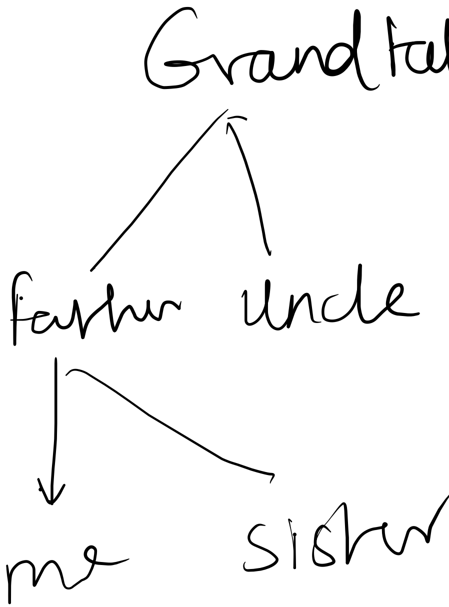
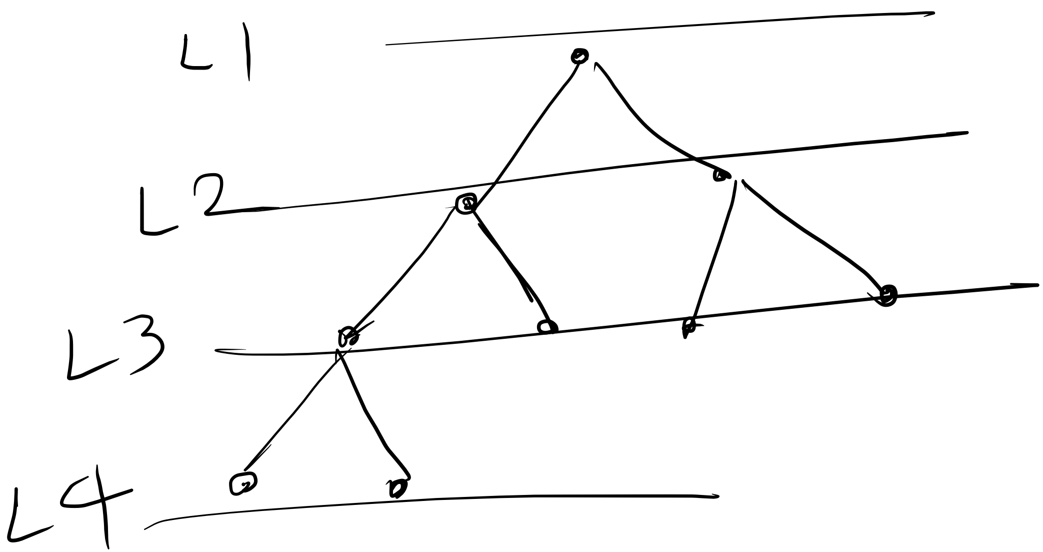
TREES

