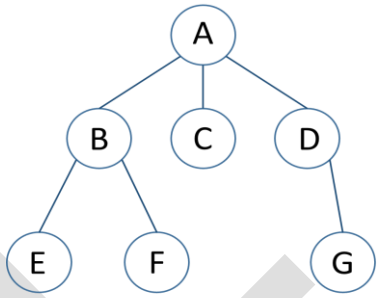
UNIT-3
TREES

1Q. Define tree. Explain tree terminologies. **----- 5 Marks**

Ans: Tree Definition: A tree is a collection of elements called nodes, represented in a hierarchical structure.

-> A tree is a non- linear data structure.

-> The first or top node in a tree is known as root node.

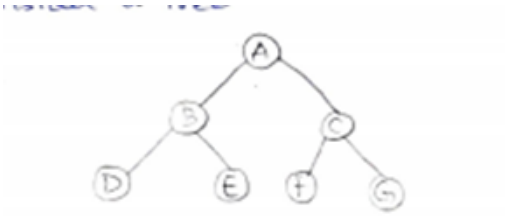


A Tree Structure

Tree Terminologies:

1.Root node: Node at the top of the hierarchy is known as "Root Node".

Consider a tree,



Here, 'A' is known as root node

2. Parent Node : A node having child nodes is known as parent node.

-> A tree can have any no.of parent nodes.

Here, A,B,C are known as parent nodes

3.Child node: In a tree datastructure, nodes derived from parent is known as child node.

Here,B,CD,E,F,G are known as CHILD NODES

4.**Sibling node:** Child nodes of same parent are known as "Sibling nodes".

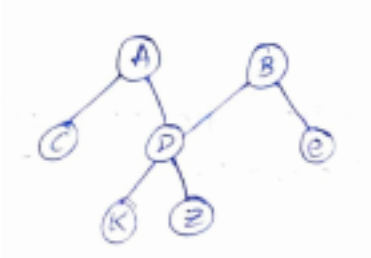
Here,{B,C},{D,E},{F,G} are sibling nodes.

5.Leaf Node: In a tree datastructure , the node which doesn't have chile nodes is known as leaf node.

Here,D ,E,F,G are known as leaf nodes.

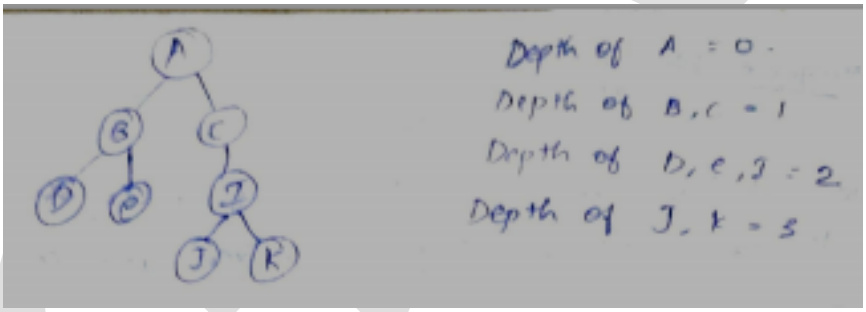
6.Edge: Line joining two nodes is known as edge.

7.Forest: A tree having "more than one root node" is known as forest.



8.Depth of a tree: no.of edges from the rootnode to the given node is known as depth of a node or leel of a node.

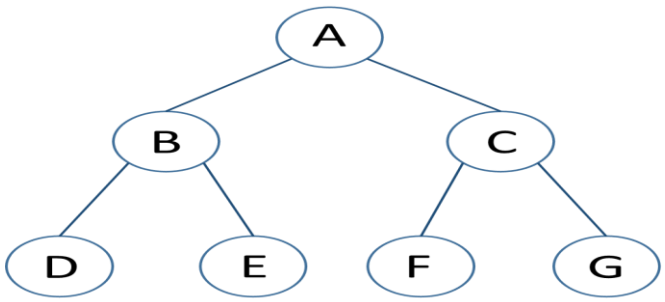
Max.depth of a node is known as depth of a tree.



9.Left Sub-tree : Sub-tree which is left to a parent node is known as left-subtree.

