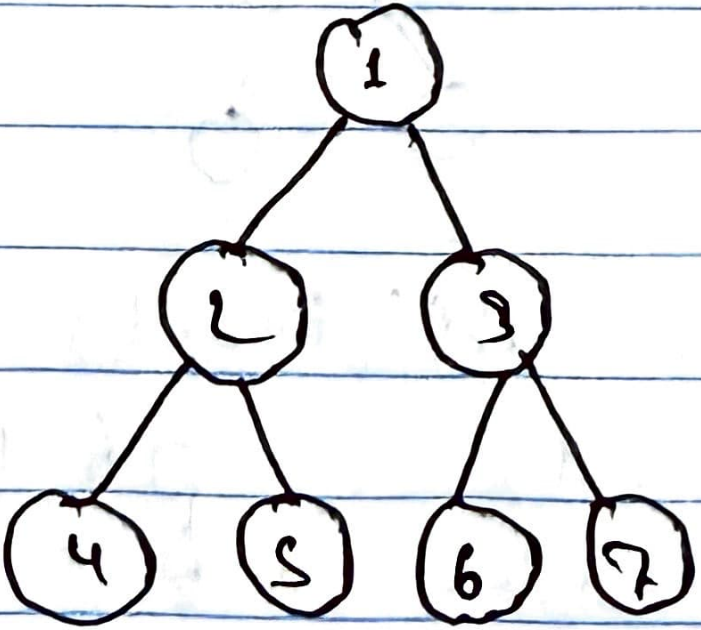
* Binary Tree :-

→ In binary tree each node can have only or max of two childs.

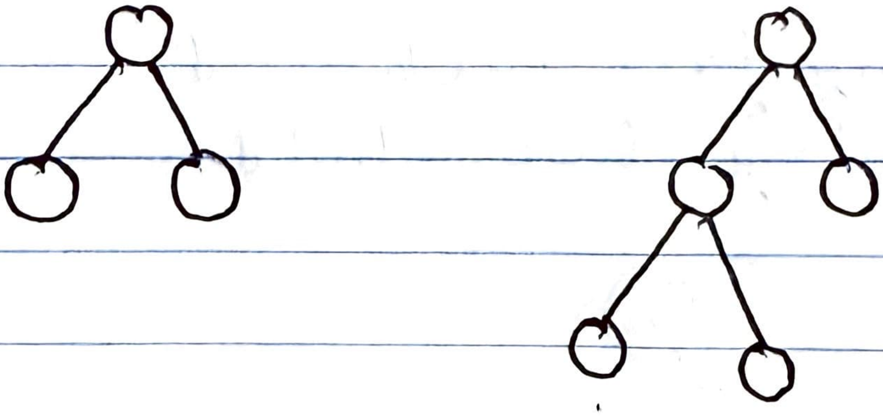


→ Binary tree can be represented with doubly linked list.

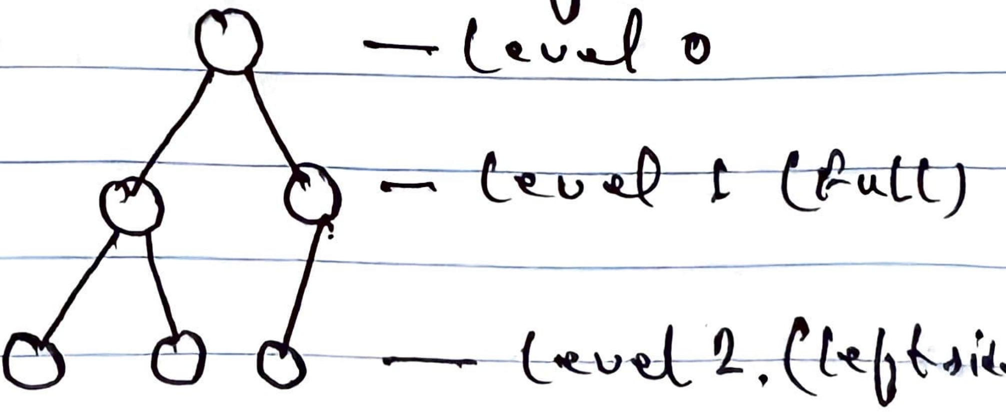
* Types of binary tree.

