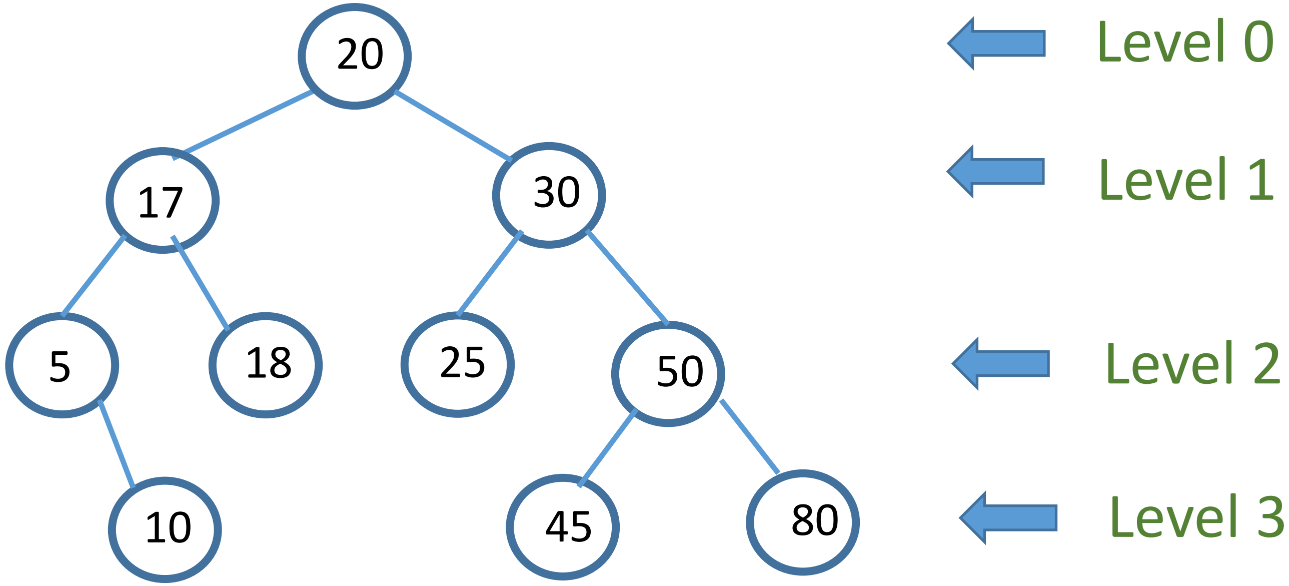
COMP 2611, DATA STRUCTURES
LECTURE 11

RETURN TO BINARY TREES

- **Performing a Level Order Traversal**
- **Types of Binary Trees**

Level Order Traversal of a Binary Tree



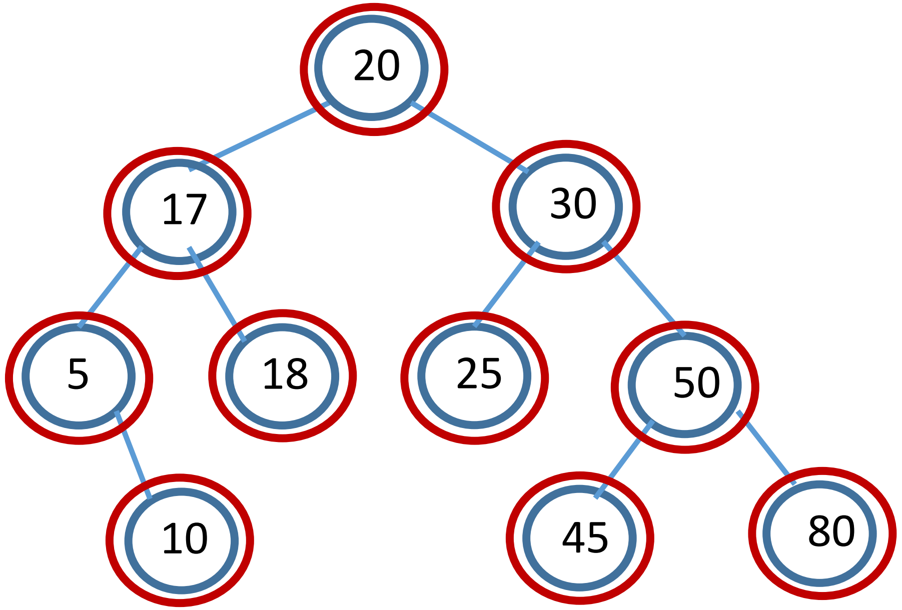
Level 0

Level 1

Level 2

Level 3

Level Order Traversal of a Binary Tree



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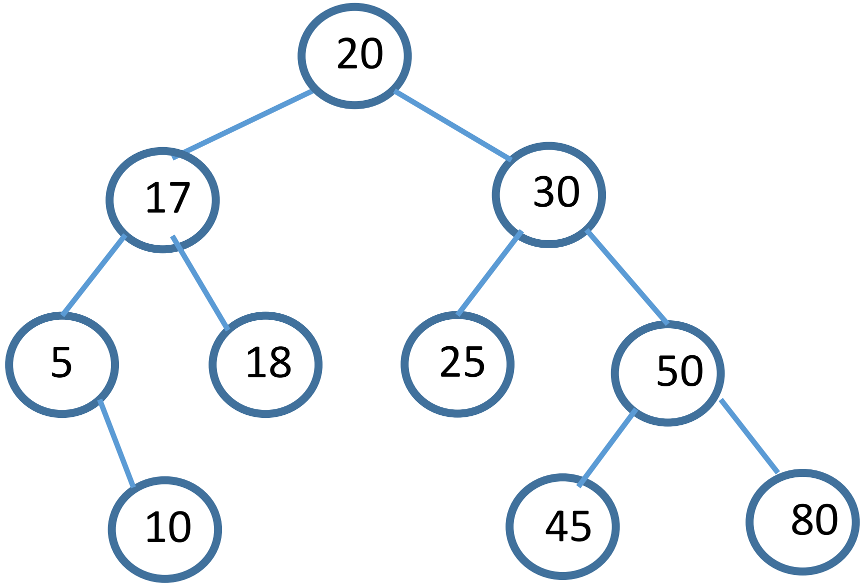