Right Sub-tree: Subtree which is right toa parent node is known as right-sub tree.

Left and Right sub-trees are present in a binary – tree.

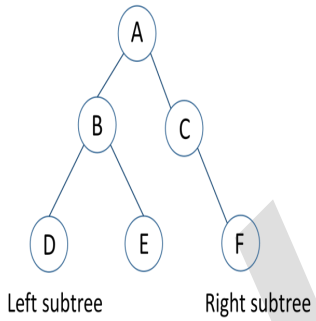


Q. Define Binary Tree. Explain types of binary trees.

-- 5 Marks (V.Imp)

Ans: Binary Tree: A binary tree is a collection of elements in which first element is called as root node and another elements are divided into two Sub- trees. They are : Left subtree, Right subtree

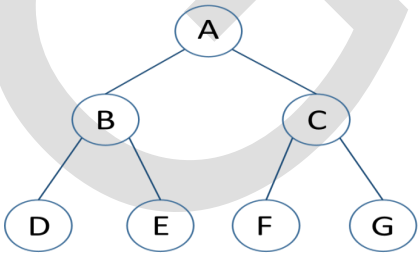
Each left and right subtree may have either 2 or 1 or 0 child nodes.

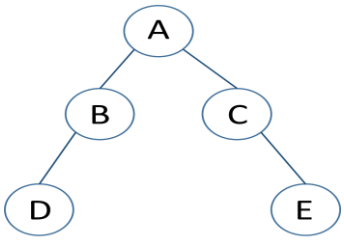


Types of binary trees:

1. Complete Binary tree
2. Binary Search tree
3. Skew tree
4. AVL tree
5. Threaded Binary Tree
6. Heap Tree
7. Strictly Binary tree

1. Complete Binary Tree: It is a binary tree where no. of nodes of Left sub tree are equal to no. of nodes of right sub tree and left sub tree, right sub tree are at same level.



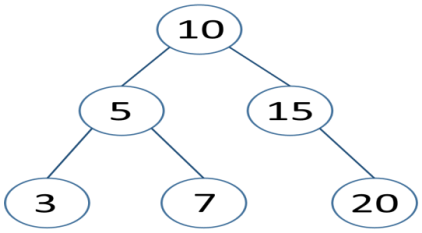


2. Binary Search Tree: It is also a Binary tree, where it follows the two given conditions.

1. All the elements of the left subtree are less than or equal to its parent node.
2. All the elements of the right subtree are greater than its parent node.

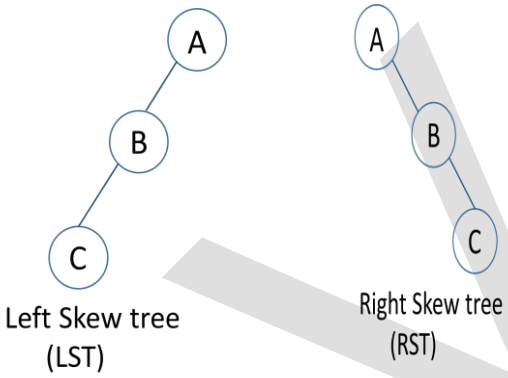
➔ Binary search tree are used in searching an element from large amount of data.

Example:



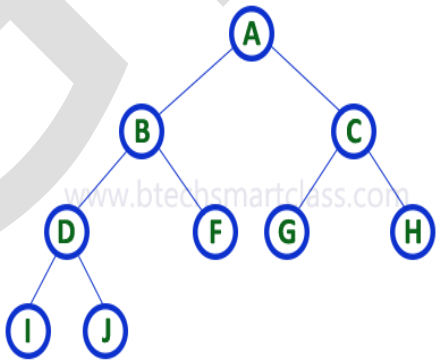
3. Skew Tree: A skew tree is a binary tree in which a parent node has only one child node that is either the left child node or right child node.

- ✓ A left skew tree is a binary tree it has only left child nodes.
- ✓ Similarly, a right skew tree is a binary tree it has only right child nodes.



4. Strictly binary tree: A binary tree in which every node has either two or zero number of child nodes is called Strictly Binary Tree.

Strictly binary tree is also called as Full Binary Tree or Proper Binary Tree or 2-Tree.

