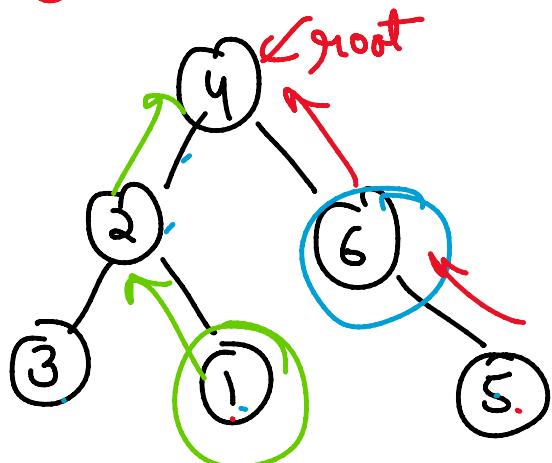


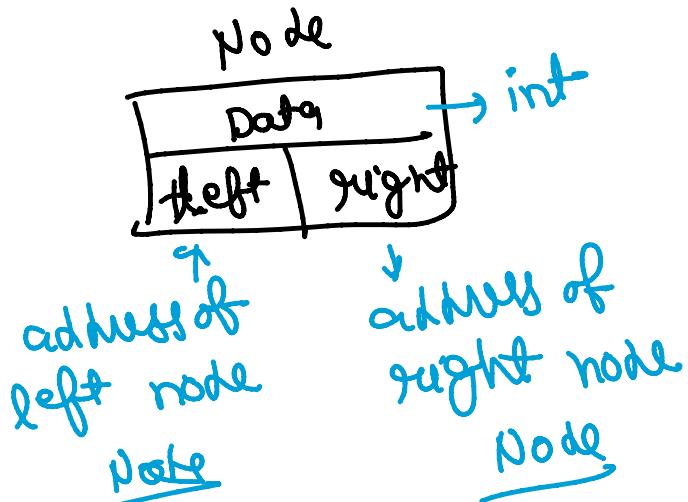
Binary Trees

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Every node can have atmost 2 children.



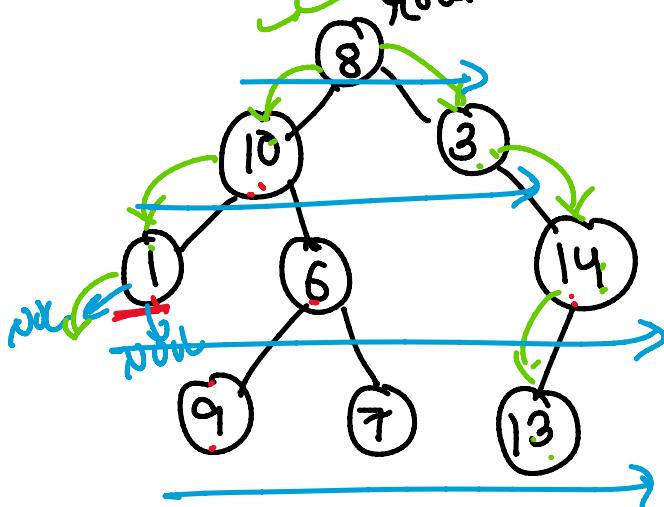
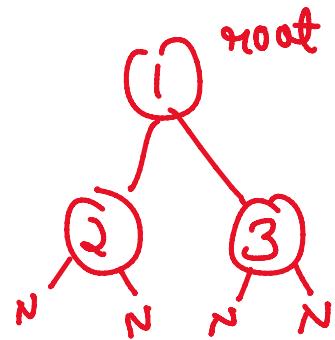
(4) root
(2,6) parent
(3,1,5) child
(3,1), (2,6) leaf
(3,1), (2,6) sibling
of same parent
(2,4) ancestors
(5,4)



Tree traversals

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- Preorder (root, left, right) (1, 2, 3)
- Inorder (left, root, right) (2, 1, 3)
- Postorder (left, right, root) (2, 3, 1)
- Levelorder



