



AVL Tree

Course on C-Programming & Data Structures: GATE - 2024 & 2025

Data Structure

Tree 9 AVL Tree Deletion

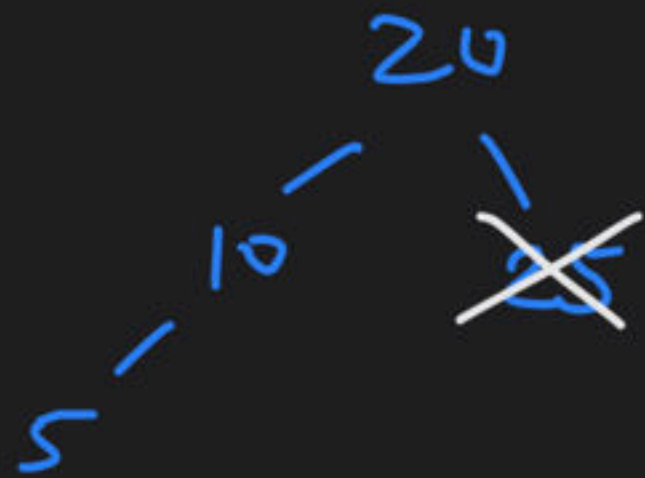
By: Vishvadeep Gothi

Deletion in AVL Tree

→ Delete node based on BST deletⁿ.

→ check for imbalance \Rightarrow in ancestors

| \rightarrow If yes then identify case & perform appropriate rotatⁿ



AVL Tree Deletion

6 cases for deletion:

1. R_0

2. R_1

3. R_{-1}

4. L_0

5. L_1

6. L_{-1}

① From imbalanced node, the direction of deleted node \Rightarrow Right

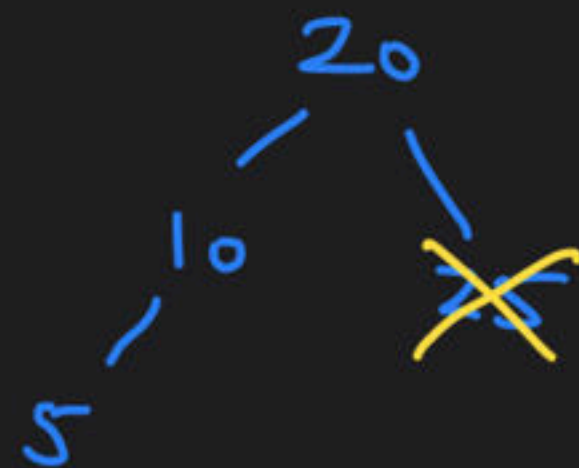
② Balance factor of left child $\Rightarrow \begin{cases} 0 \\ 1 \\ -1 \end{cases}$

① From imbalanced node, the direction of deleted node \Rightarrow Left

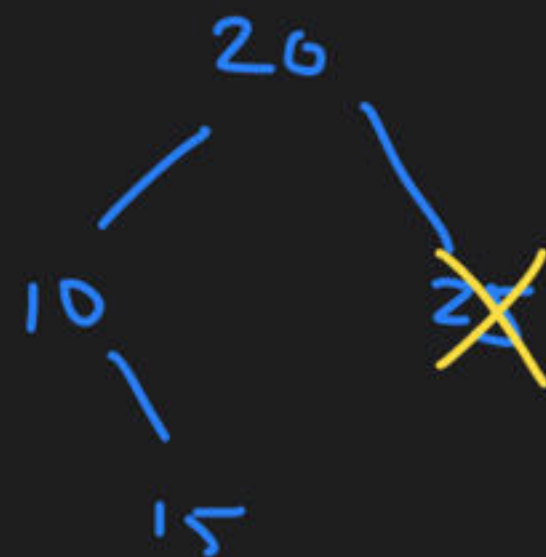
② B.f. of Right child $\Rightarrow \begin{cases} 0 \\ 1 \\ -1 \end{cases}$