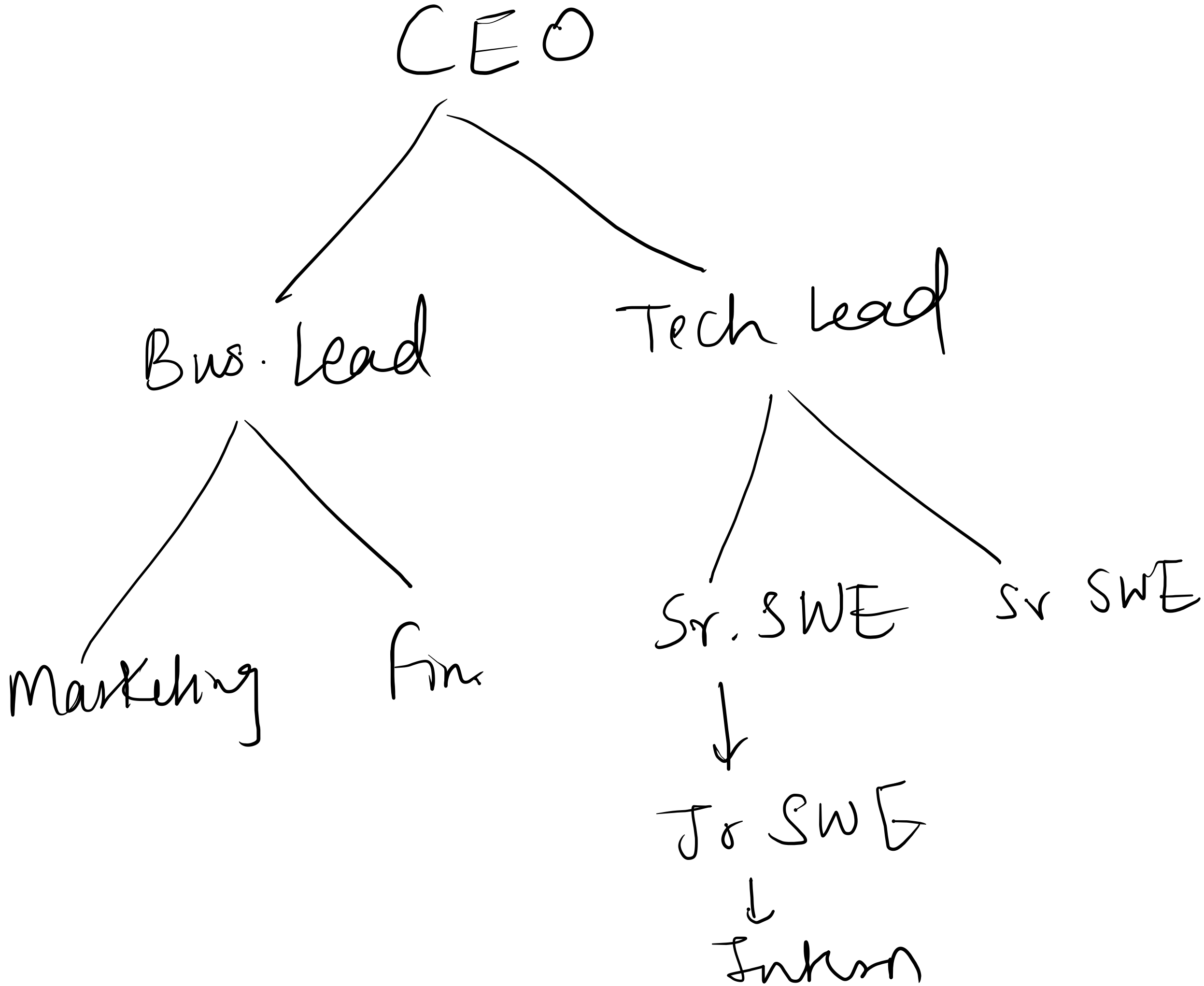
Non-linear Data Structure

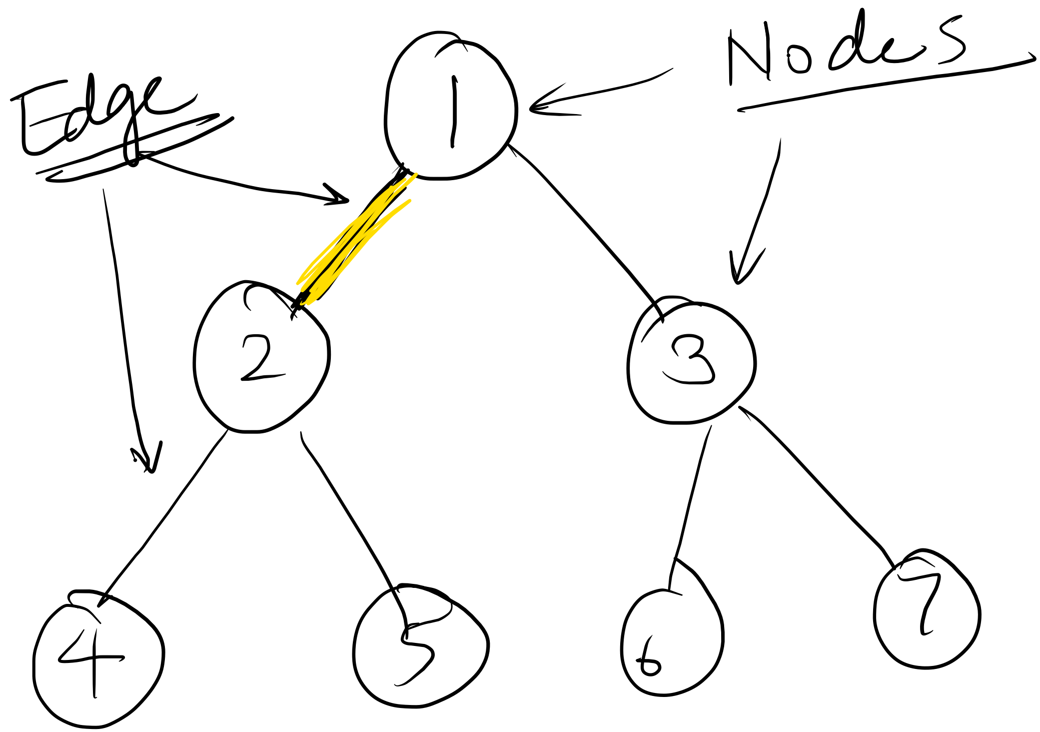
Family Tree



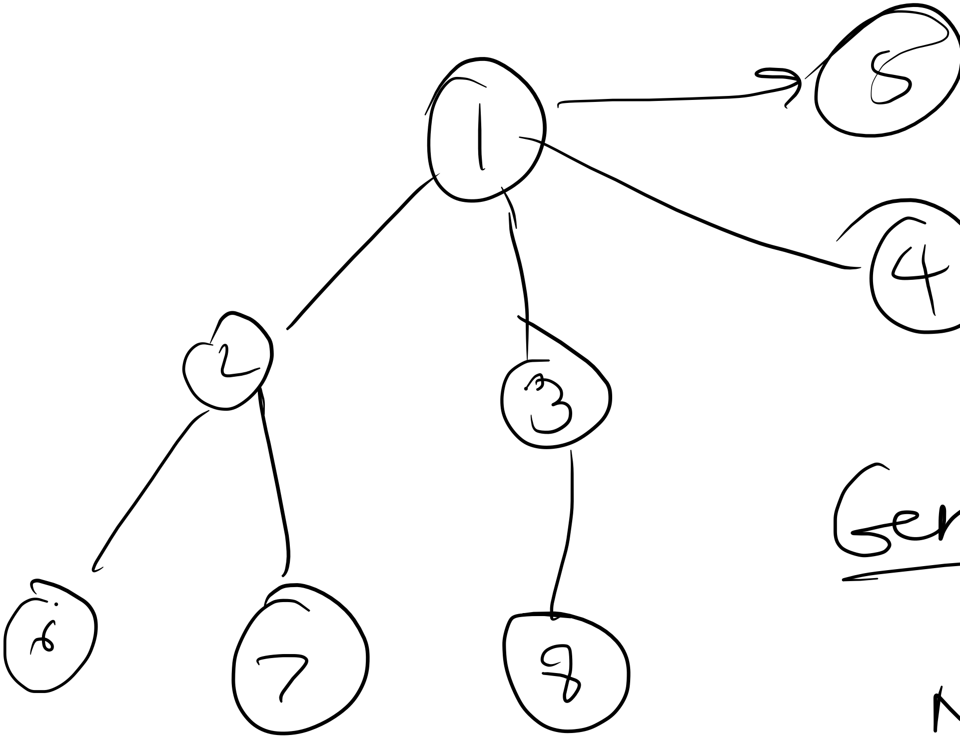
Hierarchical Structure




CEO
Bus. Lead
Tech Lead
Marketing
Fin.
Sr. SWE
Sr SWE
Jr SWE
Intern


Edge
Nodes
1
2
3
4
5
6
7

Edge → connects any two nodes

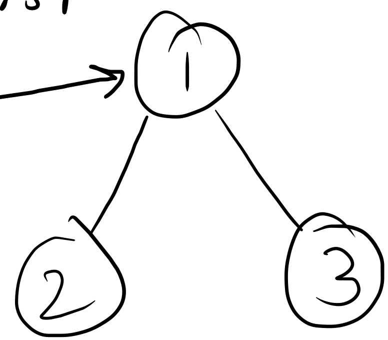


Generic tree