Preorder: 8, 10, 1, 6, 9, 7, 3, 14, 13

Inorder: 1, 10, 9, 6, 7, 8, 3, 13, 14

Postorder: 1, 9, 7, 6, 10, 13, 14, 3, 8
 | | |
 1 2 3 root

height of a tree:
8, 10, 3
1, 6, 14, 9, 7, 13

recursion

C++

root → left

root → right

root → data(val)

NULL

vector

Java

root.left

root.right

root.data(val)

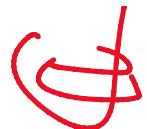
null

ArrayList



vector

Avoid U^N



Time $\leftarrow O(N)$

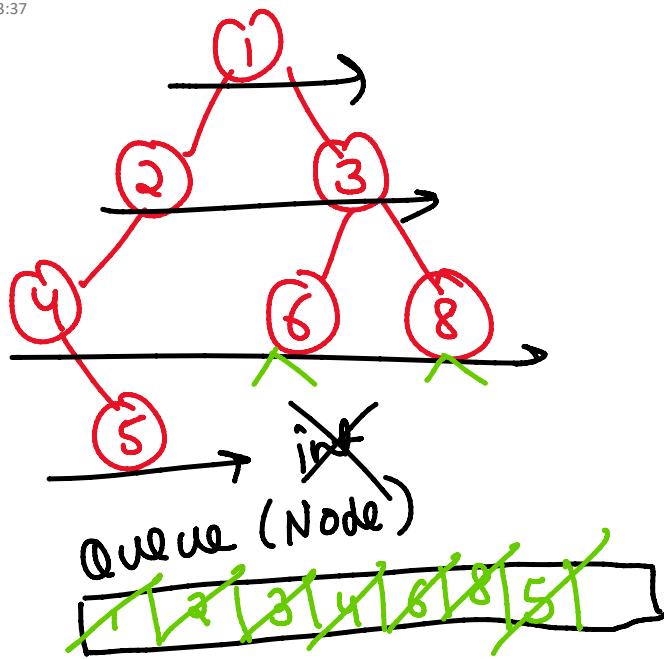


Space $\leftarrow O(N)$

↳ recursion.

Level order traversal

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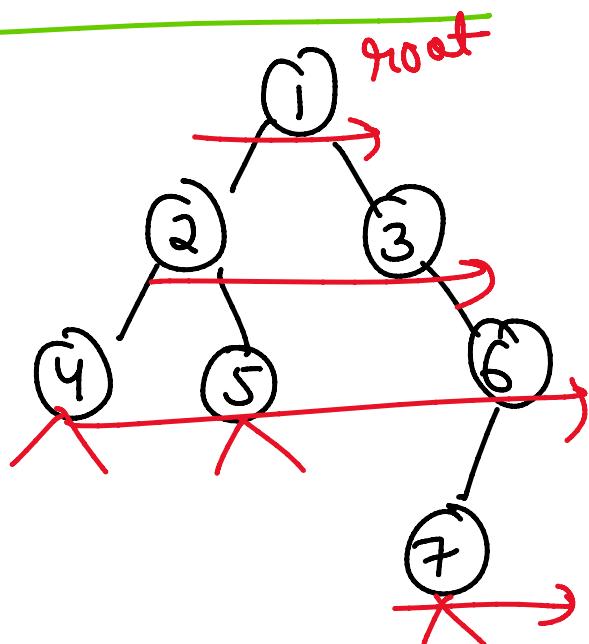


iterative
(Queue)

1, 2, 3, 4, 6, 8, 5

push the root
while (!q.empty())
 pop the element
 push the children
return ans;

[1, 2, 3, 4, 6, 8, 5]