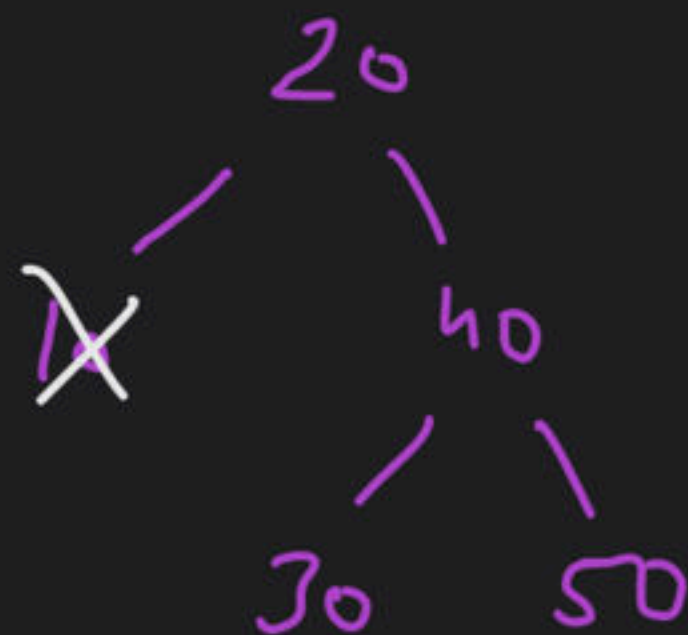
case $\Rightarrow R_0$



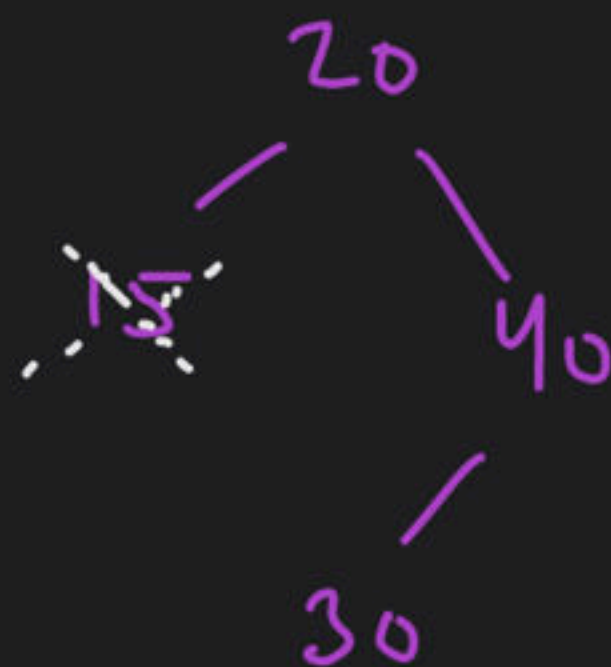
case $\Rightarrow R_1$



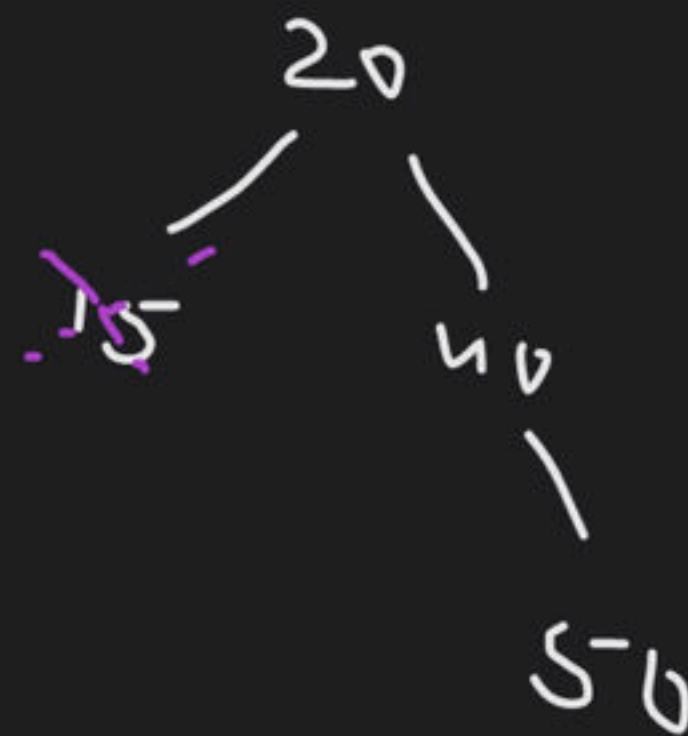
case $\Rightarrow R_{-1}$



case $\Rightarrow L_0$



case $\Rightarrow L_1$

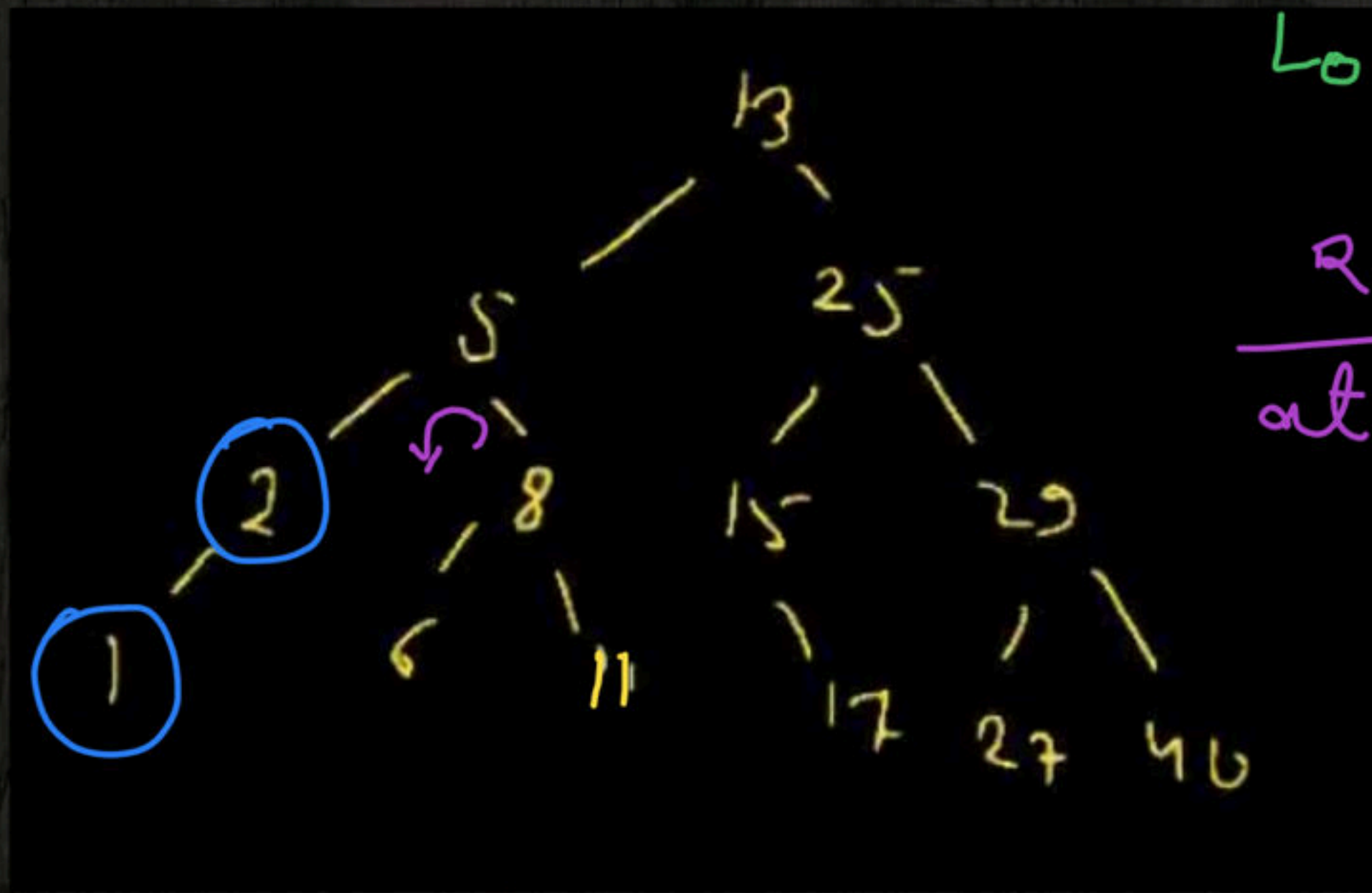


