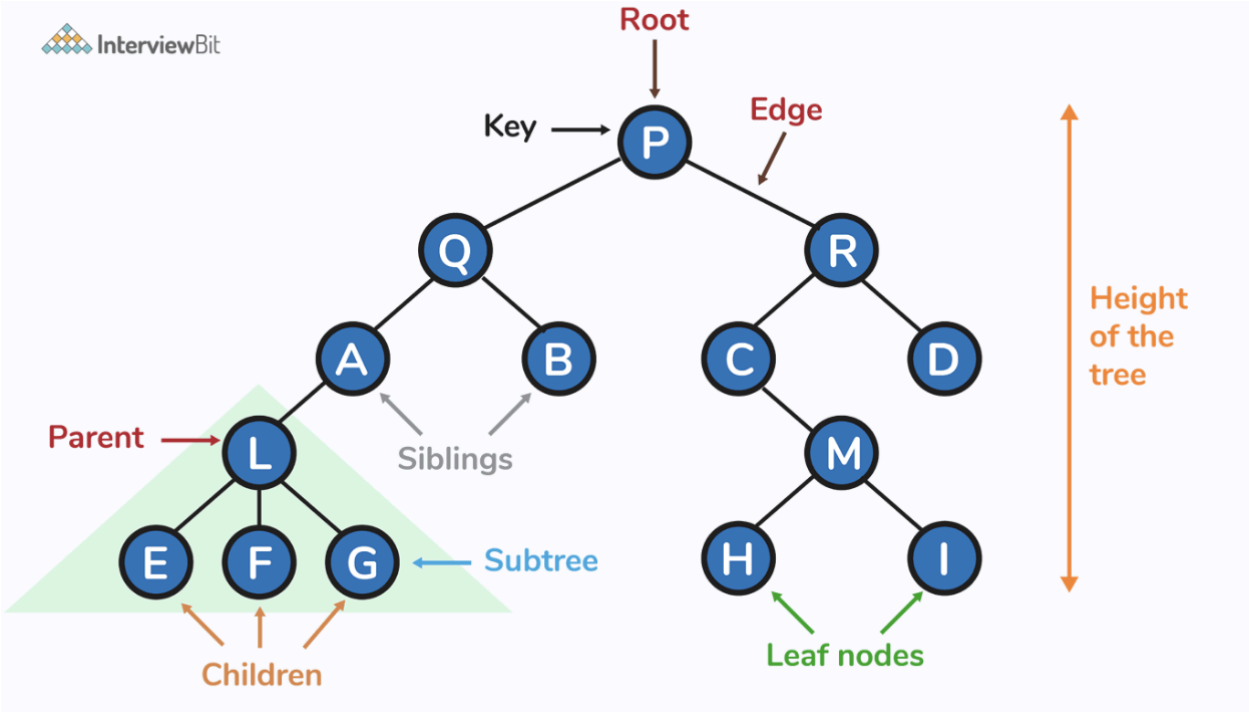
Tree

A tree is a widely used data structure in computer science.It consists of nodes connected by edges, forming a hierarchical structure.Each node can have zero or more child nodes,except for the root node which has no parent.

Some of the applications of trees are:

- Filesystems —files inside folders that are in turn inside other folders.
- Comments on social media – comments,replies to comments, replies to replies etc form a tree representation.
- Family trees — grandparents,parents,children,grandchildren etc represent the family hierarchy.