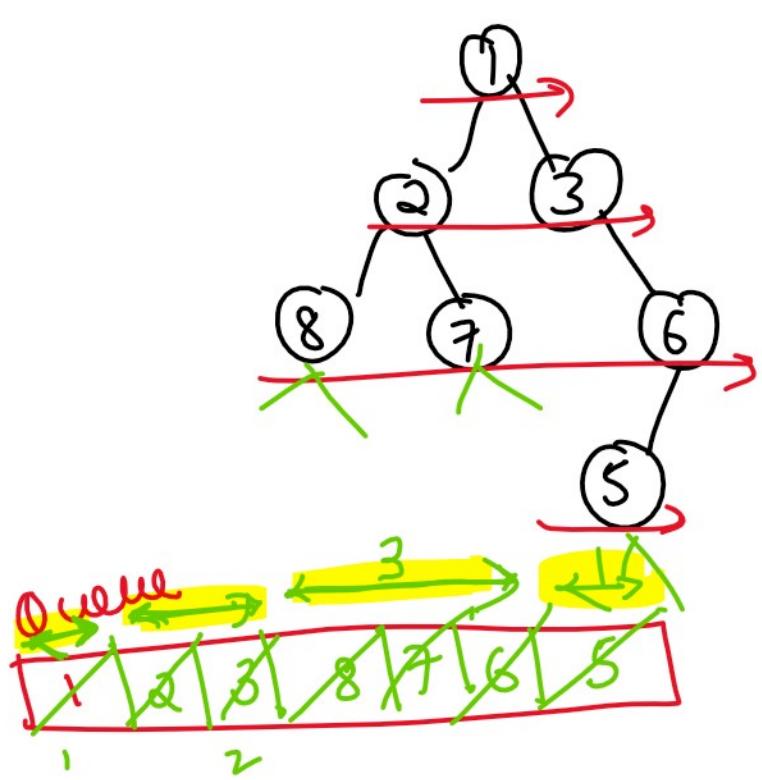


[1][2, 3][4, 5, 6][7]

Queue
~~1 2 3 4 5 6 7~~
[1, 2, 3, 4, 5, 6, 7]