Level Order Traversal of a Binary Tree



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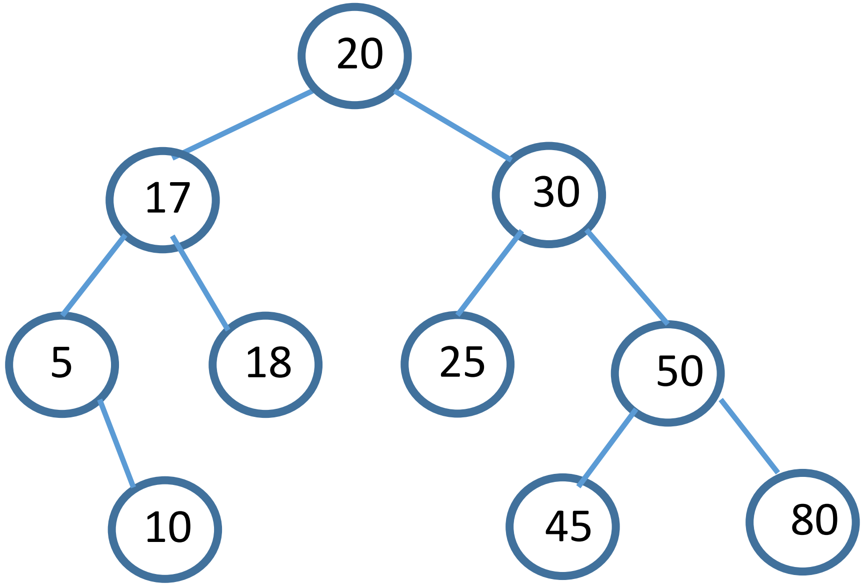
Queue:

Output:

Level Order Traversal of a Binary Tree



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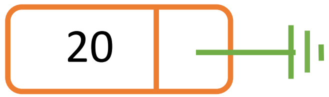

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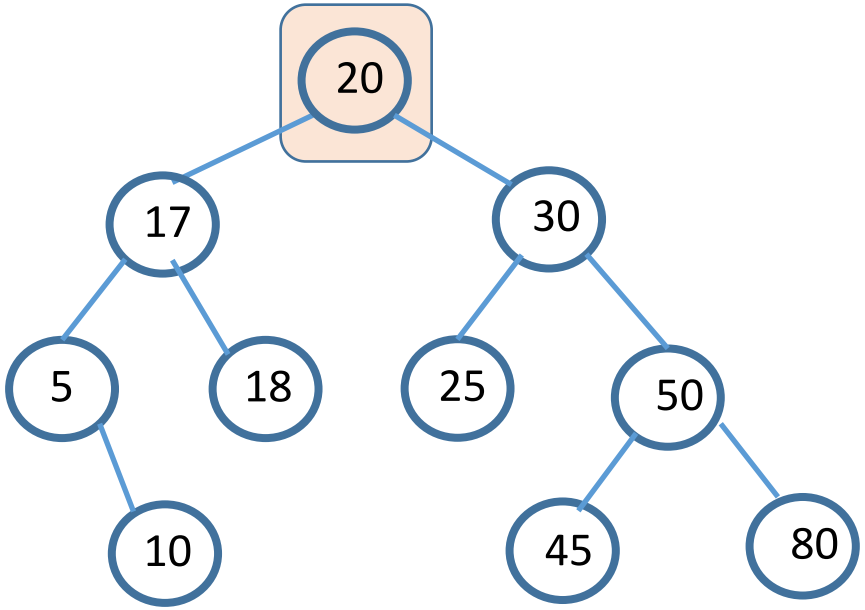