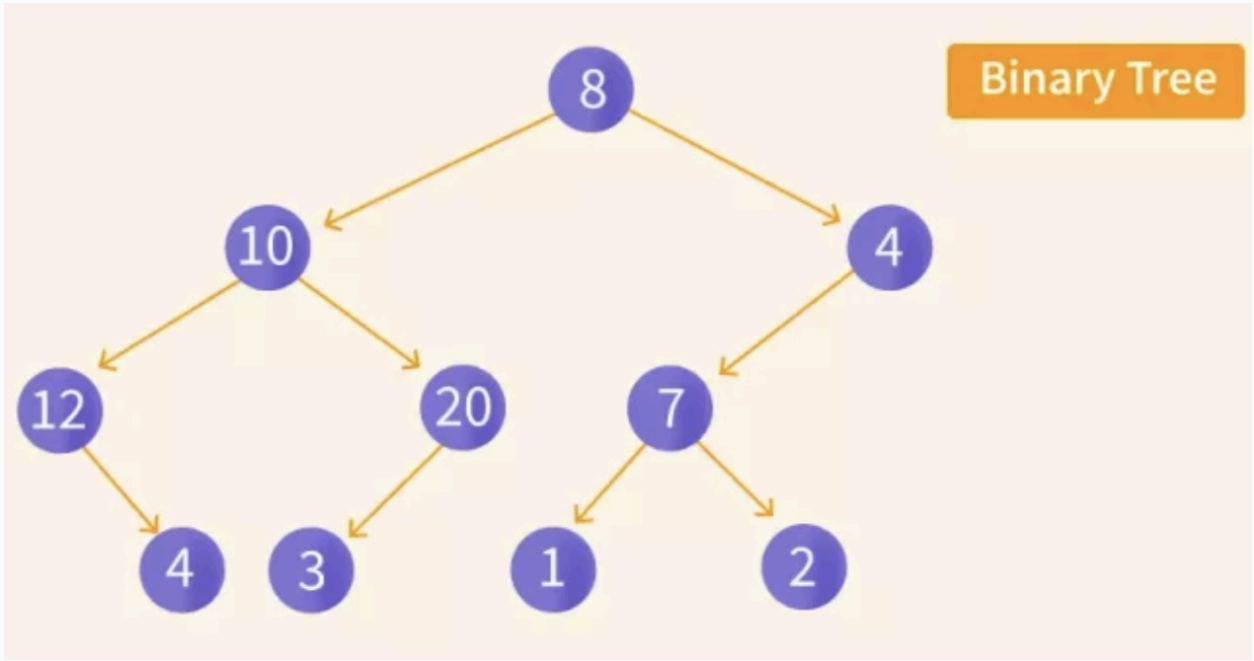
The most commonly used tree data structure are ➖

- Binary Tree
- Binary Search Tree

Lets try to see both these tree data structures in a more detailed manner.