case $\Rightarrow L_{-1}$

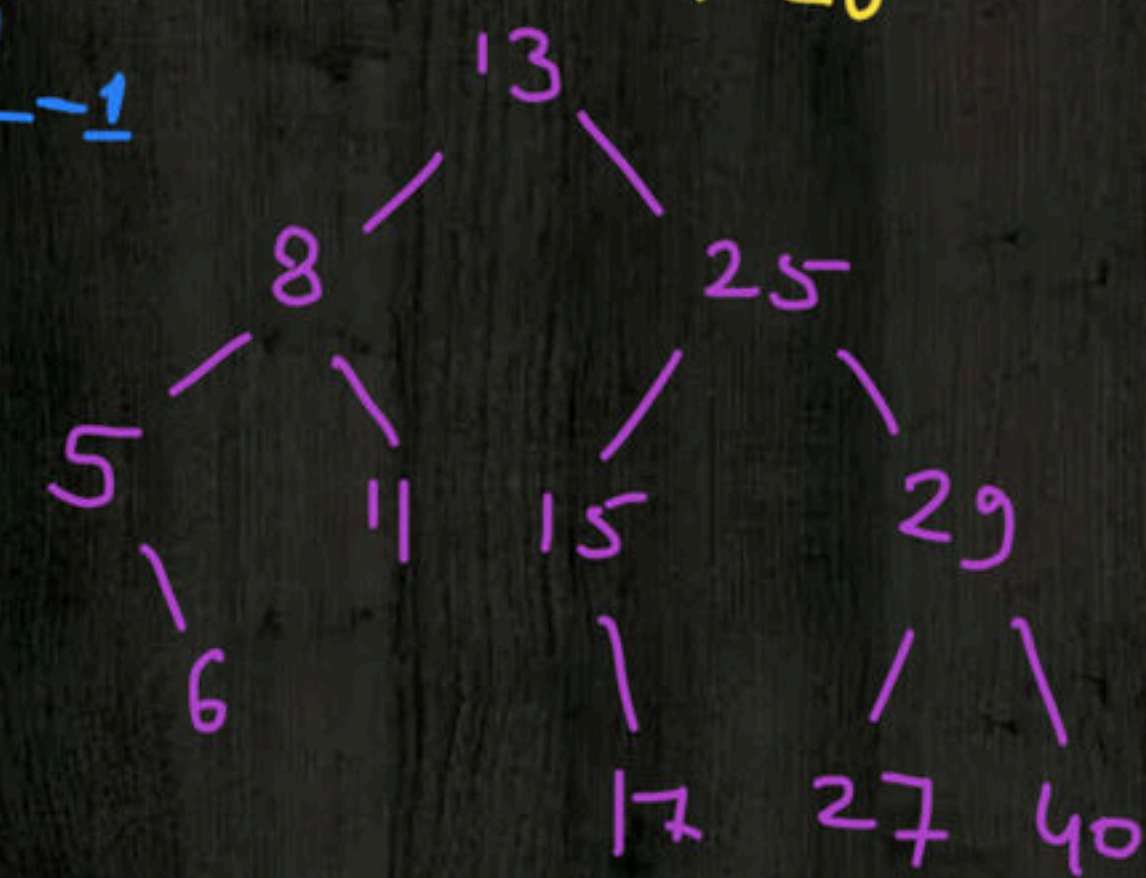
case	Rotat ⁿ
R_0	LL
R_1	LL
R_{-1}	LR
L_0	RR
L_1	RL
L_{-1}	RR

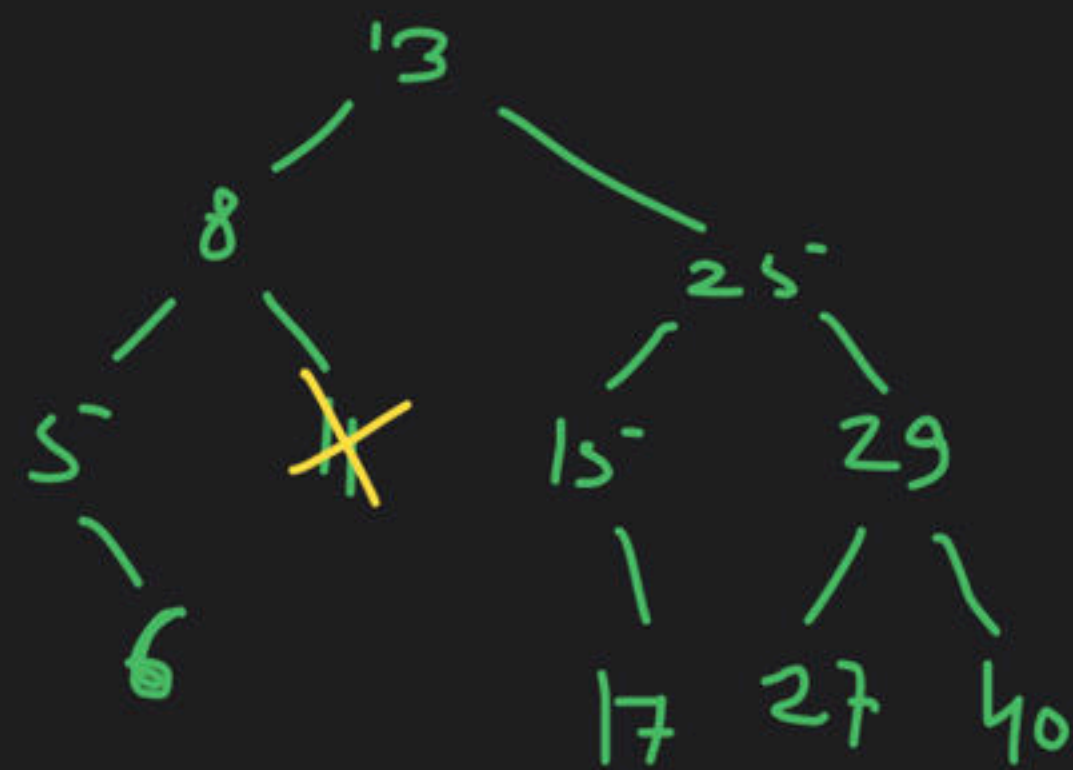
AVL Tree Deletion

Delete keys from below AVL tree: ~~1~~, ~~2~~, ~~11~~, ~~17~~, ~~5~~, ~~8~~, ~~13~~, ~~6~~, ~~15~~