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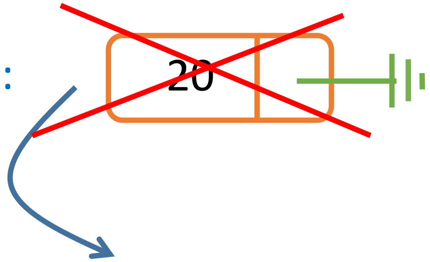
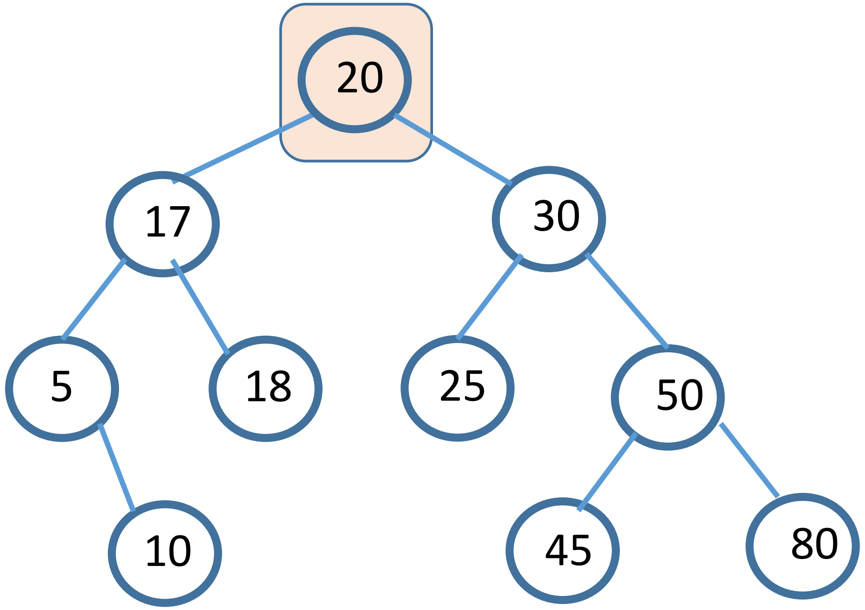


Output: 20

Level Order Traversal of a Binary Tree



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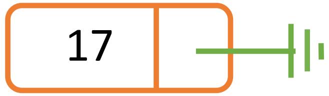

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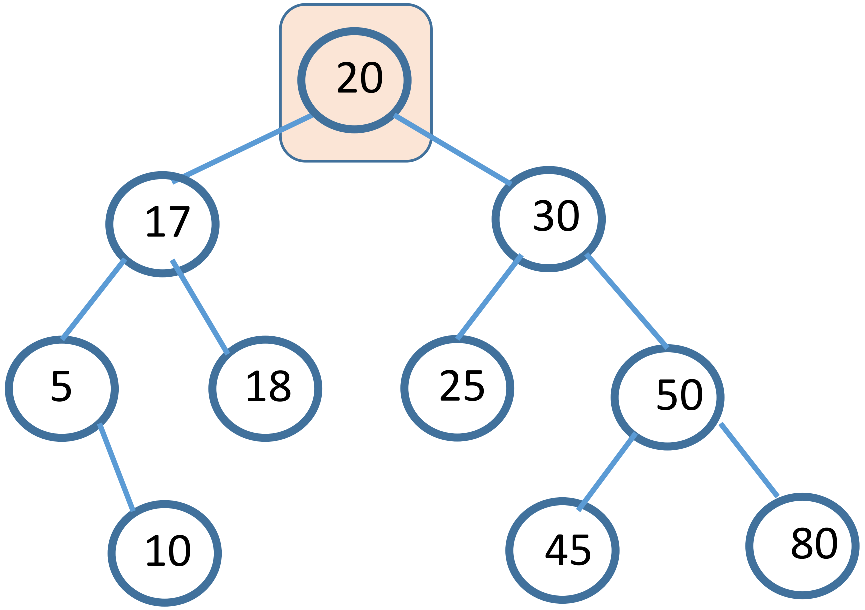

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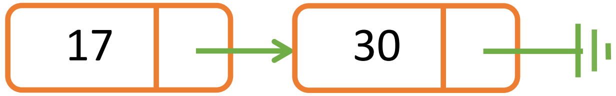