- → Full binary tree.
- → Complete binary tree
- → Perfect binary tree.
- → Balanced binary tree.
- → Degenerate binary tree.

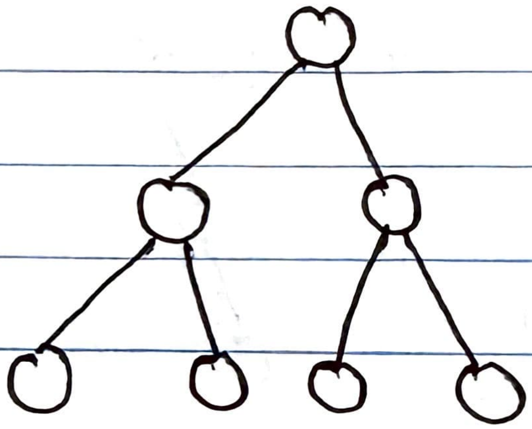
* **Full BT** → Every node has either 0 ~~element~~ or 2 children.



* **Complete BT** :- All levels completely filled with node except the last level and in the last level, all the nodes must be left aside.

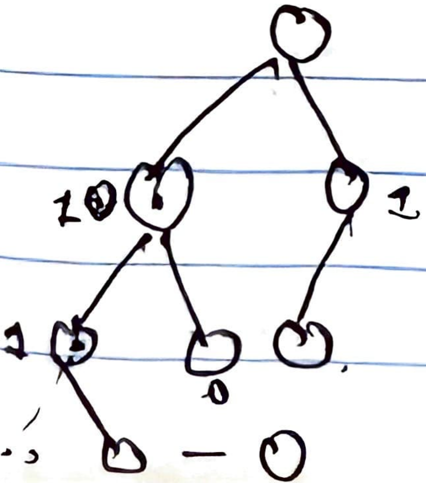


* Perfect BT :- BT in which all the internal nodes have 2 ~~ch~~ children and all the leaf nodes are at the same depth or l

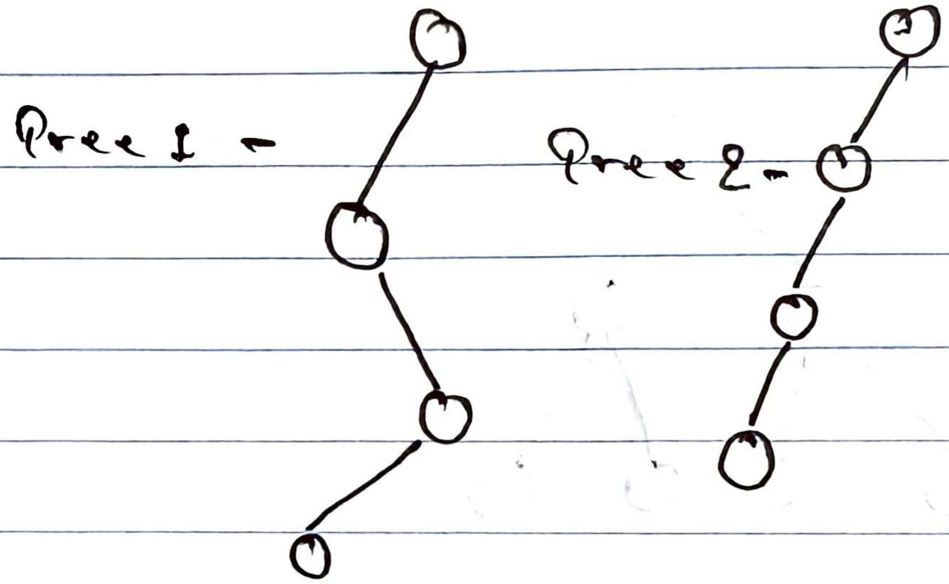


* Balanced BT :- Binary tree in which height of the left and the right sub-tree of every node may differ by atmost 1