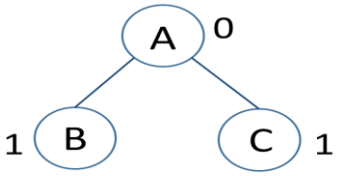


5.AVL Tree: An AVL tree is a binary tree in which height of LST- height of RST = 1 (or) 0 or -1

LST – left sub tree

RST – Right sub tree

This is also known as 'Height balanced tree'.



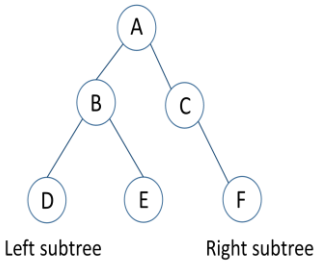
LST – RST = 1

Q. Define Binary tree. Explain representation of Binary tree.

--- 10 Marks (V.Imp)

Ans: Binary Tree: A binary tree is a collection of elements in which first element is called as root node and another elements are divided into two Sub- trees. They are : Left subtree, Right subtree

Each left and right subtree may have either 2 or 1 or 0 child nodes.



Representation of binary tree: A Binary tree can be represented (or) stored in computer memory in two ways. They are

1. Linear representation using arrays
2. Linked list representation using DLL

Linear representation of Binary tree: Representation of binary tree using arrays is known as linear representation of binary tree.

Algorithm:

1. Start
2. Create a 1-D array with size = 2^{d+1}-1., ie., a[size] Where 'd' is the depth of tree.
3. Store "root node" at index "zero" i.e., a[0] = rootnode
4. Store leftnode of parent node at index "2(i) + 1" i.e., a[2i+1] = leftnode
   where "i " is index value of parent node in array
5. Store rightnode of parent node at index "2(i) + 2" i.e., a[2i+2] = rightnode
   where "i " is index value of parent node in array
6. Repeat steps 4,5 until we store all nodes in a tree
7. STOP

Ex: consider a binary tree

Depth of tree = 2

Therefore size of array is 22+1 -1 = 7

Array Representation:

A => 0

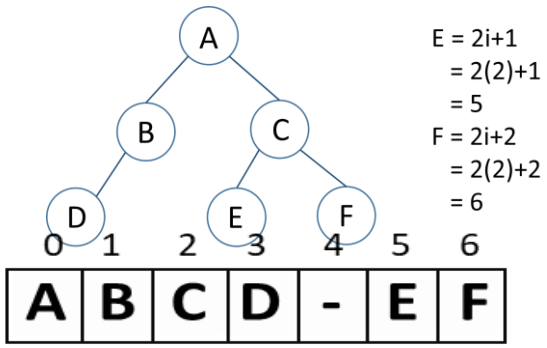
B => 2i+1 => 2(0)+1 = 1

C => 2i+2 =>2(0)+2 = 2

D =>2i+1=>2(1)+1 = 3

E=>2i+1=>2(1)+1 = 5

F =>2i+2 =>2(2)+2 = 6



Note: Array representation of binary tree best suited for complete binary tree & strictly binary tree. Memory is wasted, when we represent "skew binary tree" using arrays.

Linked List representation of Binary tree: In linked list representation we use "double linked list" to represent a binary tree

Structure of node in double linked list:

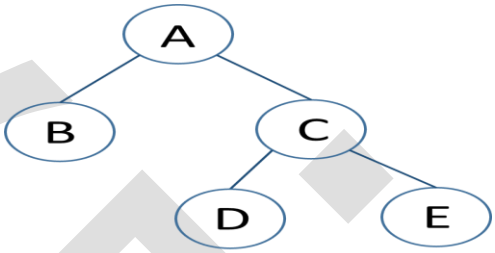
Here, previous node stores the address of left child.

Next node stores the address of right child.