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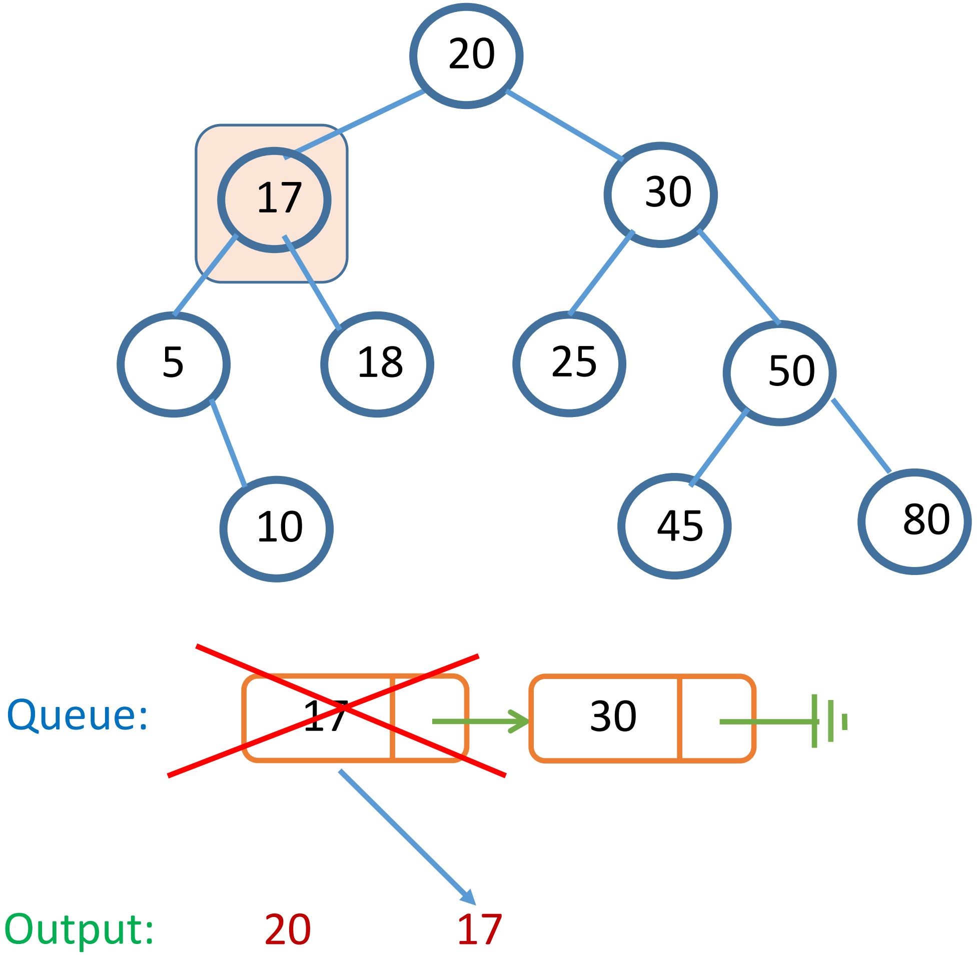
Level Order Traversal of a Binary Tree



Queue: ~~17~~ 30

Output: 20 17

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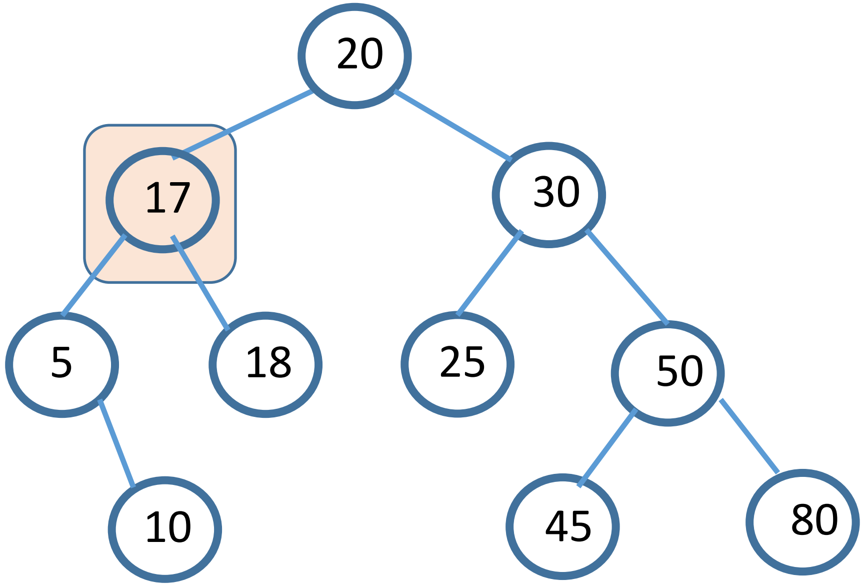

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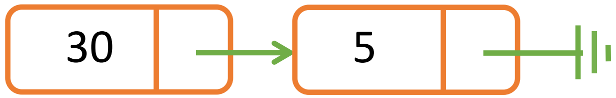