↑

- 7 8 7 7



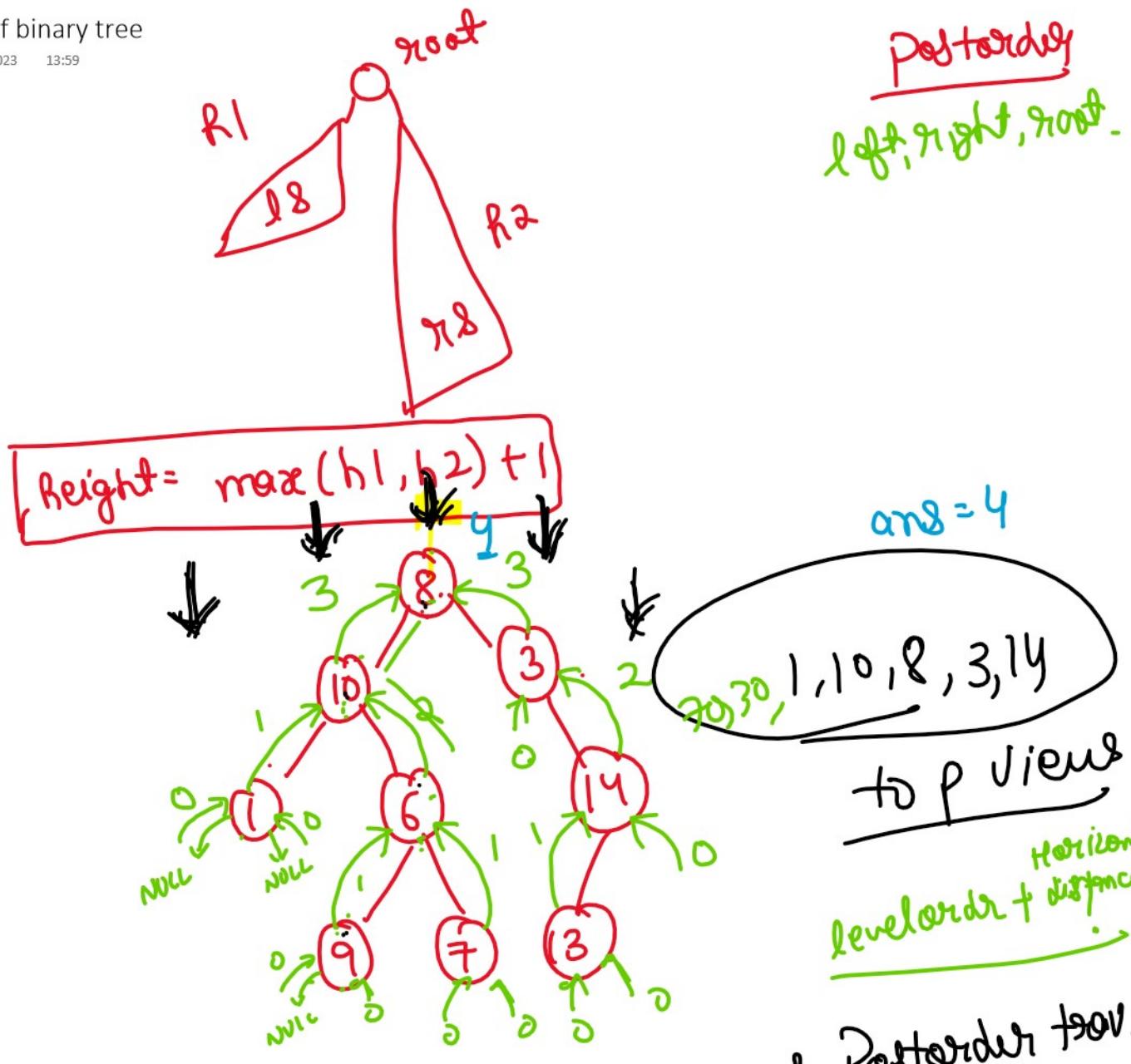
$[1], [2, 3],$
 $[8, 7, 6] [5]$



Time: $O(N)$
 Space: $O(N)$

Height of binary tree

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Postorder
left, right, root.

$$\text{ans} = 4$$

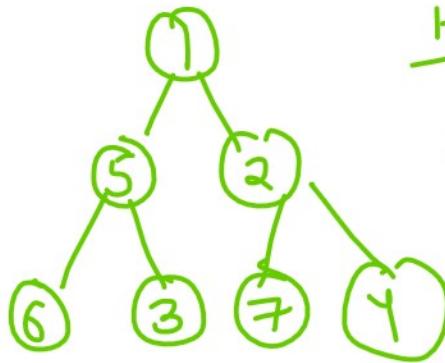
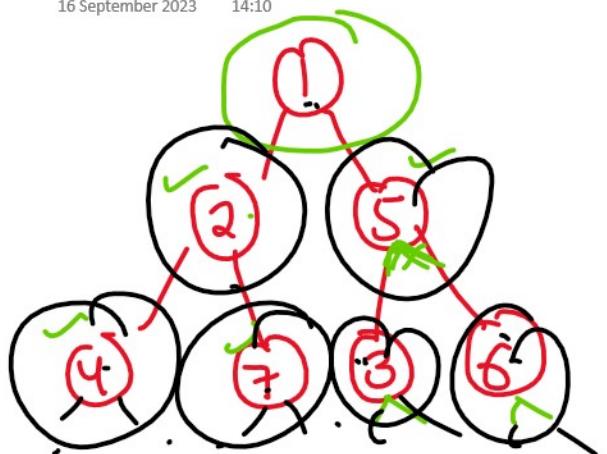
20, 30, 1, 10, 8, 3, 14