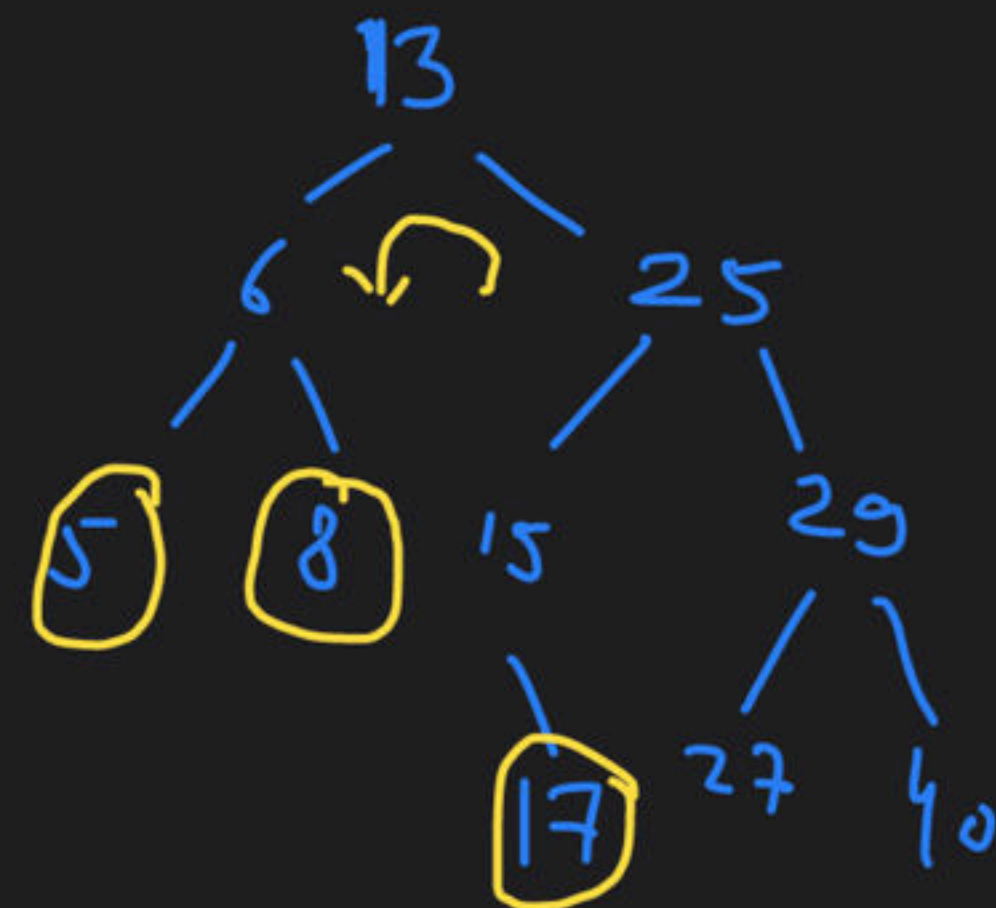
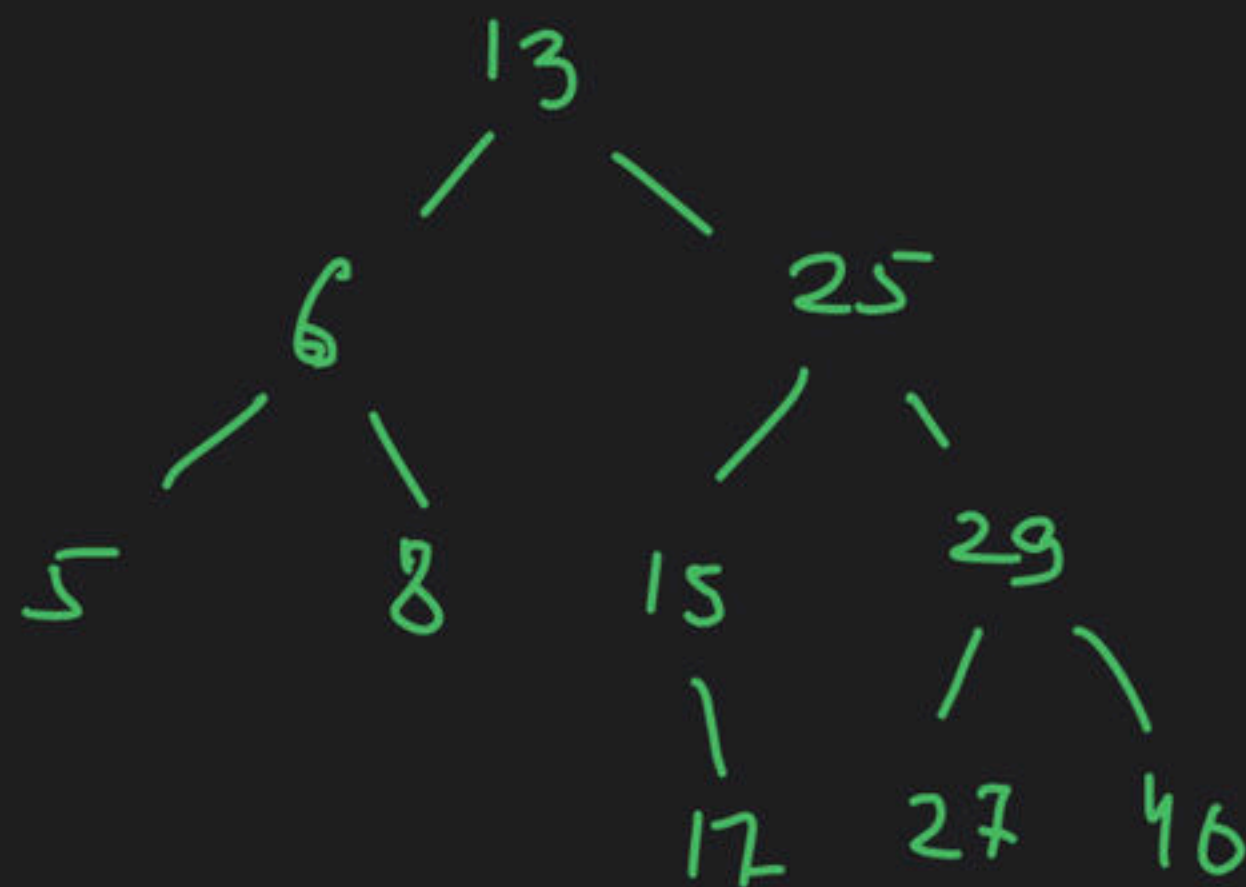