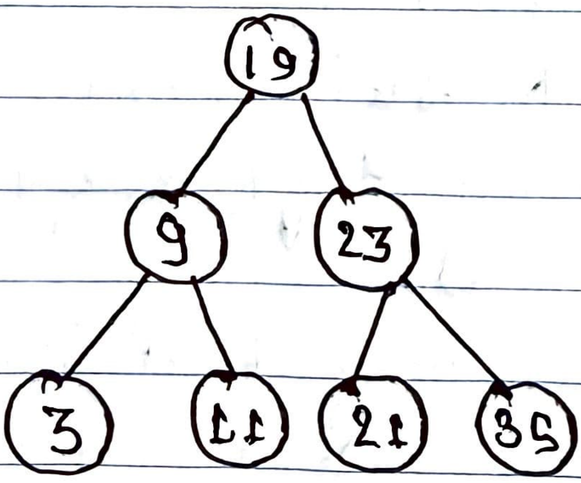
height difference = height of left − height of right



* Degenerate BT :- Where every parent node has only one child node



* Binary Search Tree :- ** ** * * *



→ All the elements on the left has to be less than root node value and all the elements on the right has to be greater than root node value.

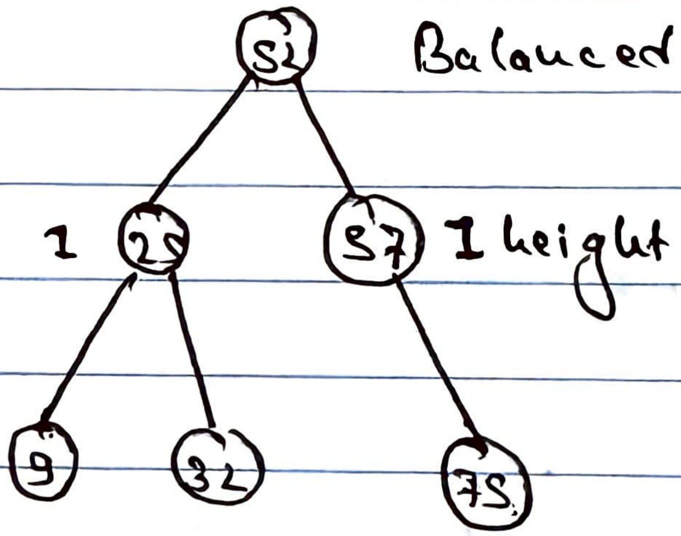
→ Types of binary search tree.

i> Balanced (height ≤ 1)

ii> Unbalanced. (height > 1).

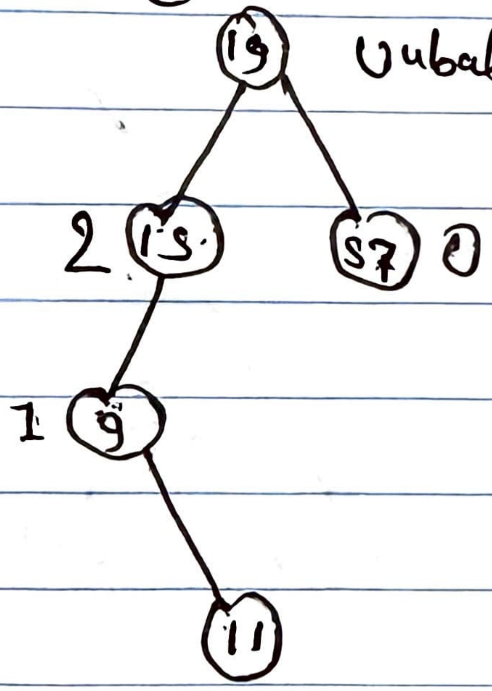
d = 1 − 1 = 0 < 1

Balanced.