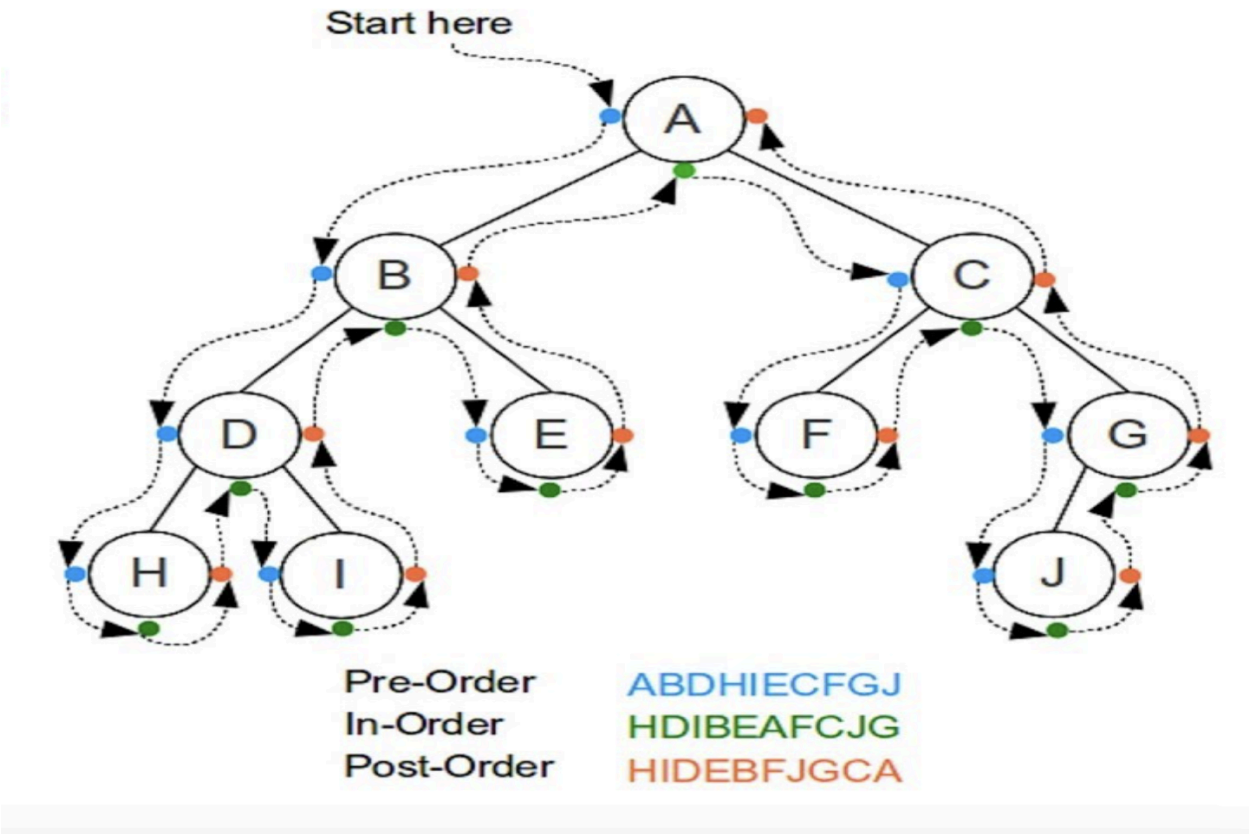
Binary Tree

A binary tree is a tree data structure whose **all nodes have either zero, one, or at most two children nodes**. These two children are generally referred to as left and right children respectively.

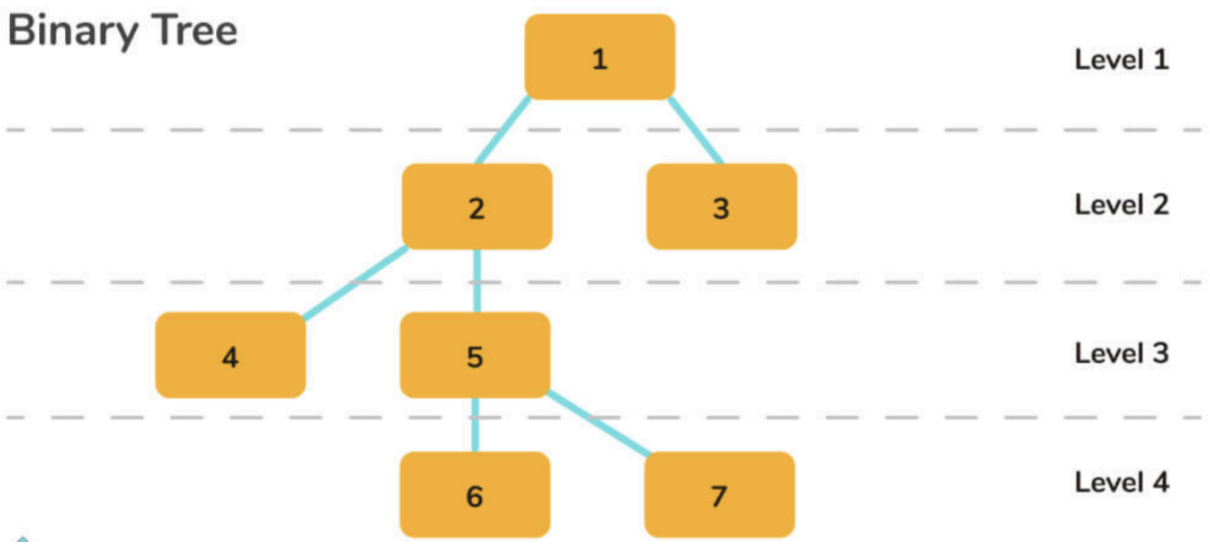


Traversal in Binary Tree

- Preorder Traversal
- Inorder Traversal
- Postorder Traversal
- Level order Traversal