RR
at 5

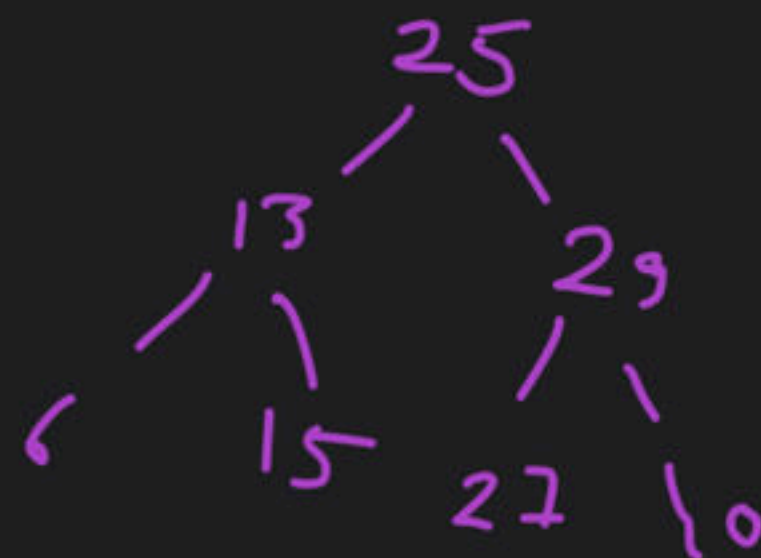


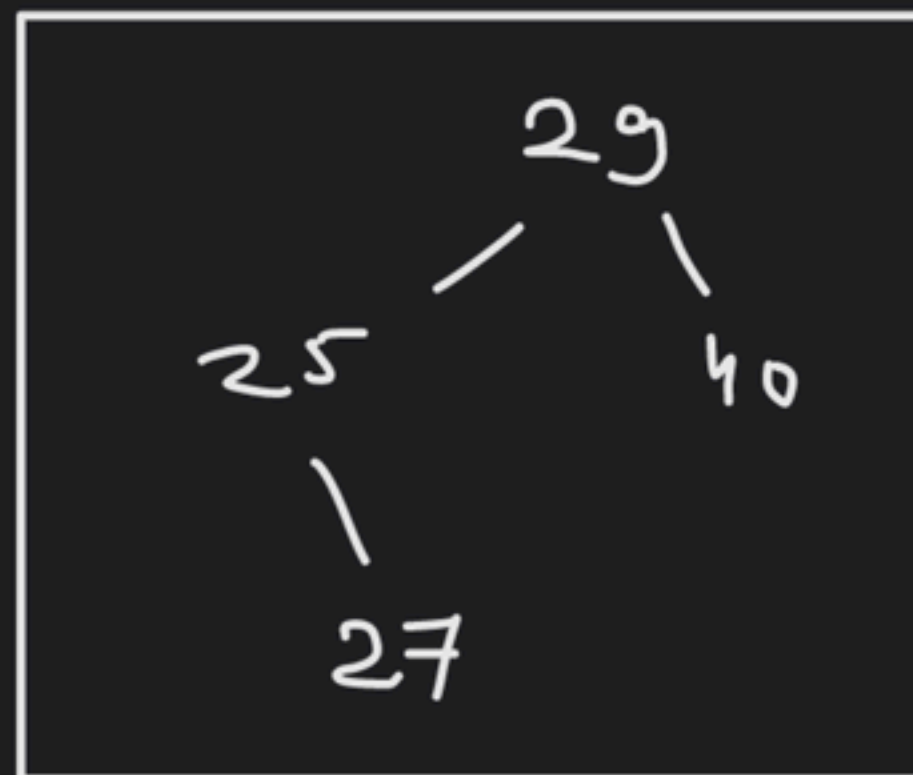
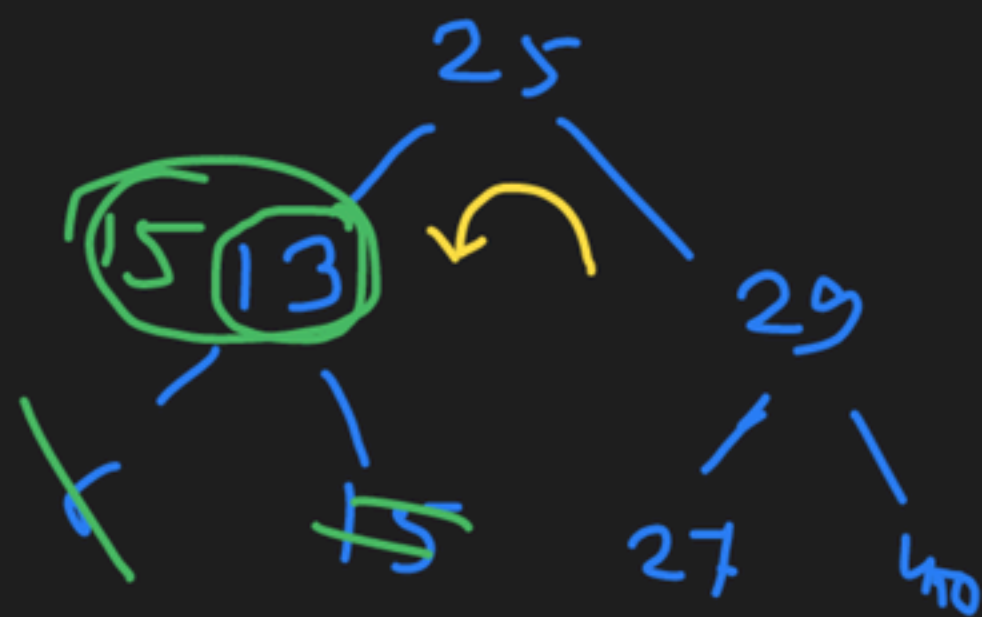


