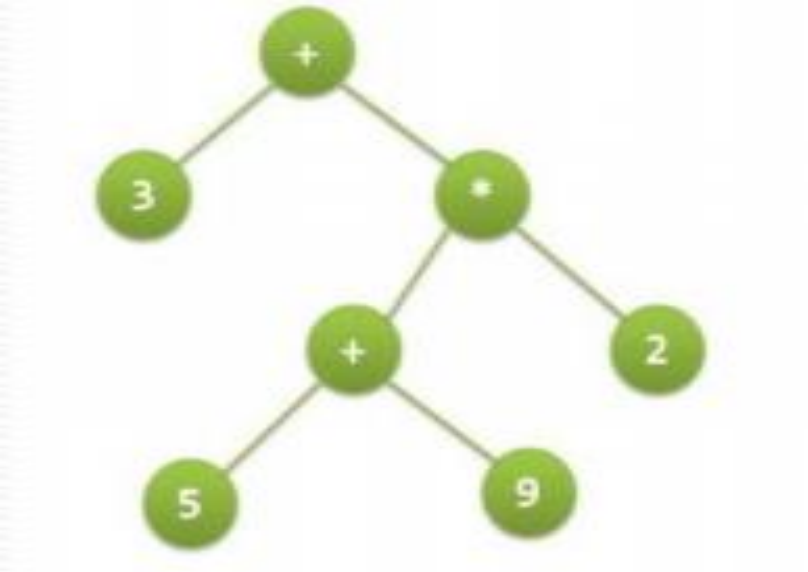
Example

expression tree for

3 + ((5 + 9) * 2)

would be:

- **Inorder traverse**



- Inorder traversal of expression tree produces infix version of given postfix expression (same with preorder traversal it gives prefix expression) .

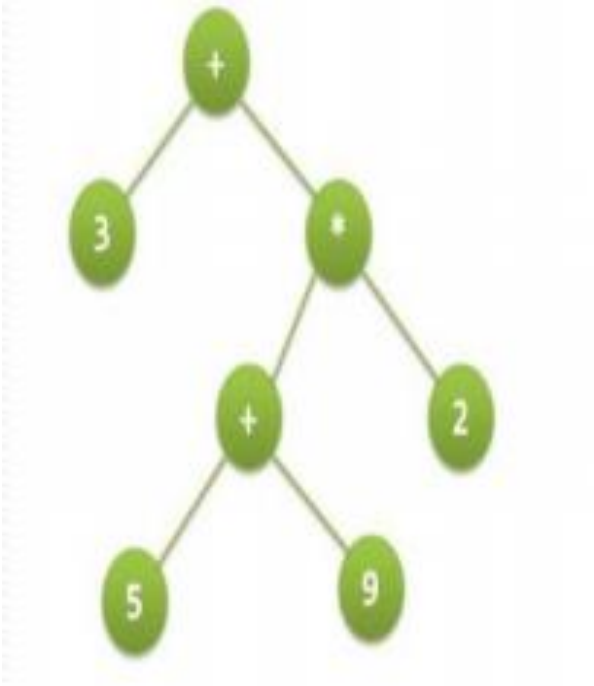
H.W1

You have the following tree ,Write the:

1- In-order traversal.

2- Pre-order traversal.

3- Post-order traversal .



H.W2

You have the following Arithmetic Expression:

A + B / C ^ (V – M) * 4

Write the:

1- In-order traversal.

2- Pre-order traversal.

3- Post-order traversal .