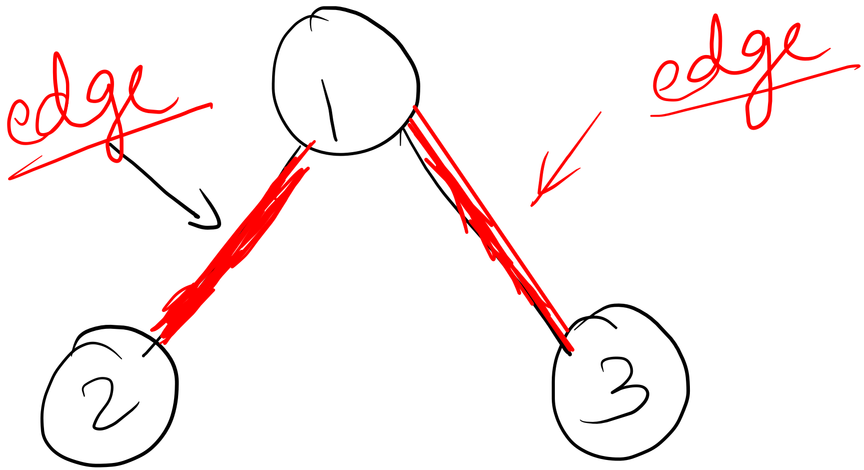
No linear

Basic Terminologies

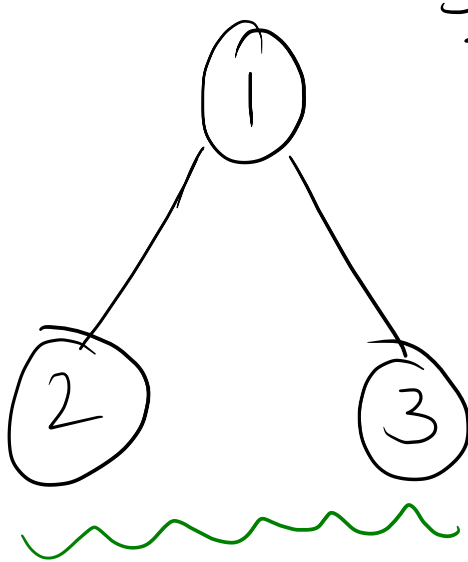
① Root → first node of the tree



② Edge → link that connects any two nodes

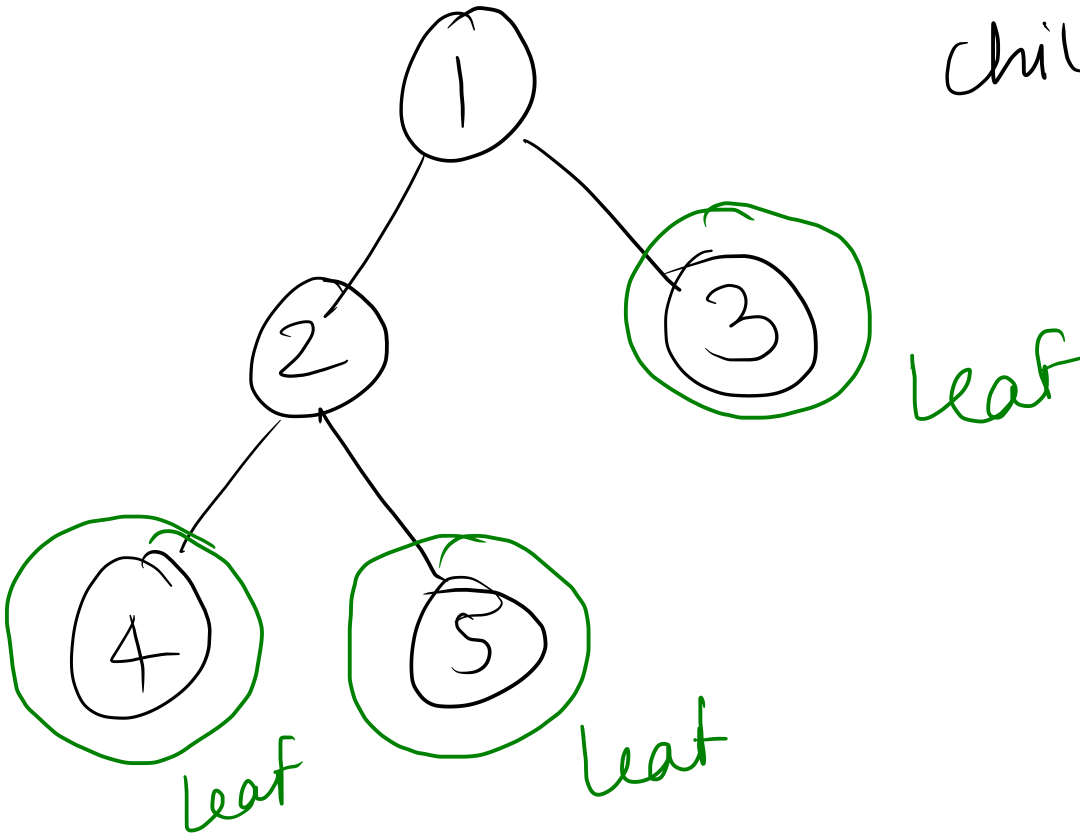


3 siblings → nodes with same parent



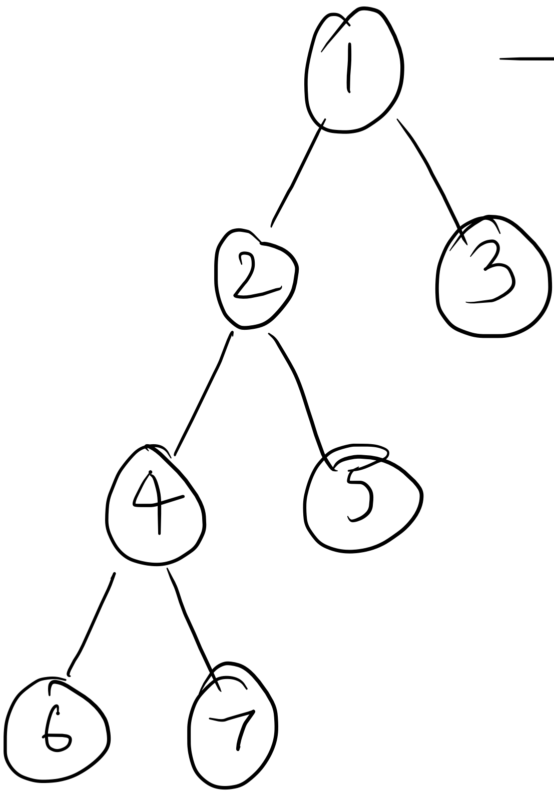
(2,3) siblings

④ <u>Leaf Node</u> → Nodes without child nodes