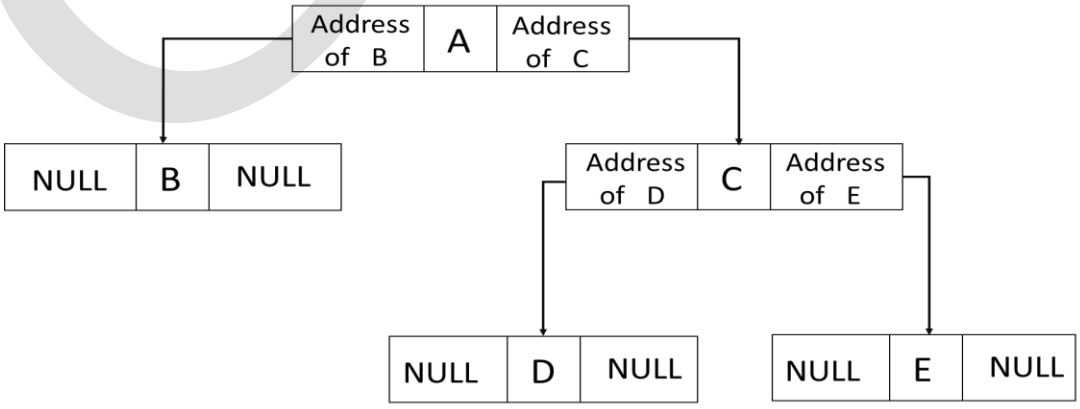
Structure of node in java:

```
class node
{
int data;
node next, previous;
}
```

Consider a binary tree



Linked list representation for above binary tree is:



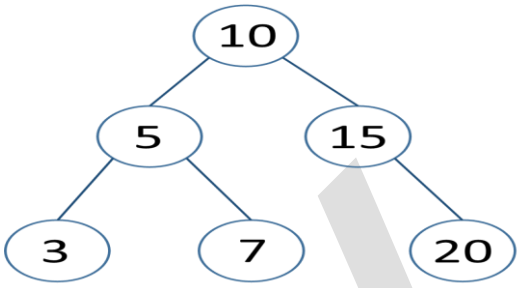
Q. Define Binary Search tree. Explain operations of Binary search tree (insert, delete, display operations)

----10 Marks (V.Imp)

Ans: **Binary Search tree :** It is also a Binary tree, where it follows the two given conditions:

1. All the elements of the left subtree are less than or equal to its parent node.
2. All the elements of the right subtree are greater than its parent node.

➔ Binary search tree are used in searching an element from large amount of data.



Operations on Binary search tree: The 3 basic operations on binary search tree are

1. Inserting a new node
2. Deleting a node
3. Displaying all the nodes of a tree (or) tree traversal

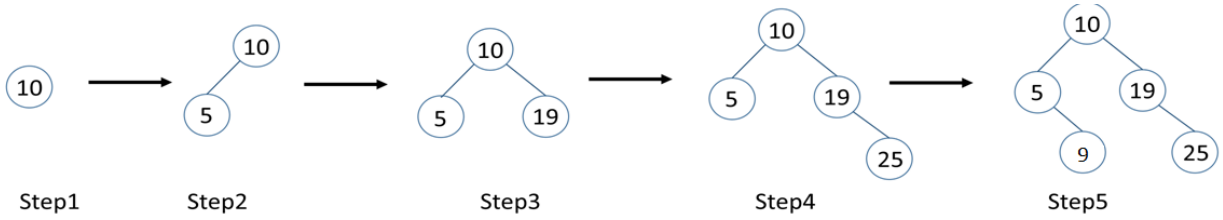
Inserting a newnode:

Algorithm:

1. Start
2. if (the tree is empty) , then
   create a new node & name it as Root node.
   else,
   if (the element <= parent node) then
   insert element as **left child** of parent node.
   else,
   Insert element as **right child** of parent node
3. STOP.

Ex: consider the elements:
10, 5, 19, 25, 9.