to print
levelorder + distance

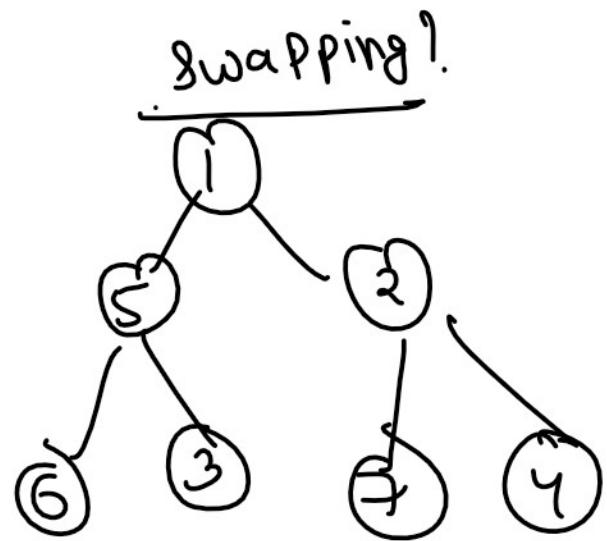
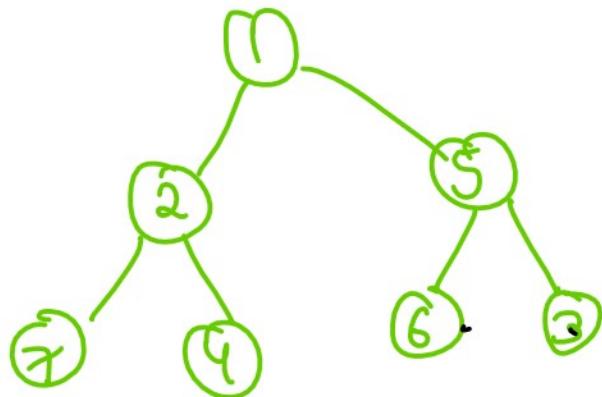
T.C. & S.C. will be same as Postorder trav.

Invert binary tree

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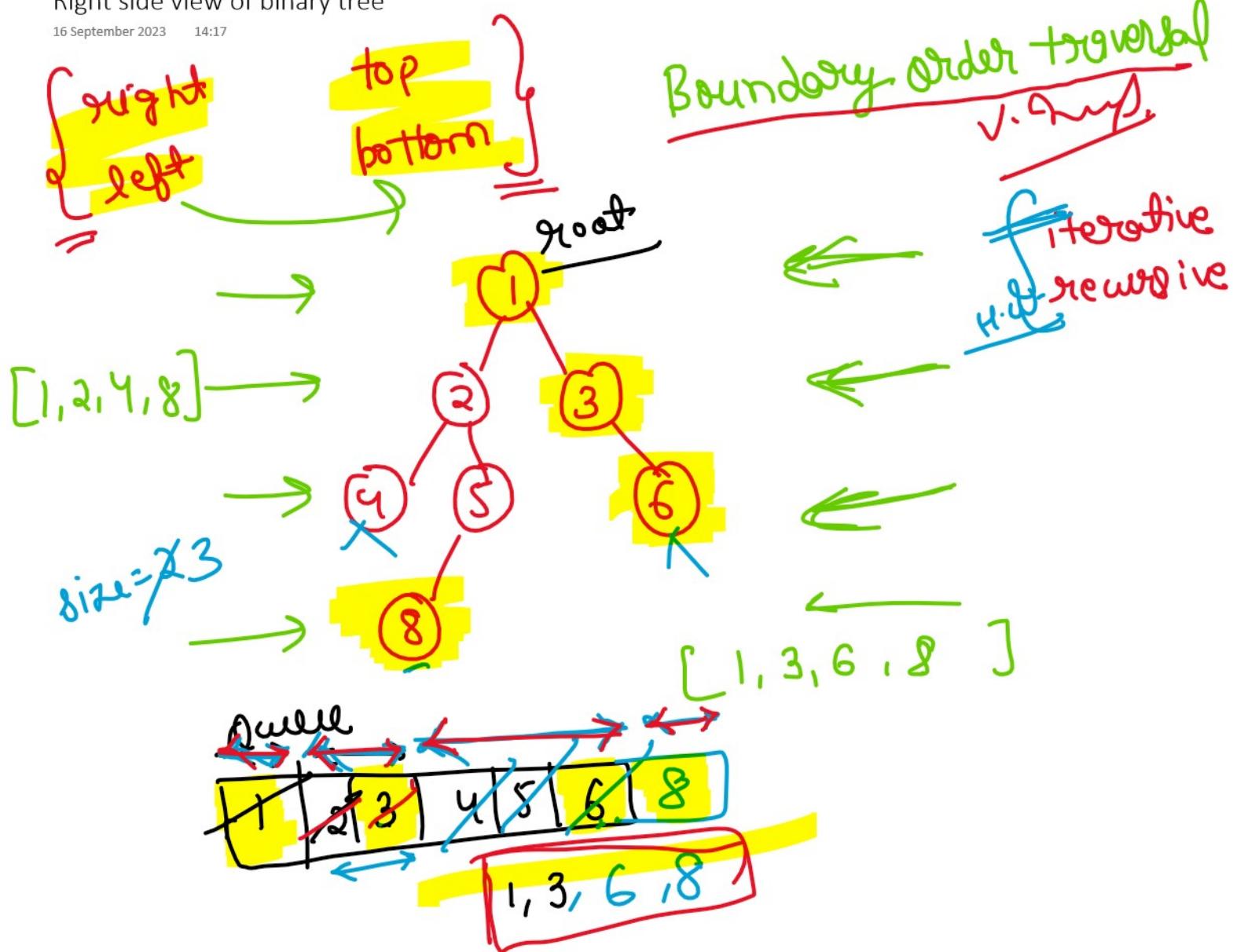
H.O.
Preorder
postorder