5 Height of the tree

↳ total number of levels

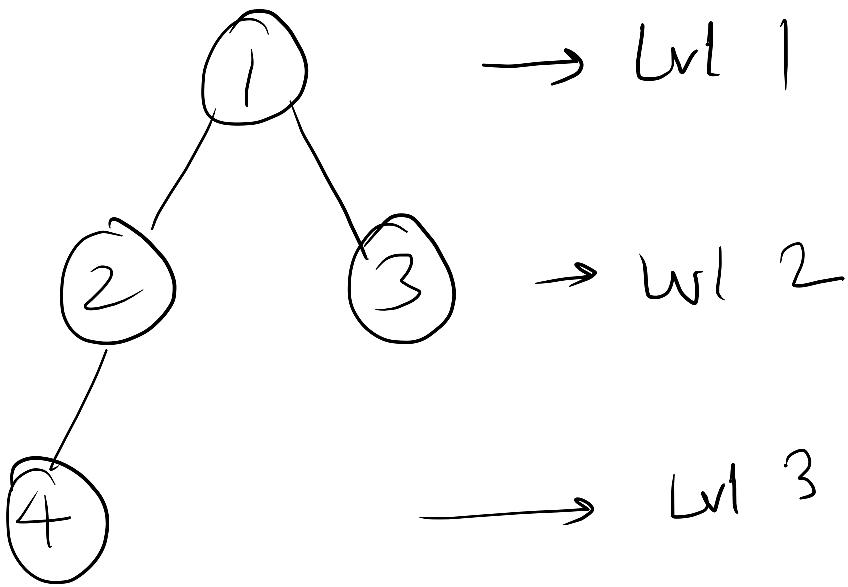


→ Level 1

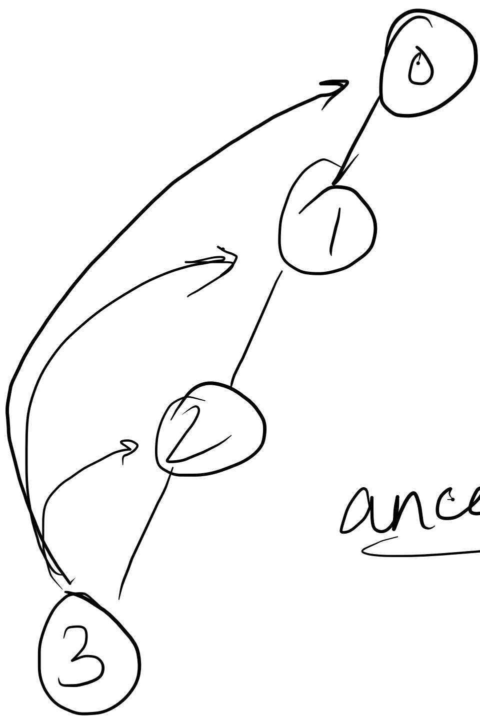
→ Level 2

→ Level 3

→ Level 4



Height of tree = 3



ancestors

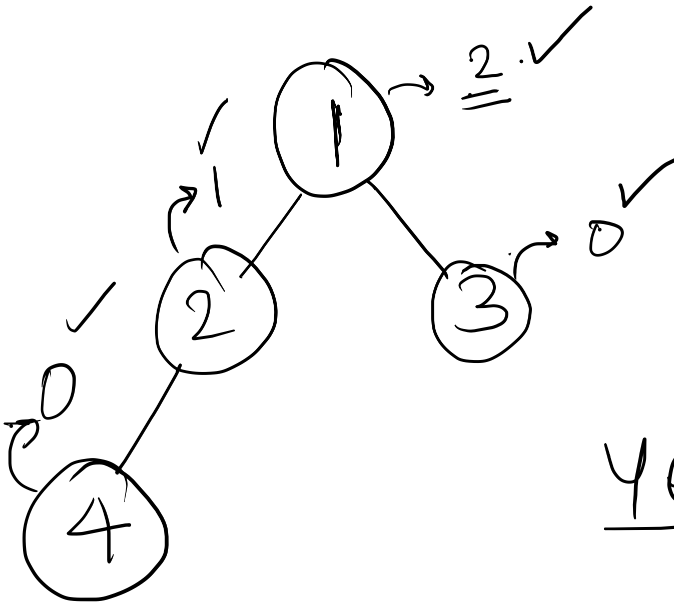
BINARY TREE

every node → atmost 2 children

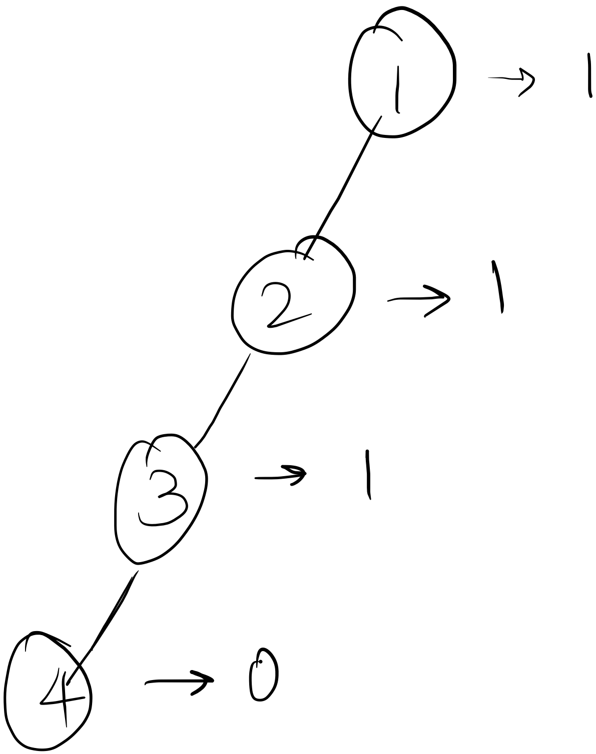
no. of children → 0, 1, 2
(for each node)