Binary search tree for the given elements is



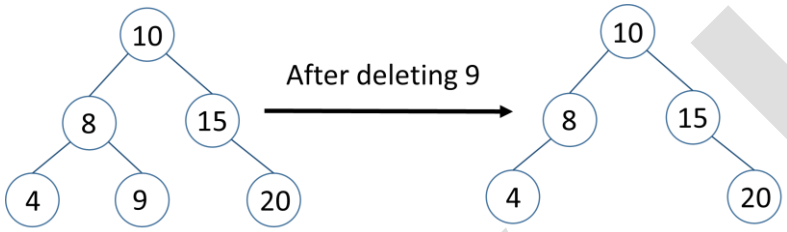
Deleting a node: Deleting a node from a binary search tree is done such that *"remaining nodes in tree must follow rules of BST".*

There are 3 types of delete techniques for BST. They are:

1. Deleting a leaf node
2. Deleting a node with single child
3. Deleting a node with two child nod**es**

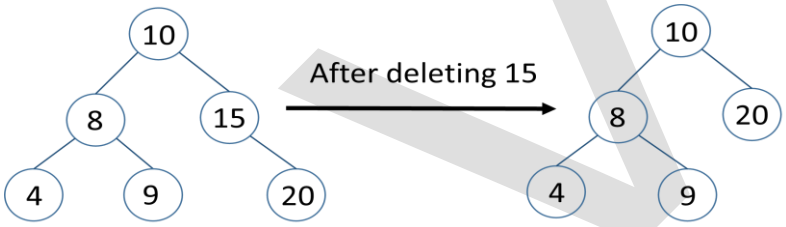
Deleting a leaf node: Deleting a leaf node from BST will not change its structure

Example:



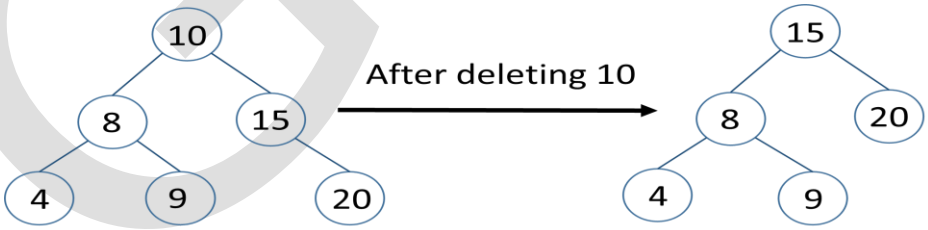
Deleting a node with single child: After deleting a node with single child, make its child node as parent node.

Example:



Deleting a node with two child nodes: After deleting a node having two child nodes, make any of its child node as parent node such that the remaining nodes follow the rules of BST.

Ex:



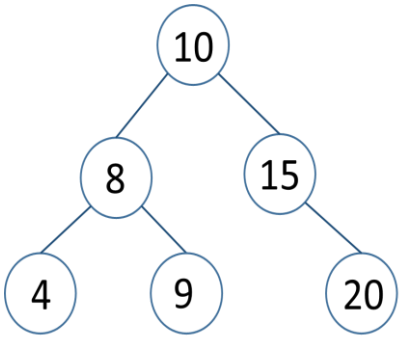
Displaying (or) visiting all nodes of a tree: Visiting all nodes of a tree is known as "Tree traversal techniques".

They are 3 types of tree traversal techniques. They are:

1. Inorder traversal (left, root, right)
2. Pre-order traversal (root, left, right)
3. Post-order traversal (left, right, root)

Example of tree traversal:

- Consider a binary search tree



Inorder : 4 8 9 10 15 19

Preorer : 10 8 4 9 15 20

Postorder : 4 9 8 20 15 10

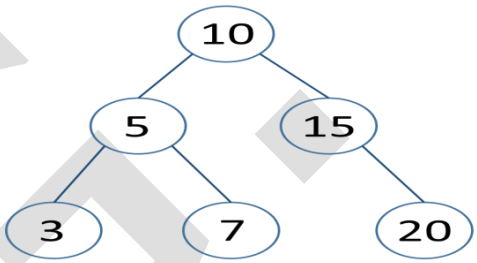
Q. Define binary search tree. Explain tree traversal techniques.

--- 10 Marks(V.Imp)

Ans: Binary Search tree : It is also a Binary tree, where it follows the two given conditions.

1. All the elements of the left subtree are less than or equal to its parent node.
2. All the elements of the right subtree are greater than its parent node.

➔ Binary search tree are used in searching an element from large amount of data.



Binary Tree Traversals: Visiting all nodes of a tree is known as "Tree traversal techniques".