swapping?

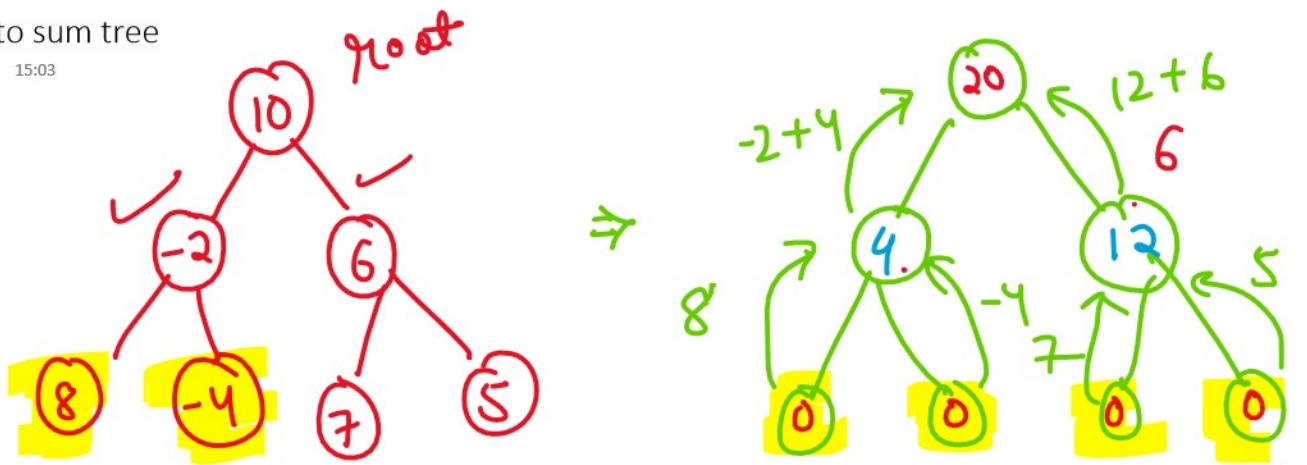
Right side view of binary tree

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Transform to sum tree

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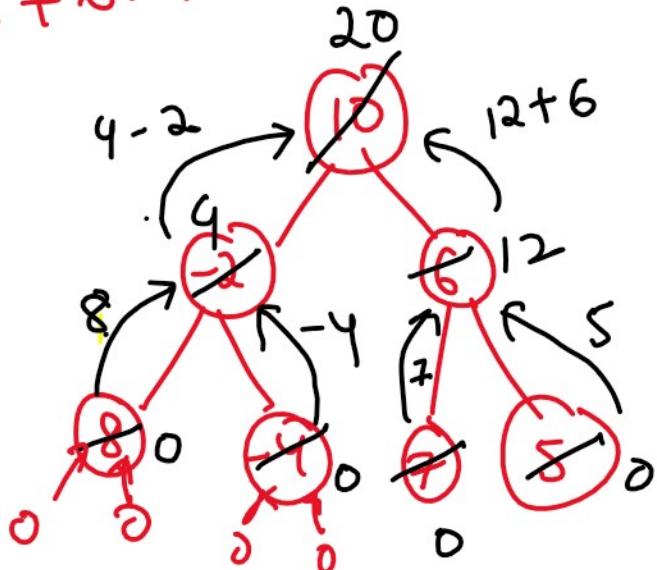