LR
at 8



RR at 13



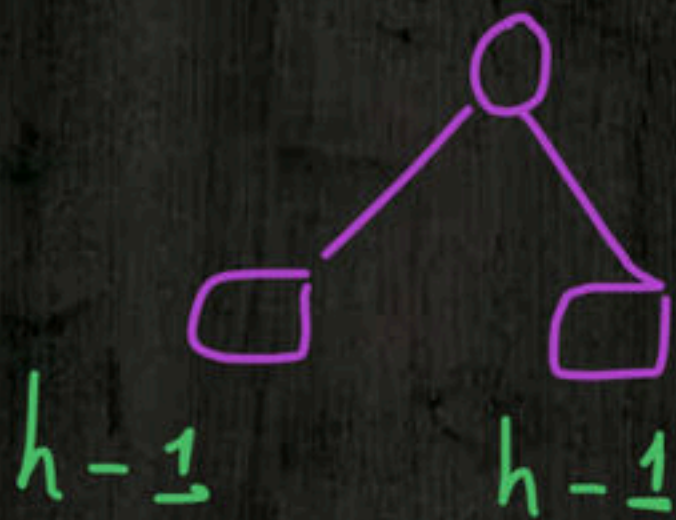


Question

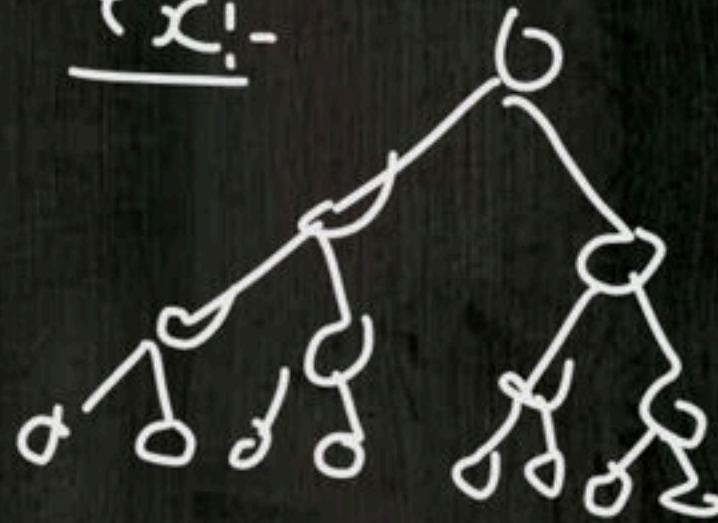
The minimum number of nodes in AVL tree with height H is _____?

max nodes

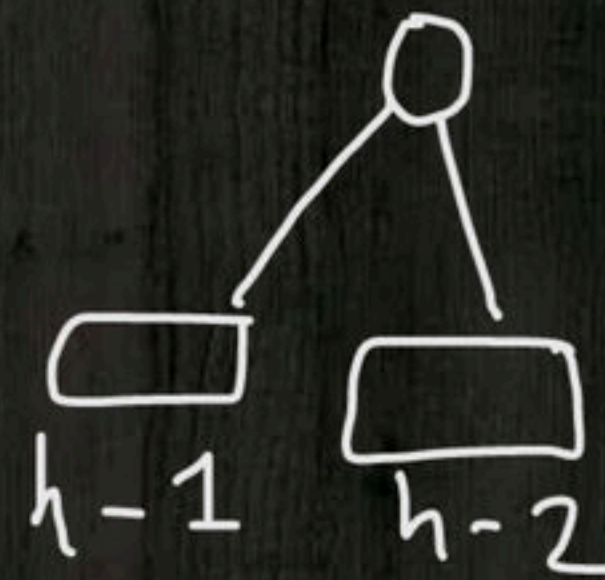
for every node



ex:-



min nodes:-



$$h = 0$$

$$n = 1$$

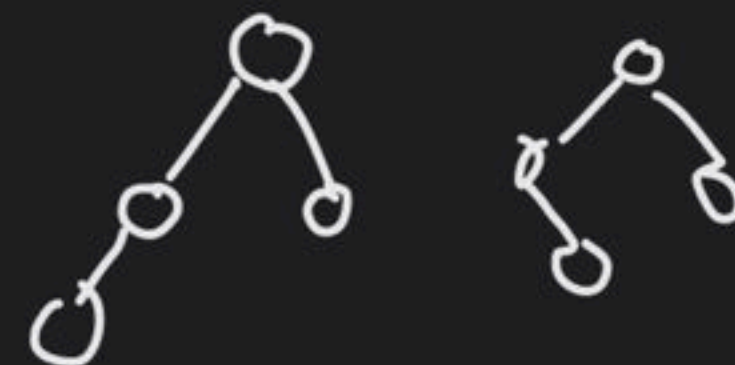
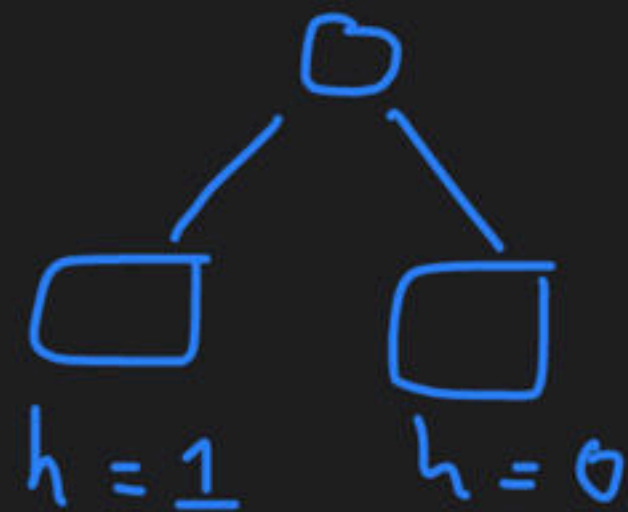


$$h = 1$$

$$n = 2$$



$$h = 2$$



$$n_{\min}(h) = \begin{cases} 1 & h = 0 \\ 2 & h = 1 \\ n_{\min}(h-1) + n_{\min}(h-2) + 1 & h \geq 2 \end{cases}$$

$$h = 0$$

$$h = 1$$

$$h \geq 2$$

h	0	1	2	3	4	5	6	7
$N_{\min}(h)$	1	2	4	7	12	20	33	54

Question

The maximum height of an AVL tree with 7 nodes is _____?