They are 3 types of tree traversal techniques. They are:

1. **Inorder traversal (left, root, right)**
2. **Pre-order traversal (root, left, right)**
3. **Post-order traversal (left, right, root)**

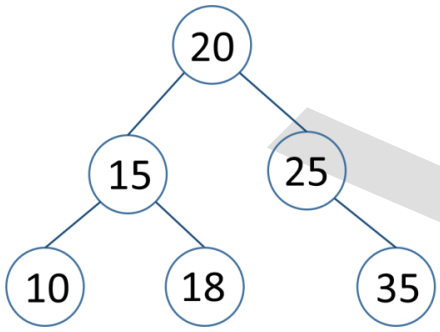
Inorder Traversal: In this traversal technique, the nodes of tree are visited in the following order

1. Visit left subtree in inorder
2. Print root node
3. Visit right subtree in inorder

Algorithm:

1. Start
2. if not empty (tree) , then
   Begin
   Inorder (left sub tree)
   Print root node
   Inorder (right sub tree)
   else
   Stop

Example:



Output of InOrder Traversal**: 10 15 18 20 25 35**

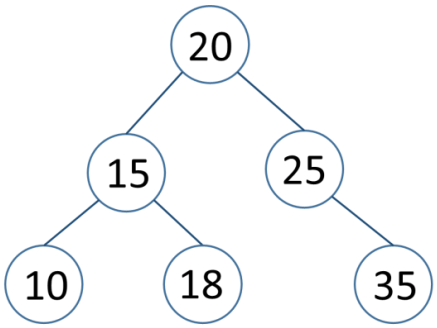
Preorder Traversal: In this traversal technique, the nodes of tree are visited in the following order

1. Print root node
2. Visit left subtree in preorder
3. Visit right subtree in preorder

Algorithm:

1. Start
2. if not empty (tree) , then
   Begin
   Print root node
   preorder (left sub tree)
   preorder(right sub tree)
   else
   Stop

Example:



Output of PreorderTraversal**:** **20 15 10 18 25 35**

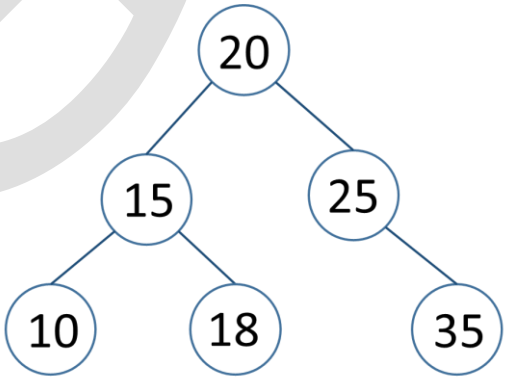
Postorder Traversal: In this traversal technique, the nodes of tree are visited in the following order

1. Visit left subtree in postorder
2. Visit right subtree in postorder
3. Print root node

Algorithm:

1. Start
2. if not empty (tree) , then
   Begin
   postorder(left sub tree)
   postorder (right sub tree)
   Print root node
   else
   Stop.

Example:



Output of PostorderTraversal**:** 10 18 15 35 25 20

Q. Explain about Expression tree. -----**5 Marks**

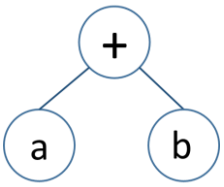
Ans: Expression tree: An Expression tree is also a binary tree. In an expression tree, arithmetic expression is represented in the form of a tree. The operator is placed as "root node" or "parent node" and operands are placed as "leaf node".

Advantages of Expression Tree:

1. Expression trees are used to convert infix expression to postfix & prefix expressions
2. Expression trees are used in mathematical calculations

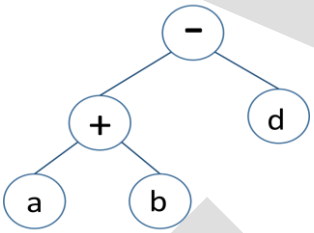
Example for Expression trees

Example1 : a+b



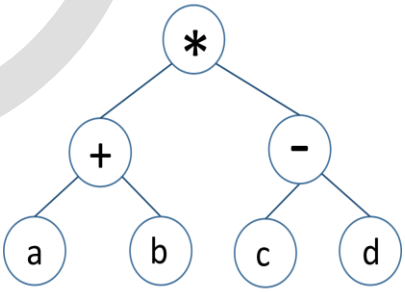
- ➔ infix : a+b
- ➔ postfix :ab+
- ➔ prefix : +ab