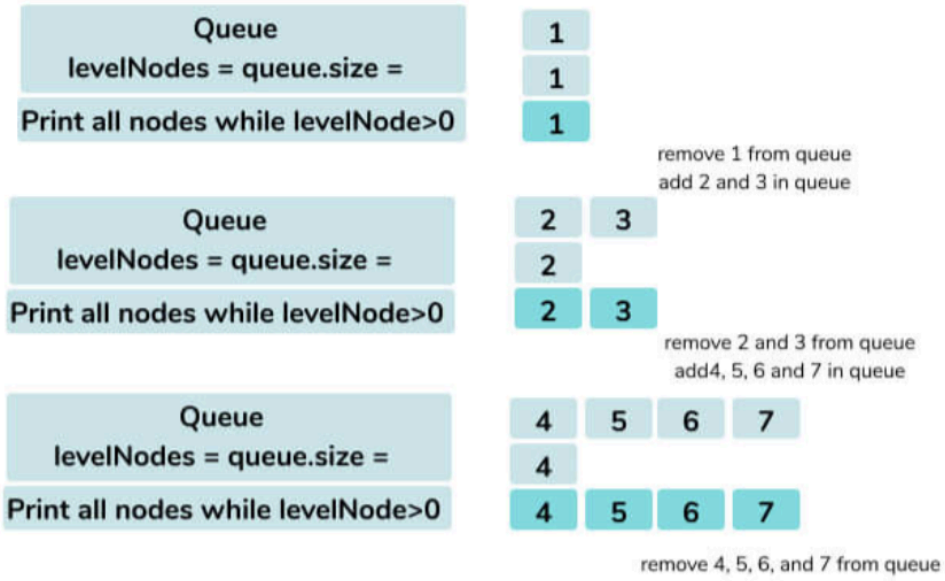
Level Order Traversal



Output
1
2 3

4 5
6 7

Approach :-



Code:-

```
void printLevelOrder(root)
{
    Queue<Node> queue = new LinkedList<Node>();
    queue.add(root);
    while (!queue.isEmpty()) {
        Node tempNode = queue.poll();
        System.out.print(tempNode.data + " ");
        if (tempNode.left != null) {
            queue.add(tempNode.left);
        }
        if (tempNode.right != null) {
            queue.add(tempNode.right);
        }
     }
}
```

Practice Questions :- Reverse Level Order

Left View of Binary tree (You can find this question in **Advanced Dsa : Trees 2: Views & Types**)

Right View of Binary tree

Search in Binary Tree

The idea is to use tree traversals to traverse the tree and while traversing check if the current node matches with the given node.

- Print YES if any node matches with the given node and return back.
- If the tree is completely traversed and none of the nodes matches then print NO.

```
boolean ifNodeExists( Node root, int key)
{
        if (root == null)
              return false;
        if (root.data == key)
              return true;
        if( ifNodeExists(root.left, key) || ifNodeExists(root.right, key) )
                return true;
   return false;
}
```

Src node to root node Path

Problem statement- Given a binary tree with distinct nodes. Store the path from the given “x” node to the root node in an arraylist.

Approach :-

A recursive function that traverses the different paths in the binary tree to find the required “x” node.

