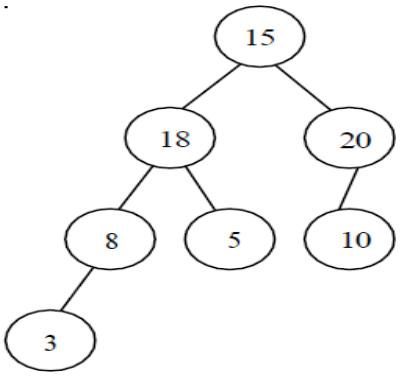
3.3 BINARY TREE

- Binary Tree is a tree in which no node can have more than two children.
- Maximum number of nodes in the tree with level i is 2^i -1. (Assume root node is at level 1)

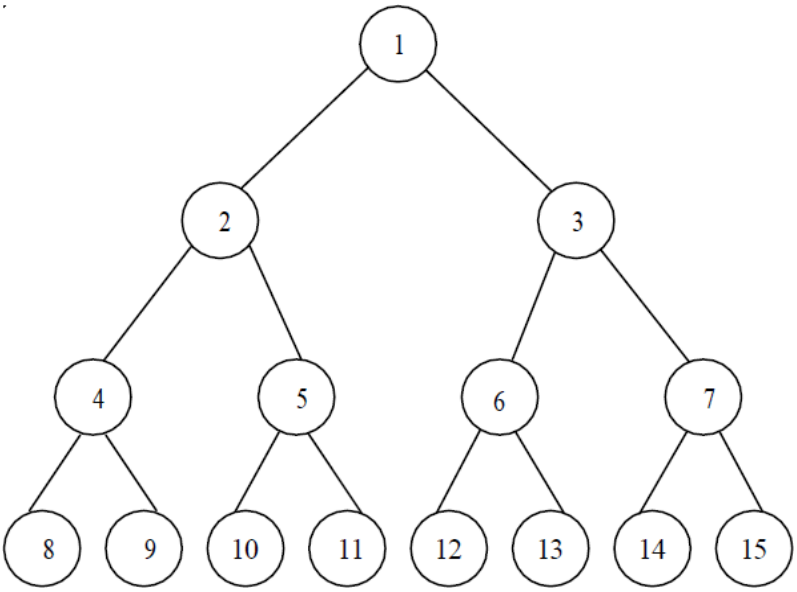


Binary Tree Node Declarations

```
class Node:
   Node* createNode(int data)
{
    Node* newNode = new Node;
    newNode->data = data;
    newNode->left = newNode->right = nullptr;
    return newNode;
    }
```

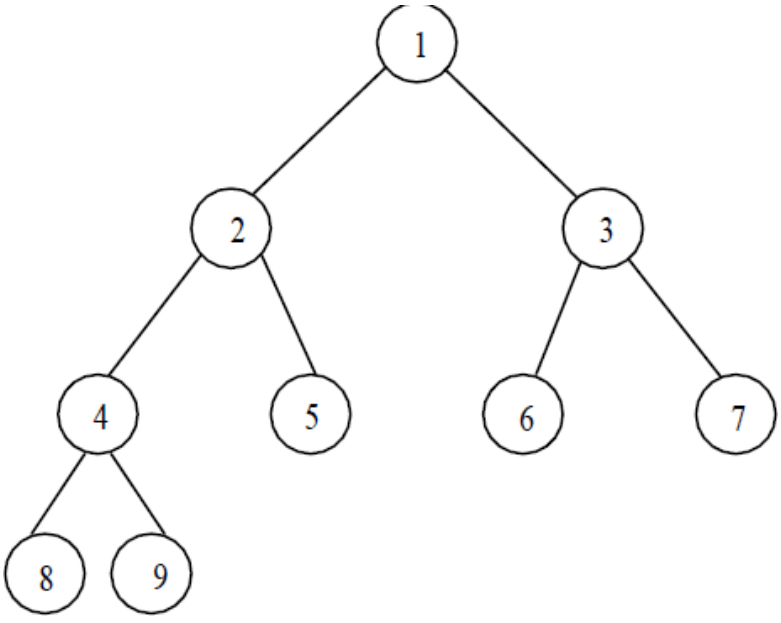
Full Binary Tree

- A full binary tree of height h has 2^{h+1} - 1 nodes.
- Here height is 3.
- No. of nodes in full binary tree is = 2^{3+1} -1= 15 nodes.
- A full binary tree (sometimes proper binary tree or 2-tree) is a tree in which every node other than the leaves has two children.