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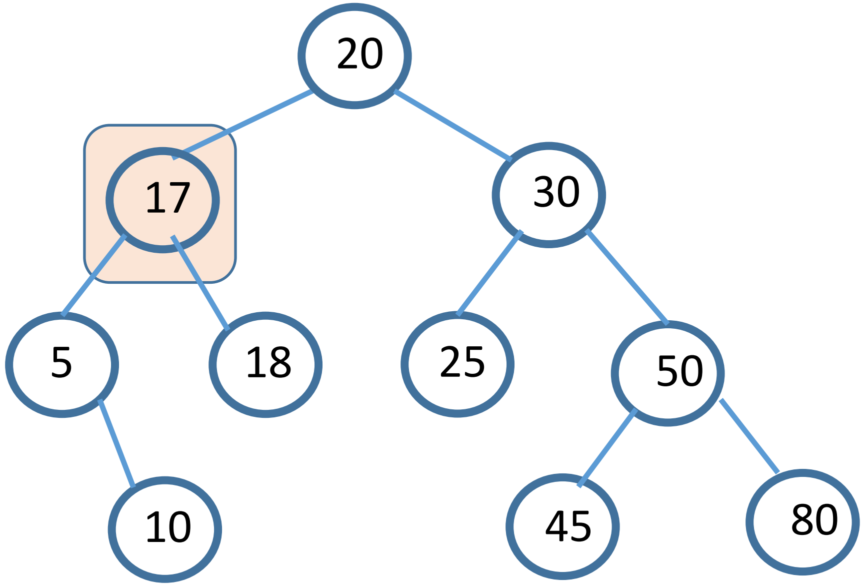
Level Order Traversal of a Binary Tree



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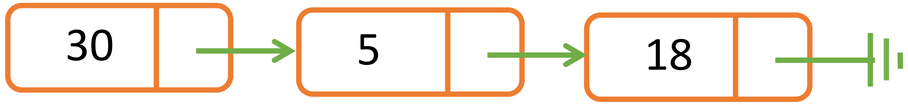

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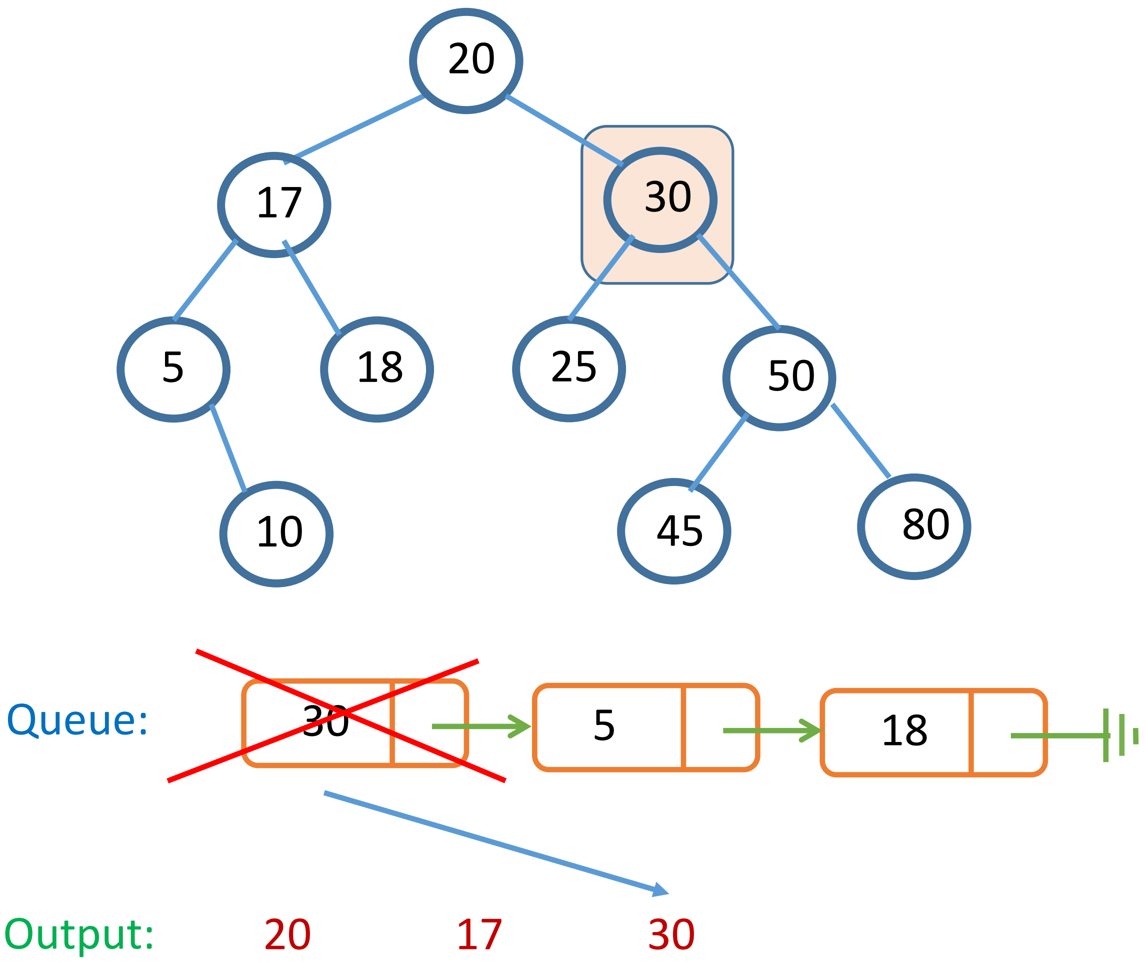
Level Order Traversal of a Binary Tree