Note:- $h(\text{tree})$ with single node 0

Ans = 3

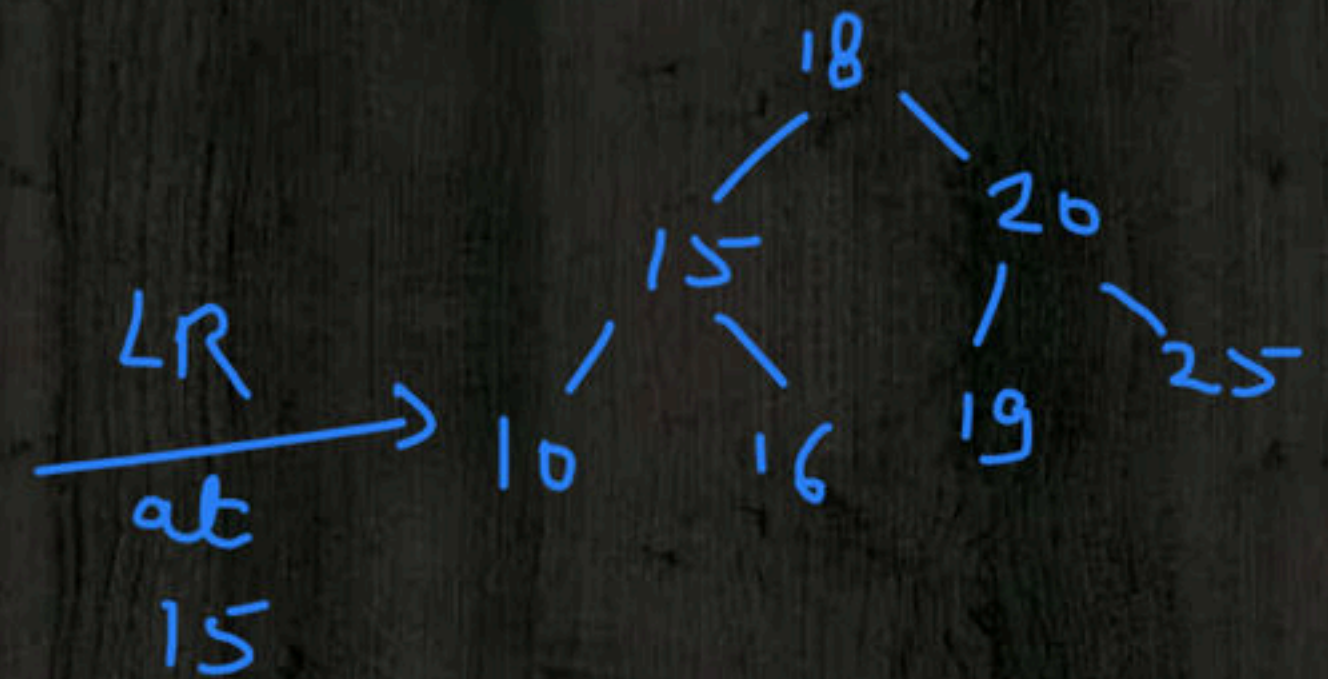
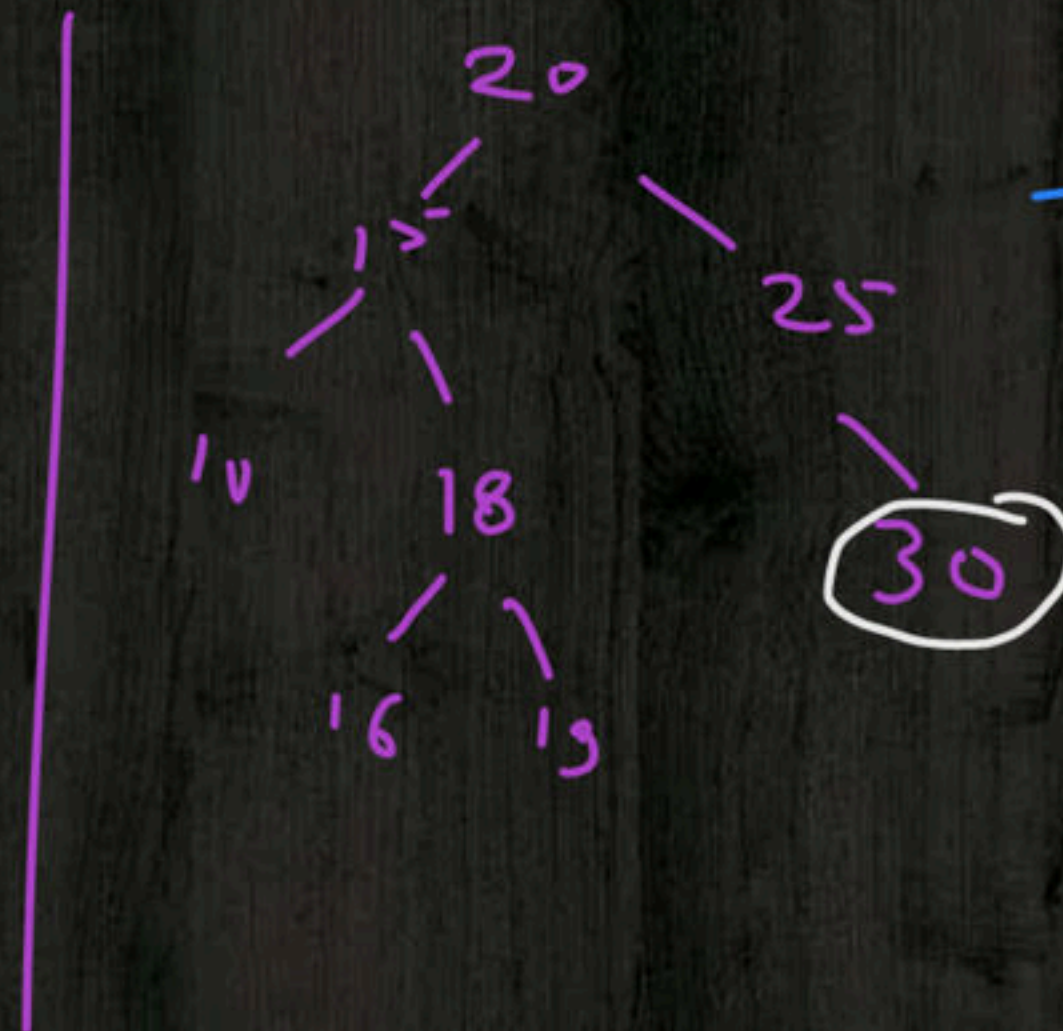
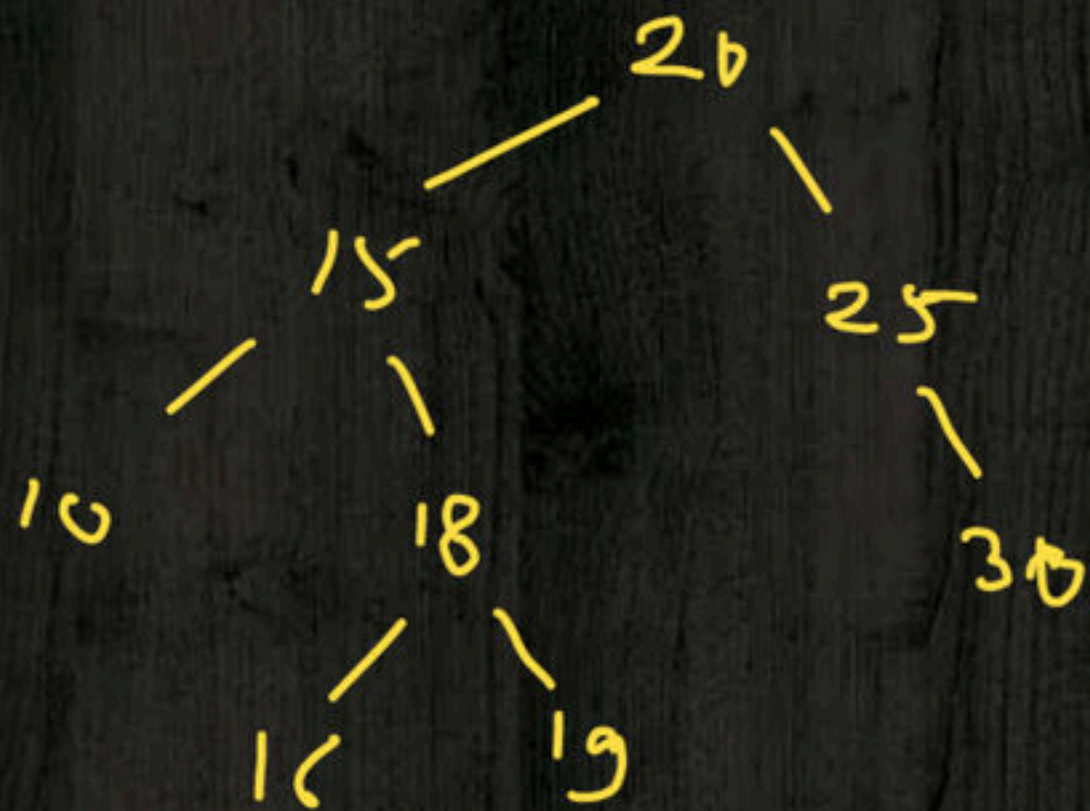