Complete Binary Tree:

- A binary tree is said to be a complete binary tree when all the levels are completely filled except the last level, which is filled from the left
- A complete binary tree of height h has between 2h and $^{2h+1}$ - 1 nodes.
- In the bottom level the elements should be filled from left to right.



- A full binary tree can be a complete binary tree, but all complete binary tree is not a full binary tree.

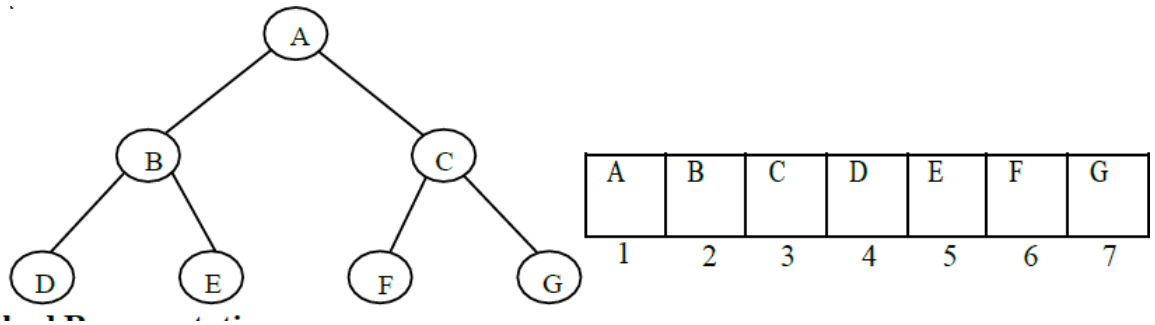
Representation of a Binary Tree

There are two ways for representing binary tree, they are

- Linear Representation
- Linked Representation

Linear Representation

- The elements are represented using arrays.
- For any element in position i, the left child is in position 2i, the right child is in position (2i + 1), and the parent is in position (i/2).