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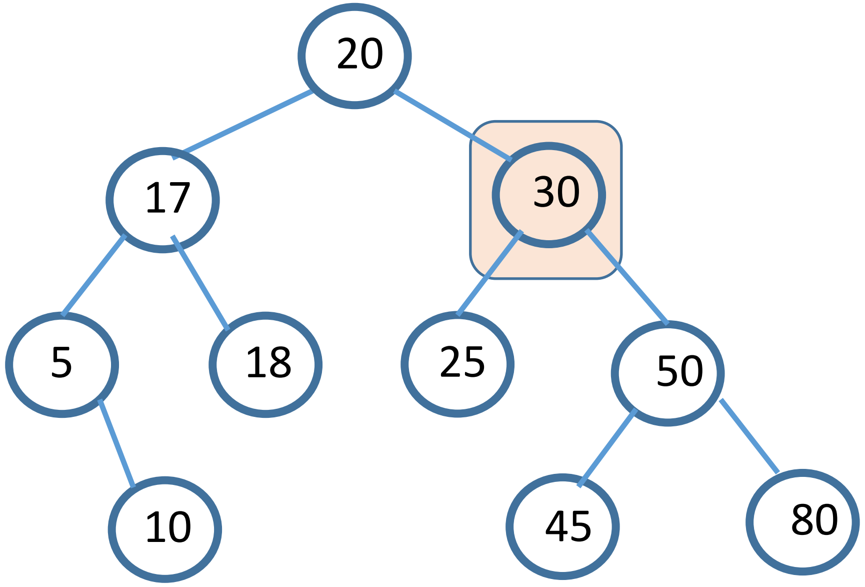

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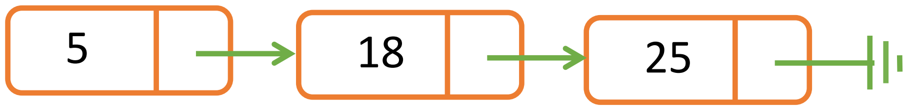
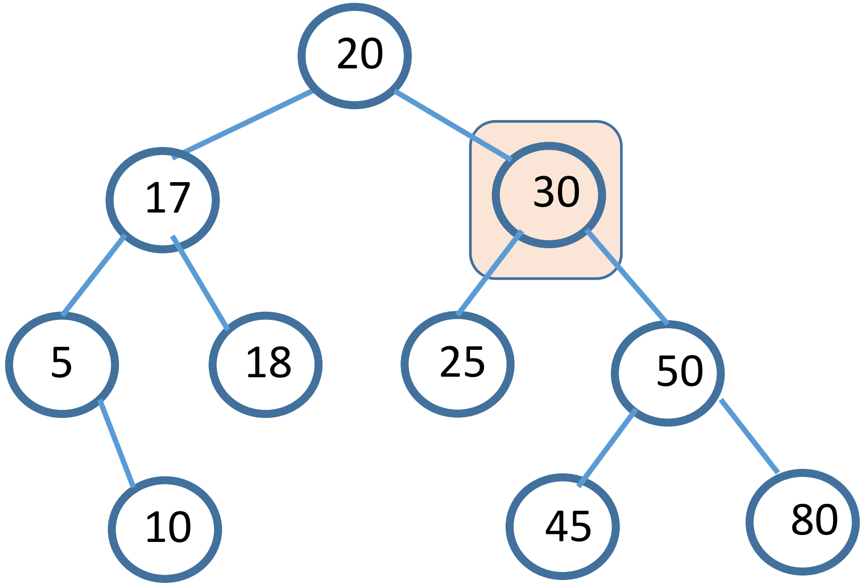