Binary Tree

(0, 1, 2) children



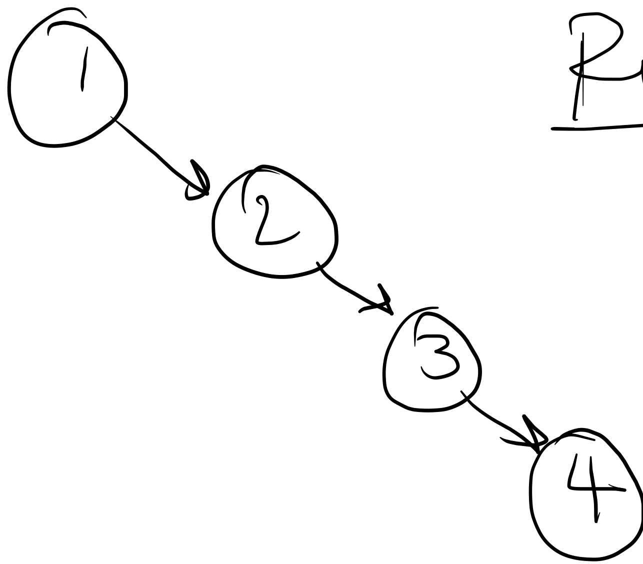
Yes → Binary Tree ✓



Left skewed

Binary Tree

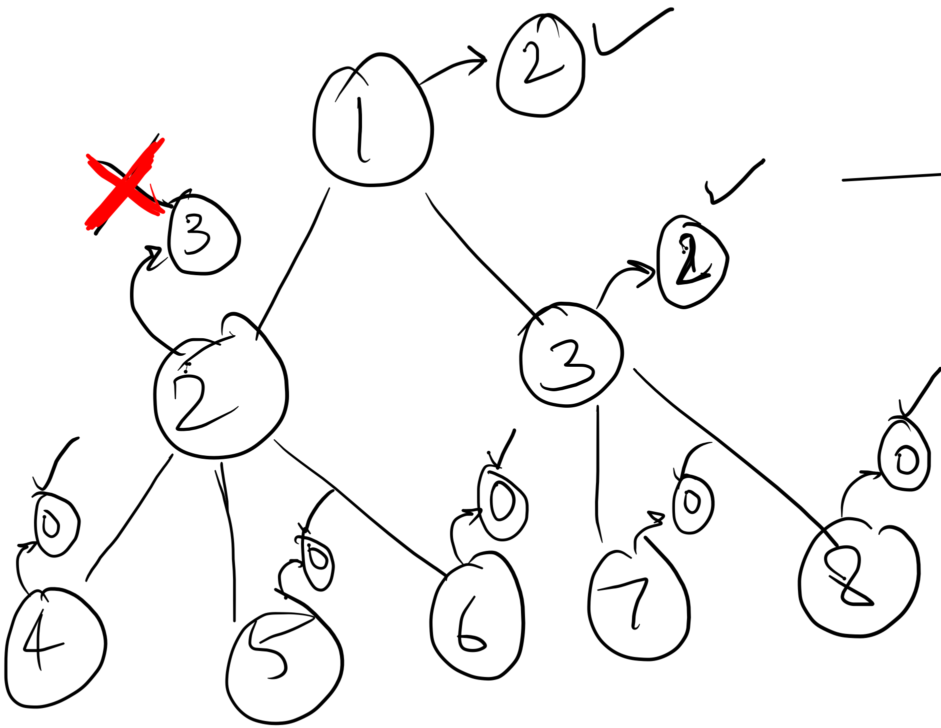
Yes



Right skewed

Binary Tree

Yes



Binary Tree

No

2 has 3 child nodes

Properties of Binary Tree

(1) Max numer nodes at Lvl L

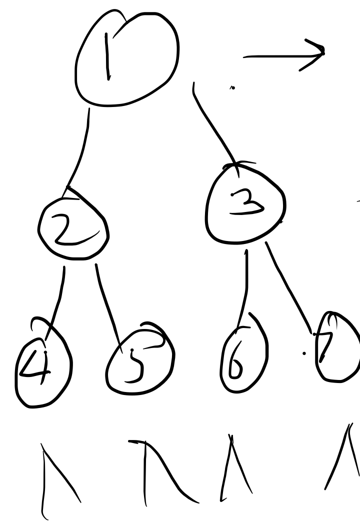
$= 2^{L-1}$

Lvl	N
1	1
2	2
3	4
4	8

$2^{3-1} = 4$

$2^{4-1} = 8$

$2^{5-1} = 16$

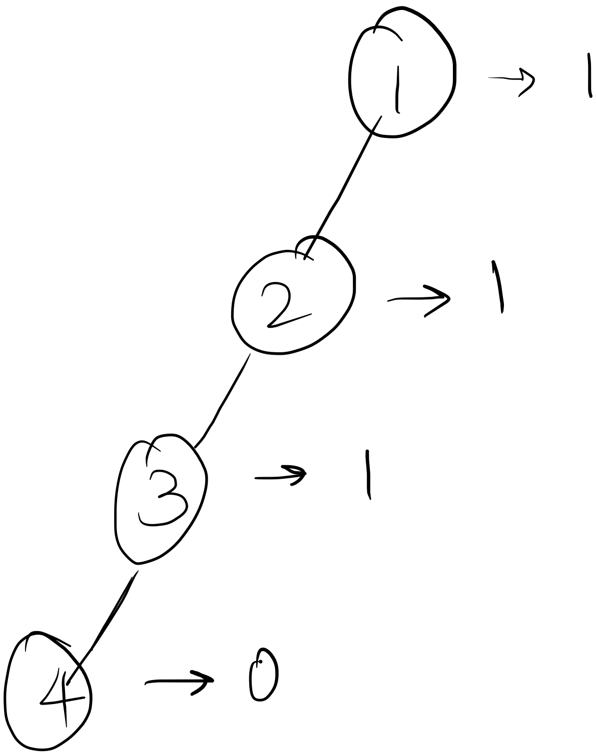


→ 1 node

→ 2 nodes

→ 4 nodes

→ 8 nodes



Left Skewed

Binary Tree

Yes

$$2^{1} \rightarrow 1$$

$$2^{2} \rightarrow 2$$

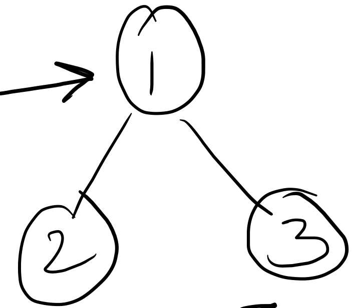
$$2^{3} \rightarrow 4$$

$$2^{4} \rightarrow 8$$

$$2^{5} \rightarrow 16$$

$$2^{\underline{L-1}}$$