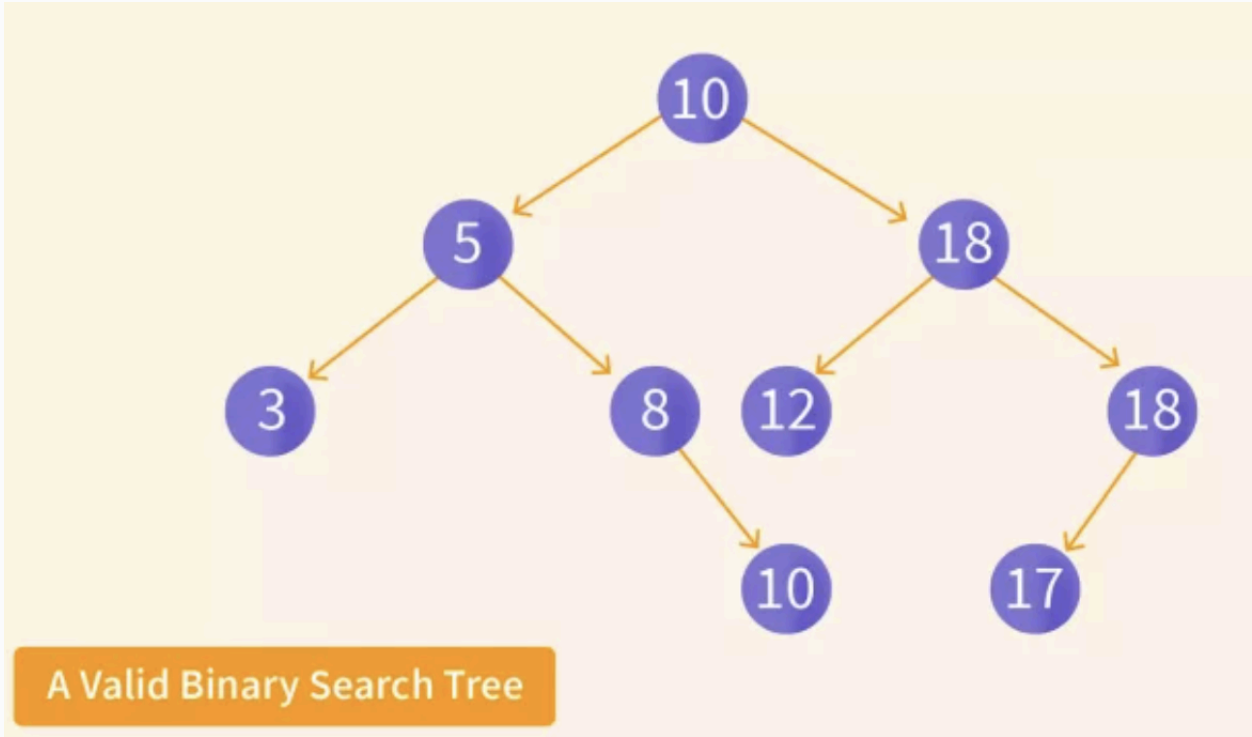
- If a node x is present then return true and accumulate the path nodes in some arraylist.
- If no path found, return empty arraylist

```
ArrayList<Node> path = new ArrayList<>();
boolean ifNodeExists( Node root, int key) {
        if (root == null)
            return false;
        if (root.data == key){
            path.add(root);
            return true;
         }
        if( ifNodeExists(root.left, key) || ifNodeExists(root.right, key)) {
             path.add(root);
             return true;
        }
   return false;
}
```

Practice Questions - [Symmetric binary tree]

Binary Search Tree

A binary search tree (BST) is a sorted binary tree, where we can easily search for any key using the binary search algorithm. To sort the BST, it has to have the following properties: The node's left subtree contains only a key that's smaller than the node's key.



Let’s talk about the special properties of the Binary Search Tree.

- The value of all the nodes in the left subtree of the root node is less than the value of the root node.
- The value of all the nodes in the right subtree is greater than the value of the root node.
- Properties 1 and 2 are true for all the nodes of the tree.

Insertion in BST

Let’s say the element we’re trying to insert is K.The algorithm doe insert operation in Binary tree is as follows :-

- if node == null, create a new node with the value of the key field equal to K. We return this newly created node directly from here.
- if K <= node.key, it means K must be inserted in the left subtree of the current node. We repeat(recur) the process from step 1 for the left subtree.
- else K > node.key, which means K must be inserted in the right subtree of the current node. We repeat(recur) the process from step 1 for the right subtree.
- Return the current node.

Search in BST

- if(node==null) k is not present in the tree.
- if(k<node.data), it means k must be present in the left subtree of the current node. We **recur** the process from step 1 for the left subtree.
- if(k > node.data), it means k must be present in the right subtree of the current node. We **recur** the process from step 1 for the right subtree.
- if(k == node.data) we have found k so return true.

LCA in BST

Problem Statement - Given a BST , find the lowest common ancestor of two given nodes in the Binary Search Tree.
The lowest common ancestor is defined between two nodes p & q as the lowest node in a tree that has both p & q as its descendants.

Approach-

- To find LCA, start from the root and compare it with both the given values.
    - If both values are smaller than current node's value, we move to left subtree
    - If both values are greater than current node's value, we move to right subtree
    - If neither condition is met, it means the current node is the LCA since one value is smaller and the other is greater.
    - We continue this process recursively until we find the LCA or reach a null position.

```
Node lowestCommonAncestor(Node root, Node p, Node q) {
        If (root.val > p.val && root.val > q.val)
                return lowestCommonAncestor(root.left,p,q);
         If (root.val < p.val && root.val < q.val)
                 return lowestCommonAncestor(root.right,p,q);
    return root;
}
```

Revision video - https://drive.google.com/drive/folders/1I2I65U4ZuAxMsaGTkT0LplbbnyzC8Y2B?usp=share_link