Output: 20 17 30

Level Order Traversal of a Binary Tree



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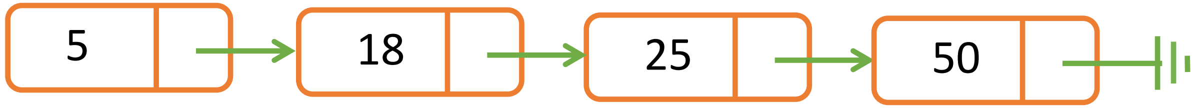
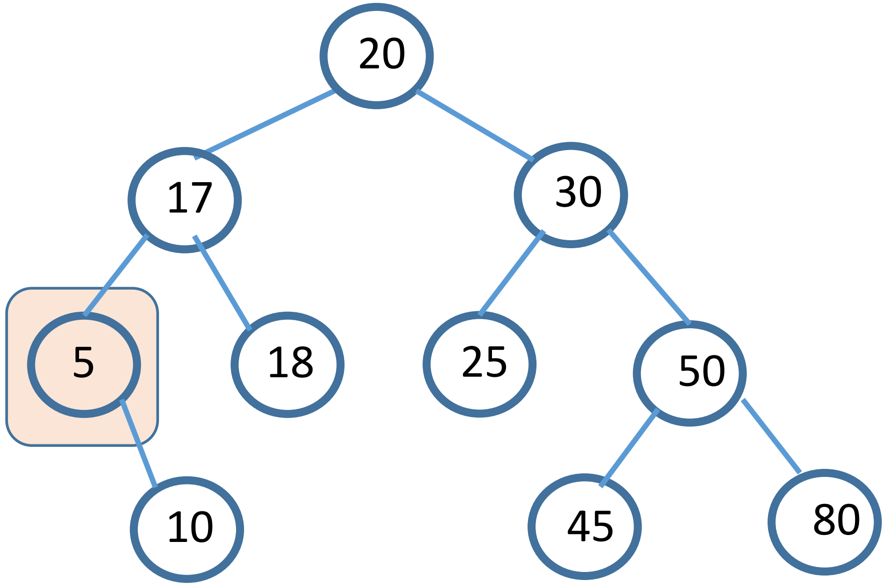


Output: 20 17 30

Level Order Traversal of a Binary Tree



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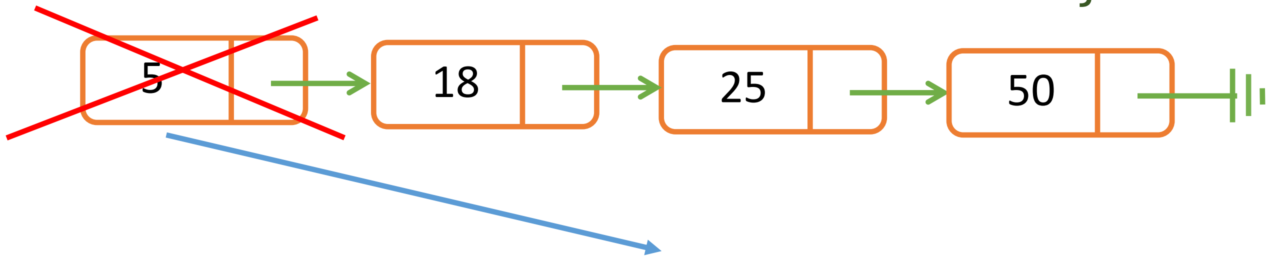
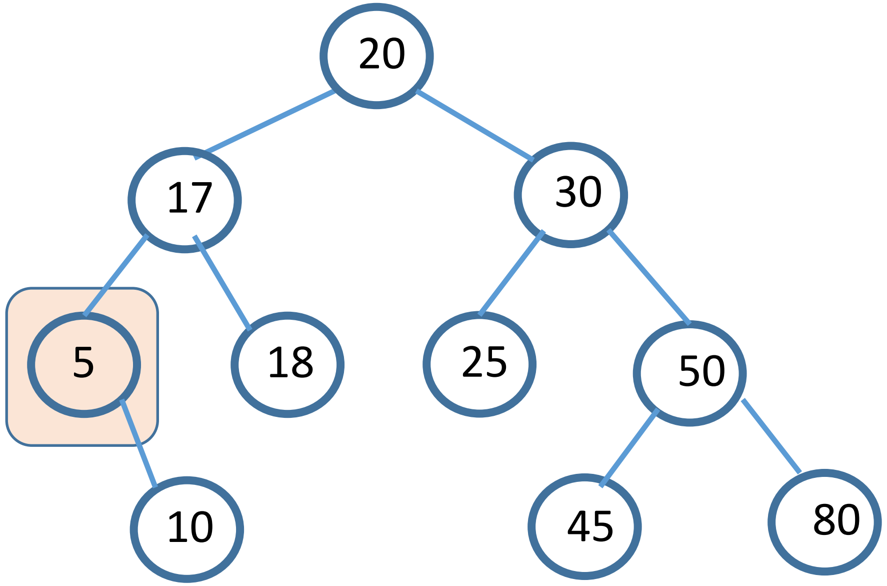


Output: 20 17 30 5

Level Order Traversal of a Binary Tree



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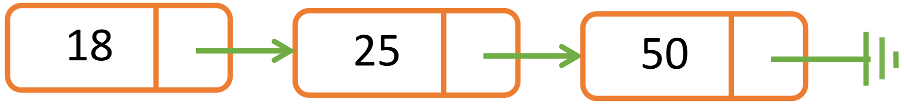