Parent Node

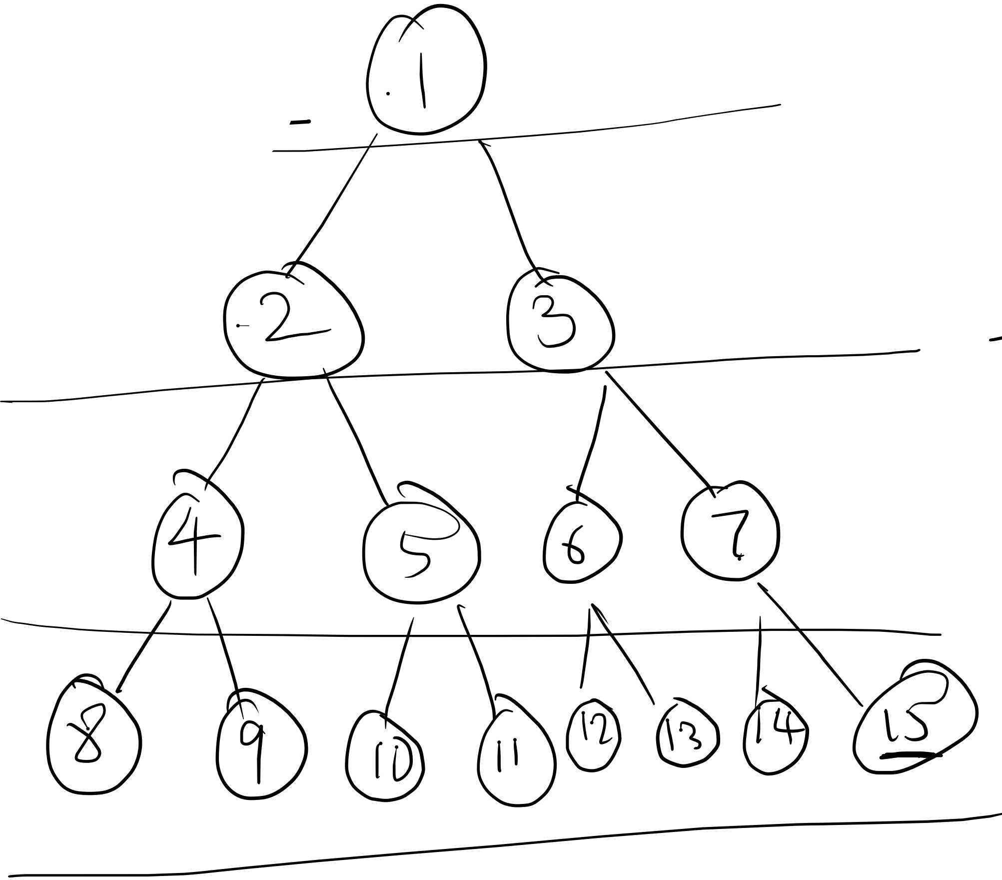


Child Node

(2) Max nodes at height h

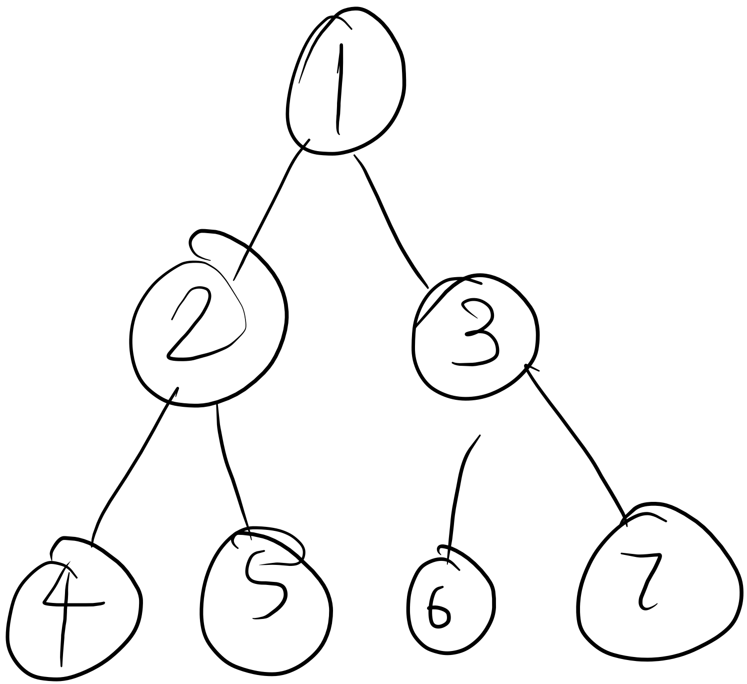
$$= 2^h - 1$$

	h	N
(1)	1	1



$$2^h - 1$$

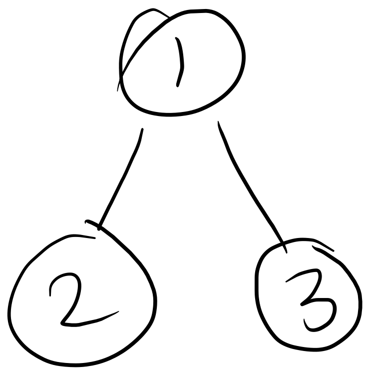
$$2^4 - 1 = 15$$



$$2^h - 1$$

$$2^3 - 1 = \underline{\underline{7}}$$

height = 2



$$2^h - 1$$

$$2^2 - 1 = 3$$

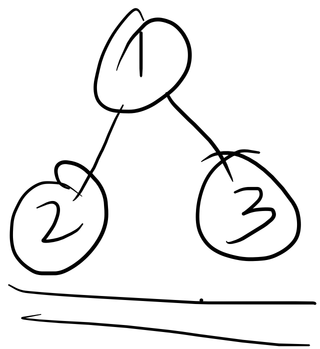
(3) For N nodes,

minimum height $= \log_2(N) + 1$

$= \log_2 3 + 1$

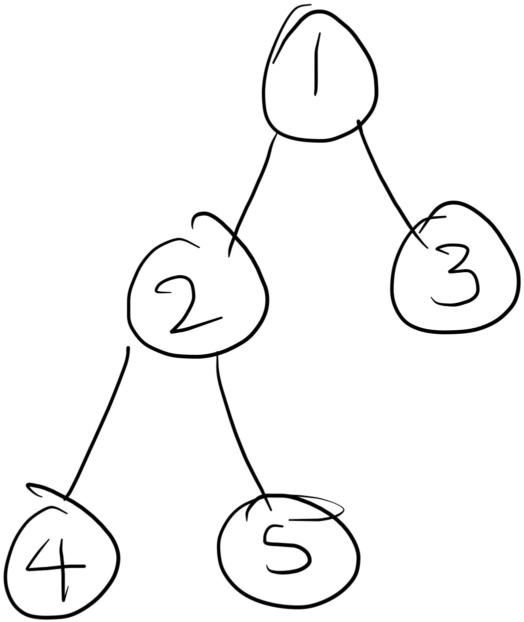
Nodes $= 3$

height $= 2$



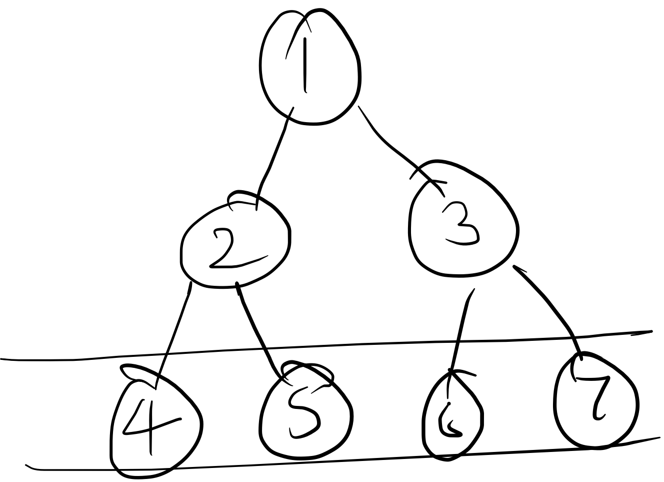
$= 1 + 1$

$= 2$



$$\text{height} = \log_2 5 + 1 = 2 + 1 = 3$$

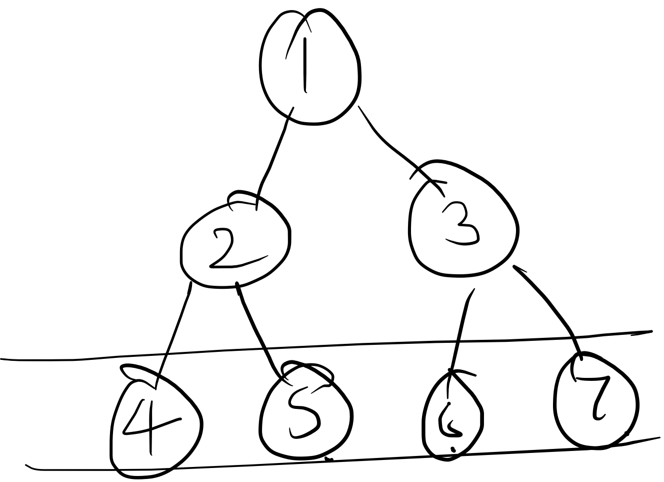
④ B.T. with L leaves
will have atleast $\boxed{\log_2 L + 1}$ level