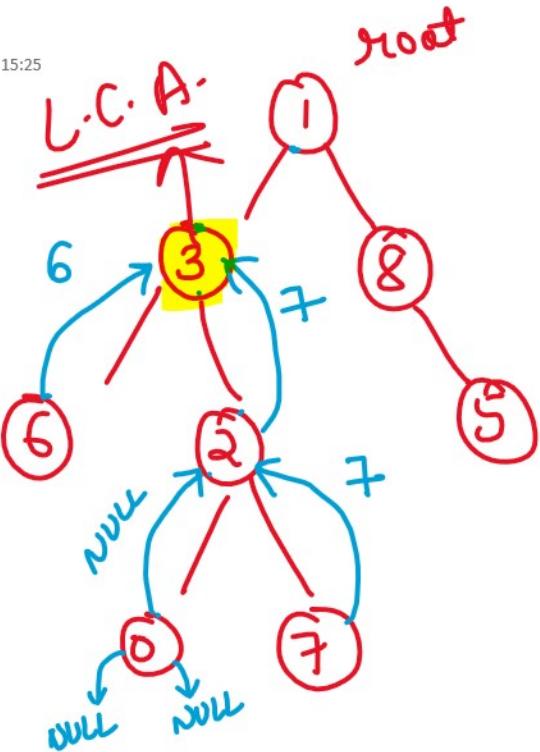
each node will store sum of left and right subtrees
leaf node value should be 0.

$$-2 + 6 + 4 + 12 = 20$$

postorder
left, right, root

temp





$$p = 6, q = 7$$

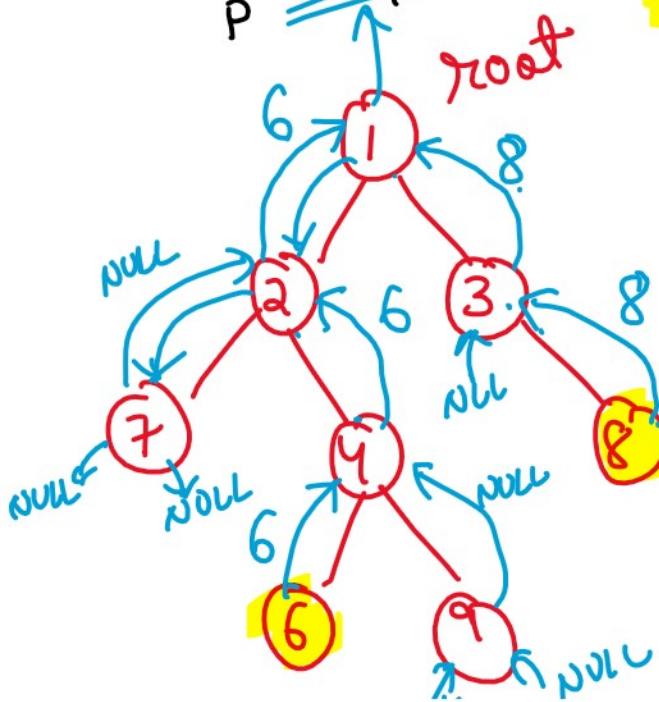
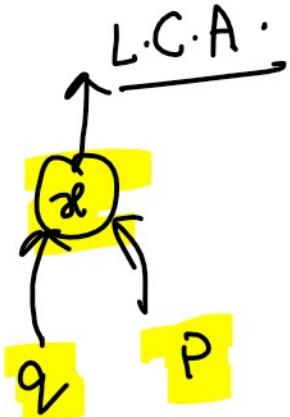
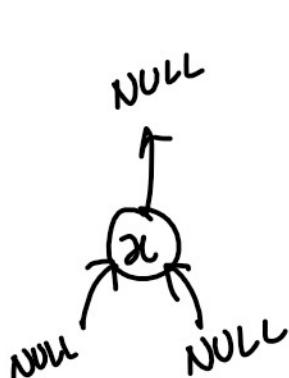
$$\text{and} = 3$$