Example2 : a+b-d



- ➔ infix : a+b-d
- ➔ postfix : ab+d-
- ➔ prefix : - +abd

Example3: a+b*c-d



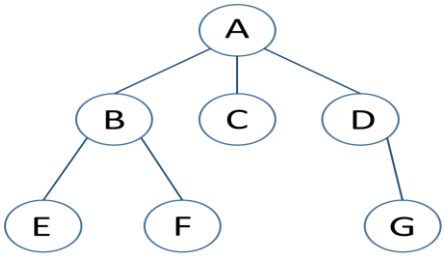
- ➔ infix : a+b*c-d
- ➔ postfix : ab+cd-*
- ➔ prefix : *+ab-cd

Q .Define heap tree. Explain types of heap trees. **-----5 Marks**

Tree: A tree is a collection of elements called nodes, represented in a hierarchical structure.

-> A tree is a non- linear data structure.

-> The first or top node in a tree is known as **root node**.



A Tree Structure

Heap tree: Heap tree is a binary tree with the values of parent node greater than or less than its child nodes.

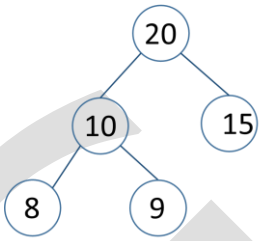
There are two types of heap trees. They are

- Max heap tree
- Min heap tree

Maxheap tree: In a heap tree, if the values of parent node is greater than its child node is known as max heap tree.

In general a common heap tree is known as max heap tree

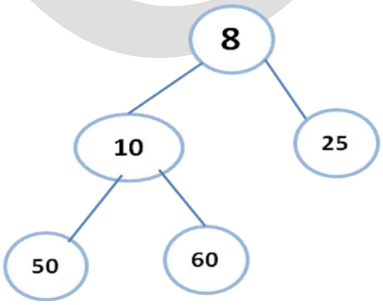
Ex:



- It is used in printing the elements in descending order.
- Output for above max. heap tree is 20 15 10 9 8

Minheap tree: In a heap tree, if the values of parent node is less than its child node is known as min heap tree.

Ex:



- It is used in printing the elements in ascending order.
- Output for above min. heap tree is 8 10 25 50 60

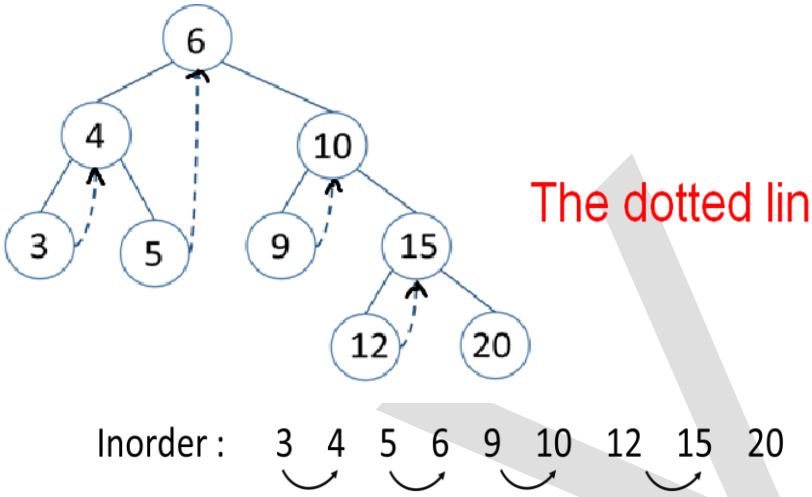
Q. Explain about Threaded Binary Tree

Ans: Threaded Binary Tree: A threaded binary tree is a binary search tree in which the "leaf nodes of a tree" points to its inorder successor / inorder predecessor.