4 leaves $\rightarrow \log_2 4 + 1$

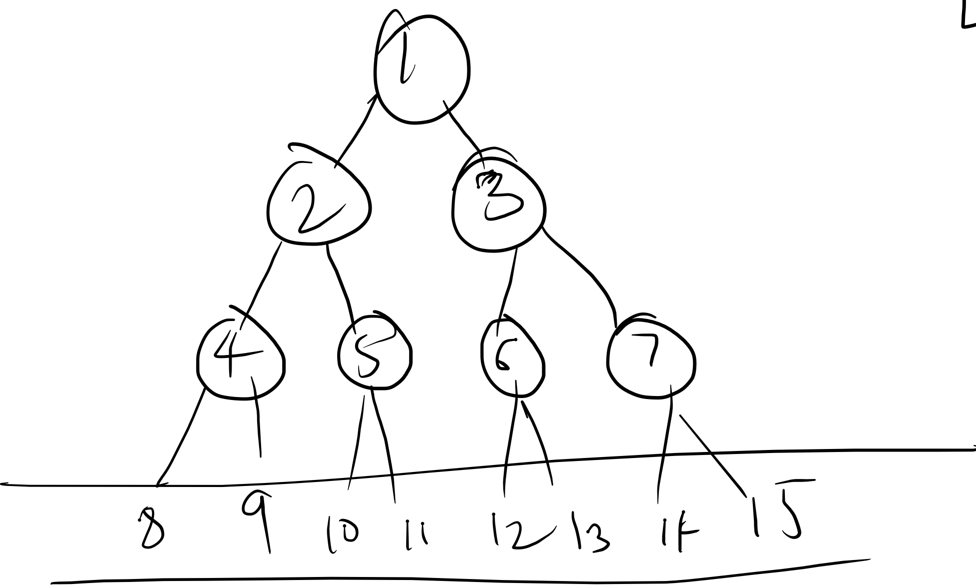
$= 3$ levels

4 B.T. with L leaves will have atleast $\boxed{\log_2 L + 1}$ level



$\underline{\underline{4}}$ leaves $\rightarrow \log_2 4 + 1$

$= \underline{3 \text{ levels}}$



Leaves = 8

$\log_2 L + 1$

$= \log_2 8 + 1$

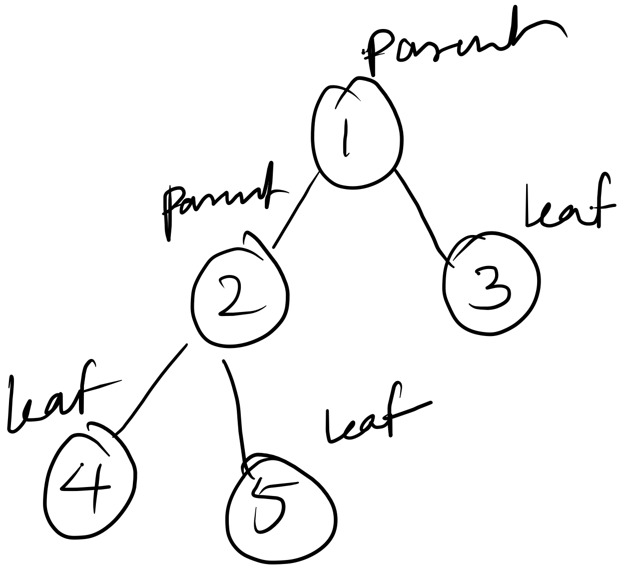
$= 3 + 1$

$= 4$ levels

B.T with every node → 0 children

OR

→ 2 children

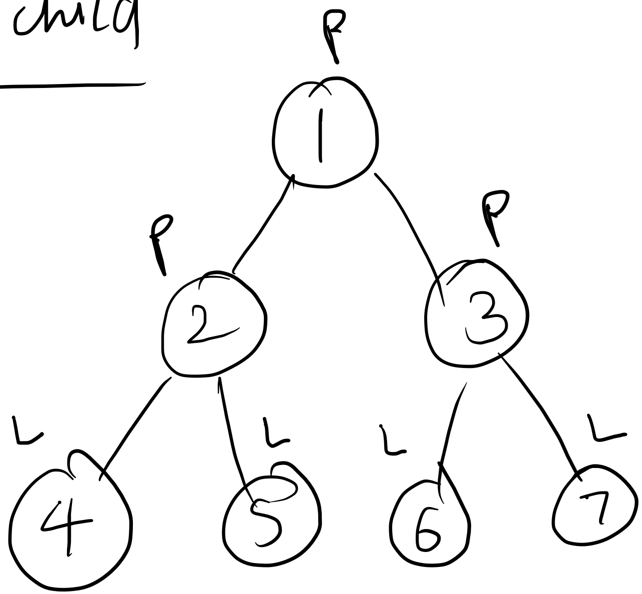


parents = 2

leaves = 3

leaves = parents + 1

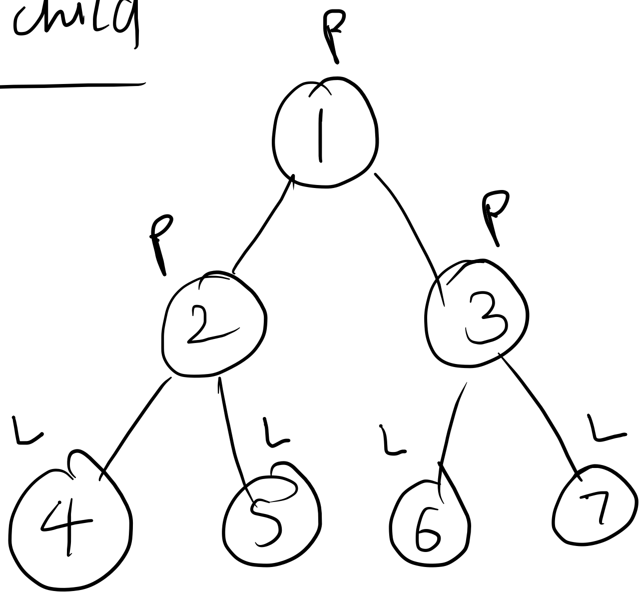