$$p = 2, q = 5$$

$$\text{and} = 1$$

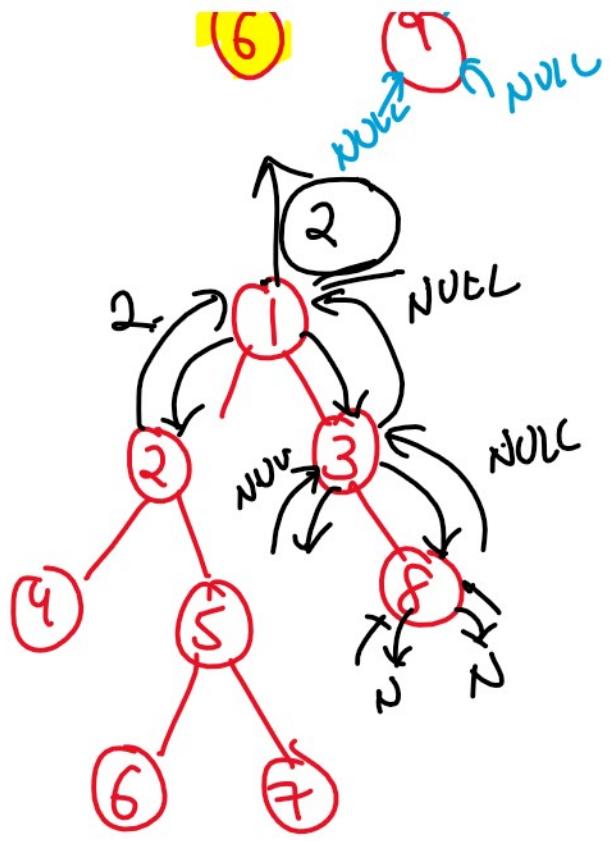
$$p = 3, q = 0 \text{ (edge case)}$$

$$\text{and} = 3$$



$$p = 6$$

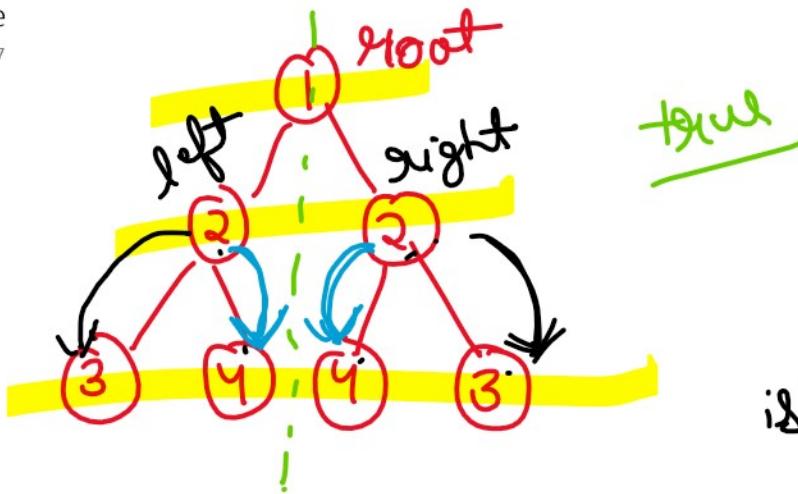
$$q = 8$$



$$\begin{cases}
 p = 2 \\
 q = 7 \\
 \end{cases} \quad \equiv \quad \alpha_{NB} = 2$$

Symmetric tree

16 September 2023 15:47



~~Recursive~~
~~Iterative~~
Hu

isSymm (left, right)

- NULL - NULL (+true)
(false)
- NULL - 2 (false)
- x - y (false)
- x - x (+true)

(left → left, right → right) & & (left → right, right → left)