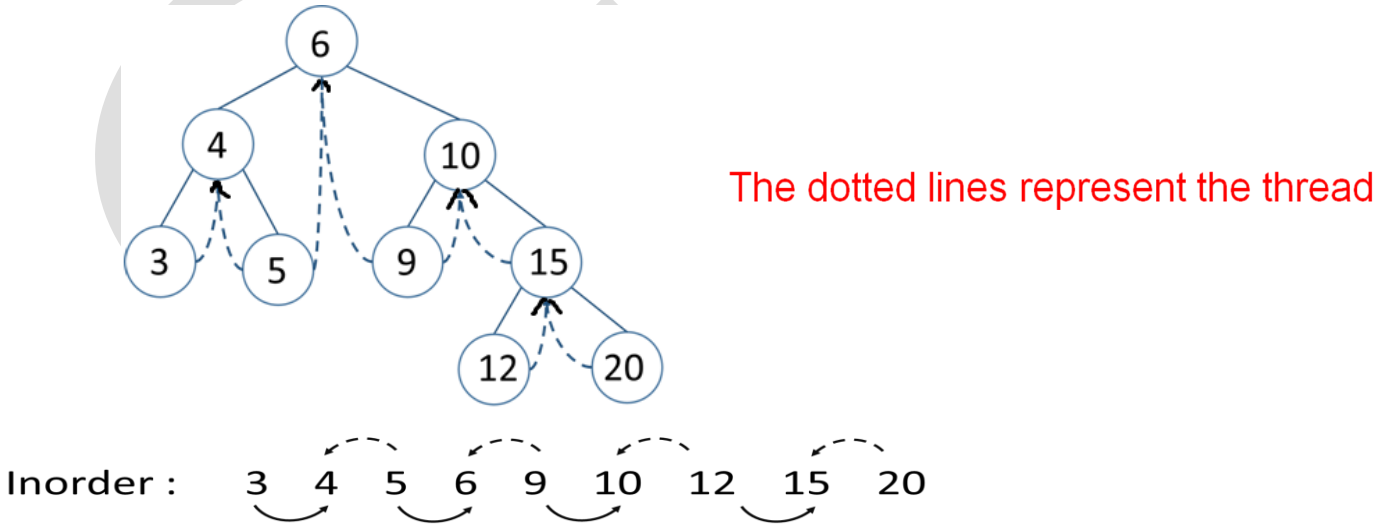
Types of threaded binary tree:

1. Single threaded binary tree
2. Double threaded binary tree

Single threaded binary tree: A single threaded binary search tree is a binary tree where leaf node of binary tree points to its 'Inorder successor' **.**



Double threaded binary tree: A double threaded binary search tree points to its inorder predecessor and inorder successor respectively.



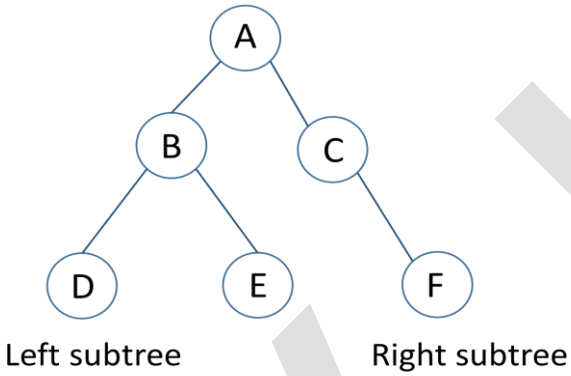
Advantages & Disadvantages of Threaded Binary Tree:

1. It is used in fast searching
2. It is used in printing traversals order quickly.
3. Tree becomes more complex
4. Programming is more difficult**.**

Q Define binary tree. Explain applications of binary tree -----5 Marks

Ans: Binary Tree A binary tree is a collection of elements in which first element is called as root node and another elements are divided into two Sub- trees. They are : **Left subtree, Right subtree**

Each left and right subtree may have either 2 or 1 or 0 child nodes.



Applications of Binary Tree:

1. Trees are used to represent hierarchical data.
2. Trees are used to represent mathematical expressions.
3. Tress are used in searching an element quickly.
4. Trees are used in sorting the elements either in ascending or in descending order.
5. Trees are used in designing digital images and 3-D animations or visual effects.
6. Trees are used to represent files in file system or in windows explorer.