(0,2) child



Parents = 3
Leaves = 4

4 = 3 + 1
leaves = parents + 1

(0,2) child

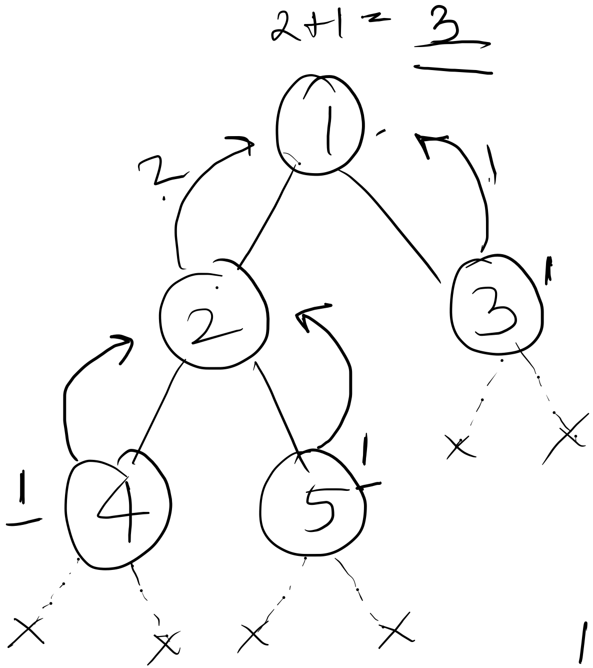


Parents = 3

Leaves = 4

$4 = 3 + 1$

leaves = parents + 1



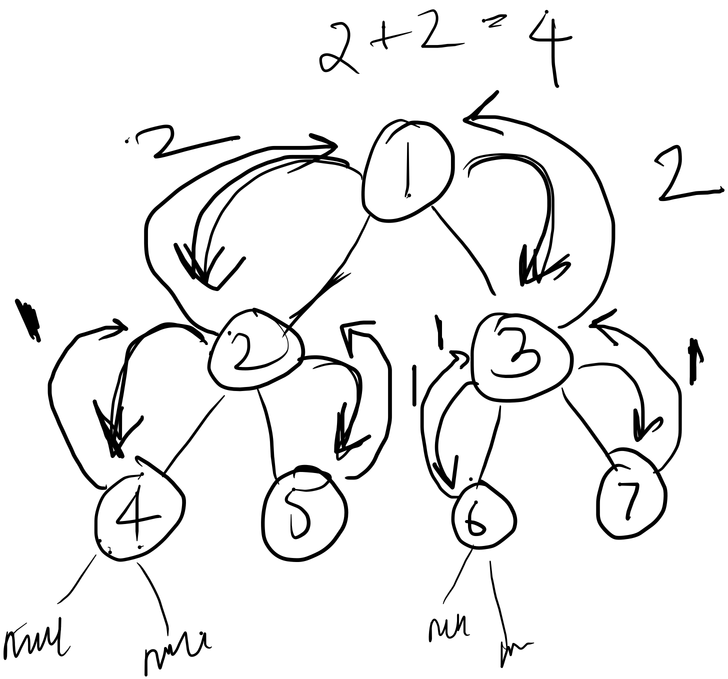
Leaf

node.left = null

&&

node.right = null

1+1+1 = 3



if (node.left == null & node.right == null)

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return 1

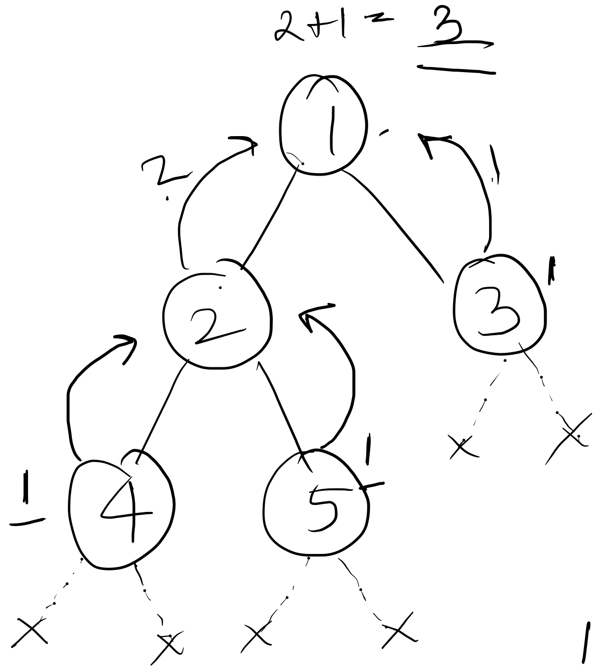
Next

Traversal

Inorder

Preorder

Postorder



Leaf

node.left = null

&&

node.right = null

1+1+1 = 3

7.8

ceil = 8

floor = 7