Linked Representation

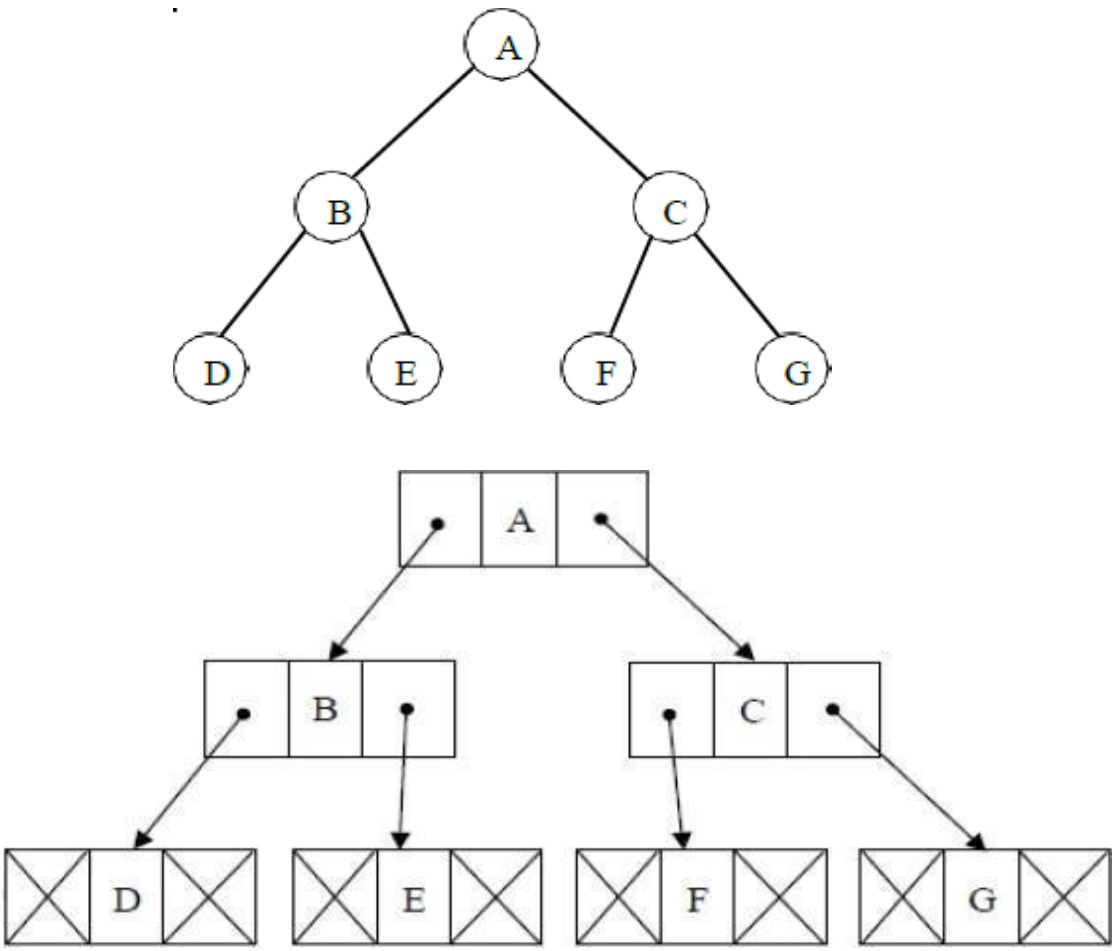
- The elements are represented using pointers.
- Each node in linked representation has three fields, namely,

  * Pointer to the left subtree

  * Data field

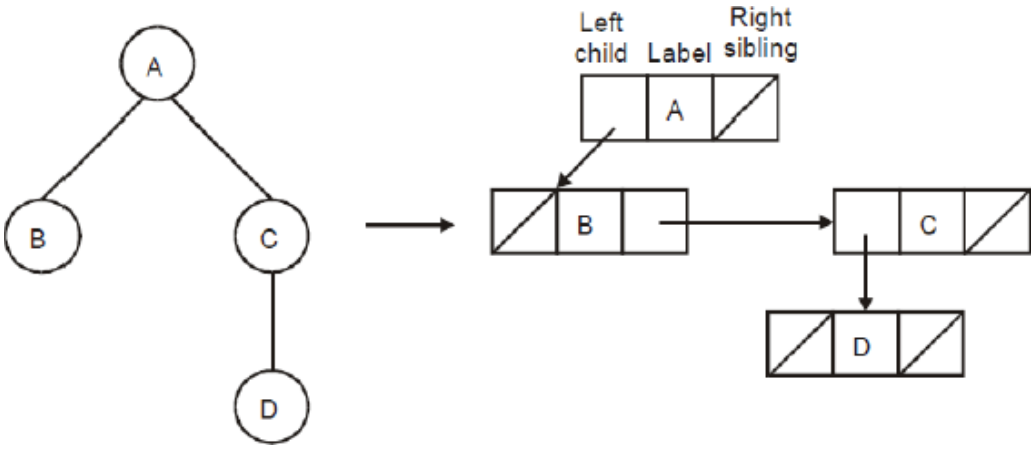
  * Pointer to the right subtree

- In leaf nodes, both the pointer fields are assigned as NULL.



The Leftmost-child, Right-sibling Data Structures

- In this representation, each node contains three fields namely, leftmost child, label and right sibling.
- Then, next pointers of node point to right siblings, and leftmost-child in cellspace.


A
B
C
D
Left child
Label
Right sibling
A
B
C
D