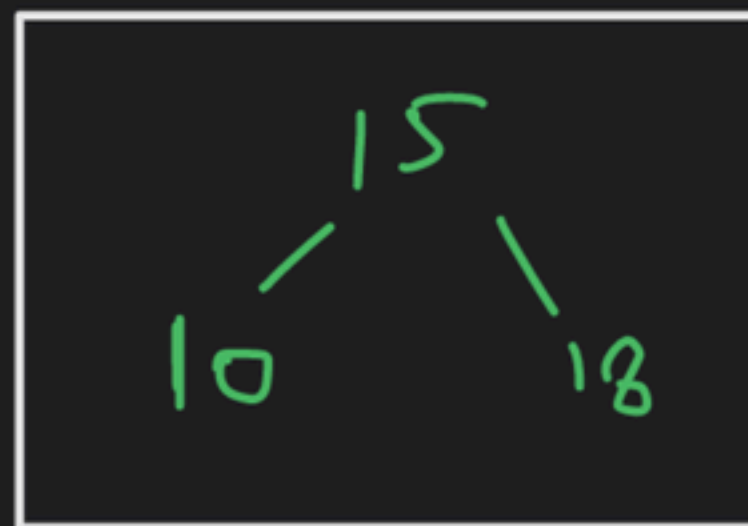
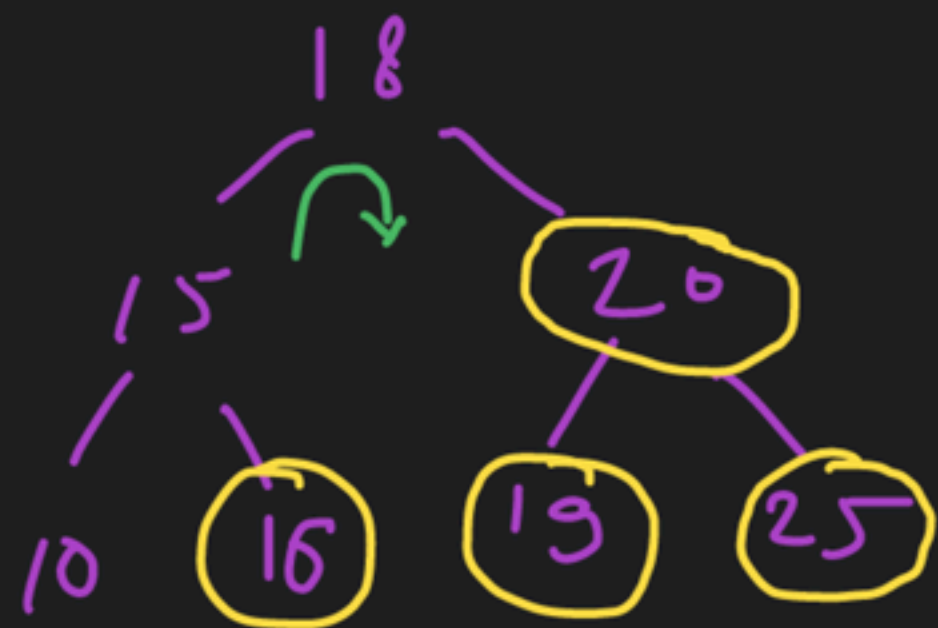
DPP

Question 5

Insert the following sequence of elements into an AVL tree, starting with an empty tree: 10, 20, 15, 25, 30, 16, 18, 19

Then delete the keys: 30, 25, 16, 19, 20





Happy Learning