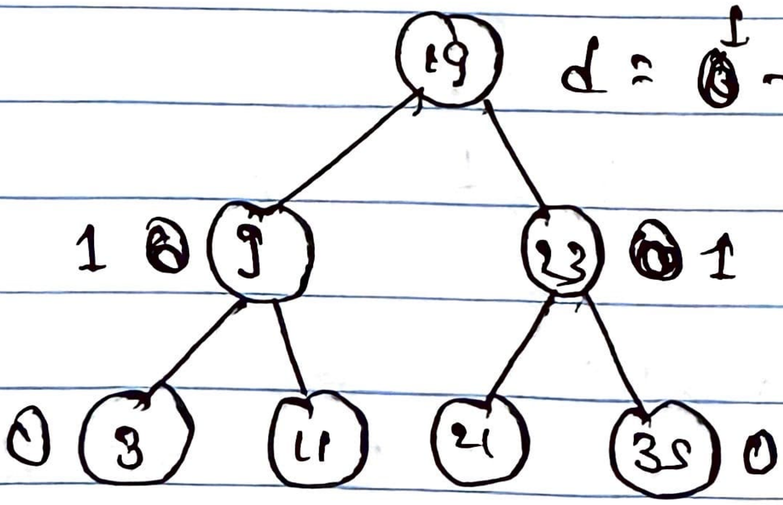
d = 2 − 0 = 2 > 1

Unbalanced



d = 1 − 1 = 0

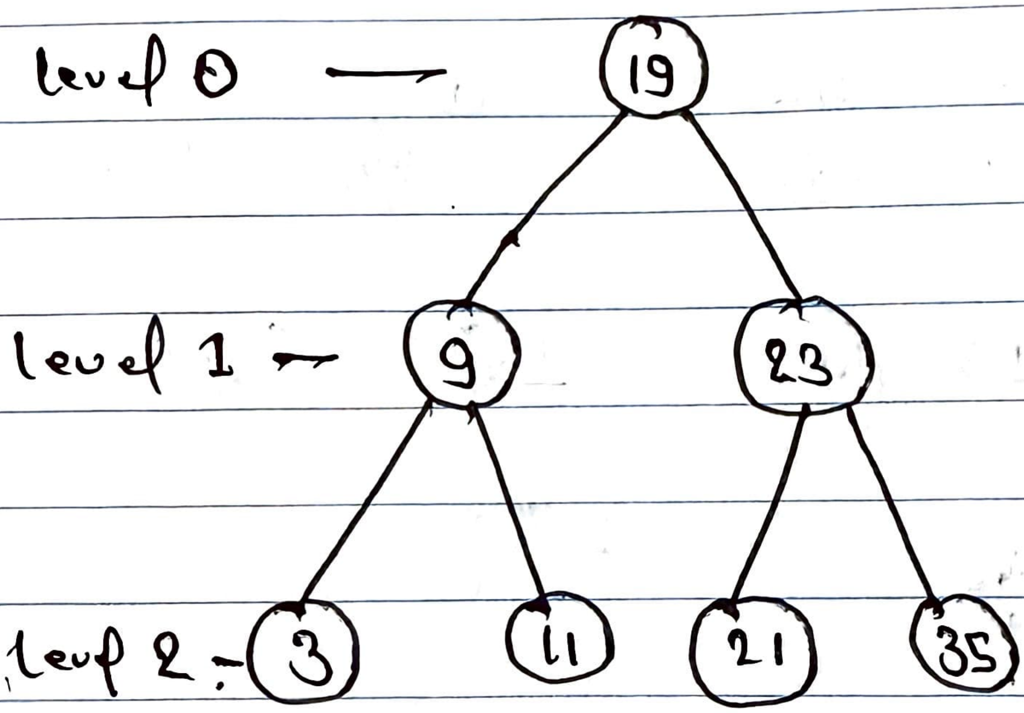
Balanced BT



* complexity of BST (log n)
 " " UBST (n).
(Search operation)

* To calculate the height of BST.

$$\boxed{n = 2^{h+1} - 1}$$



$$n = 2^{2+1} - 1$$
$$= 2^{3} - 1$$
$$\Rightarrow 8 - 1 = 7$$

* Insert operation.

→ ~~BST~~ Balanced ~~BST~~ ~~bata~~ BST.
log(n)

→ Unbalanced - O(n)

* Delete operation,
→ Node has 0, or 1 or 2 child.

* for node has 0 childe - $O(\log(n))$
→ for node has 1 child - $O(\log(n))$
→ for - node has 2 child - $O(\log(n))$
Worst case in all is $O(n)$.

* AVL and Red Black Tree:

When we start adding new node on one of the sides of Balanced tree we are eventually going to make balanced the tree unbalanced. To avoid this ~~AVL~~ Red black tree introduced. It automatically update the tree to make it balance.