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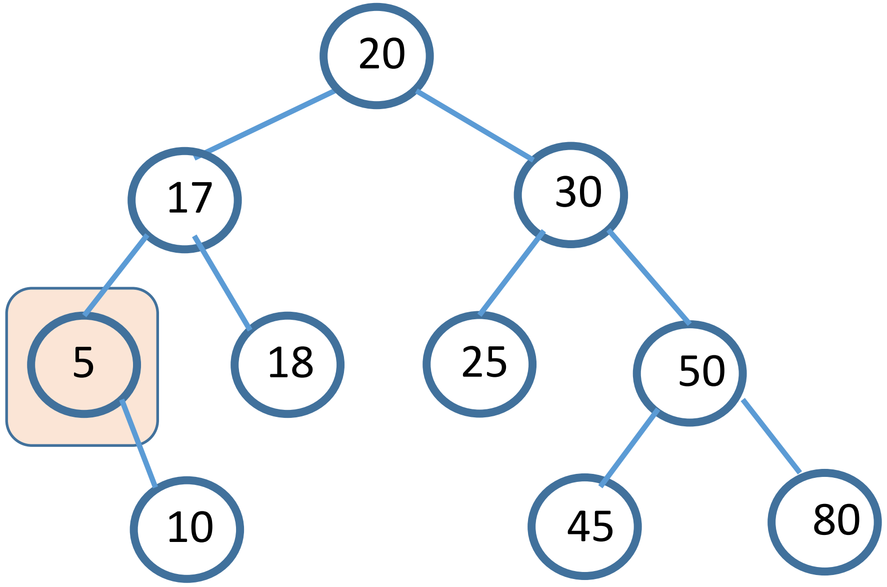
Level Order Traversal of a Binary Tree



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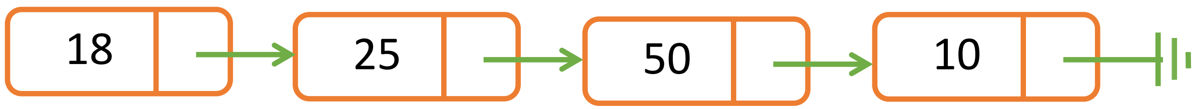

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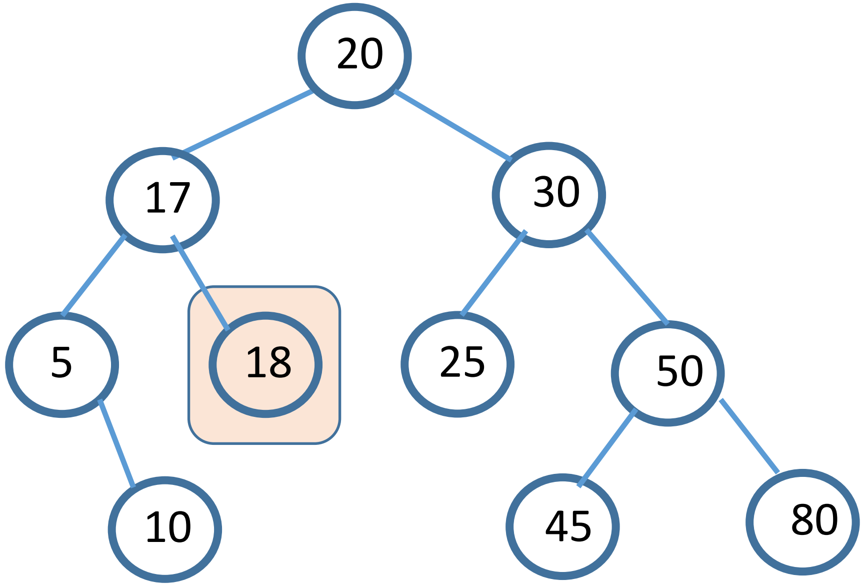
Level Order Traversal of a Binary Tree



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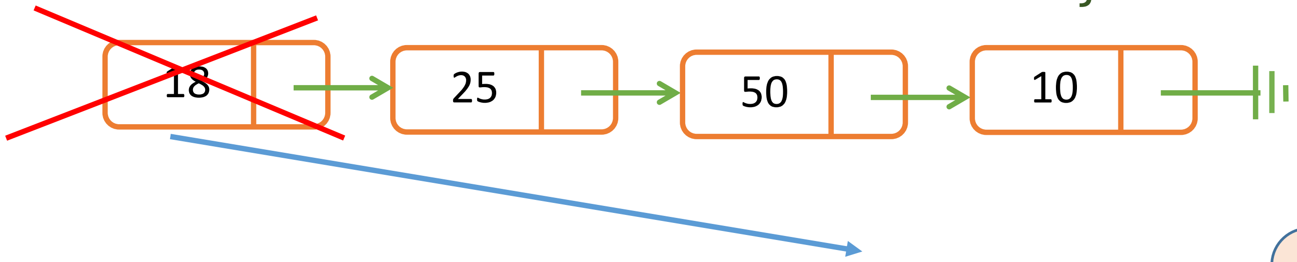


Output: 20 17 30 5 18

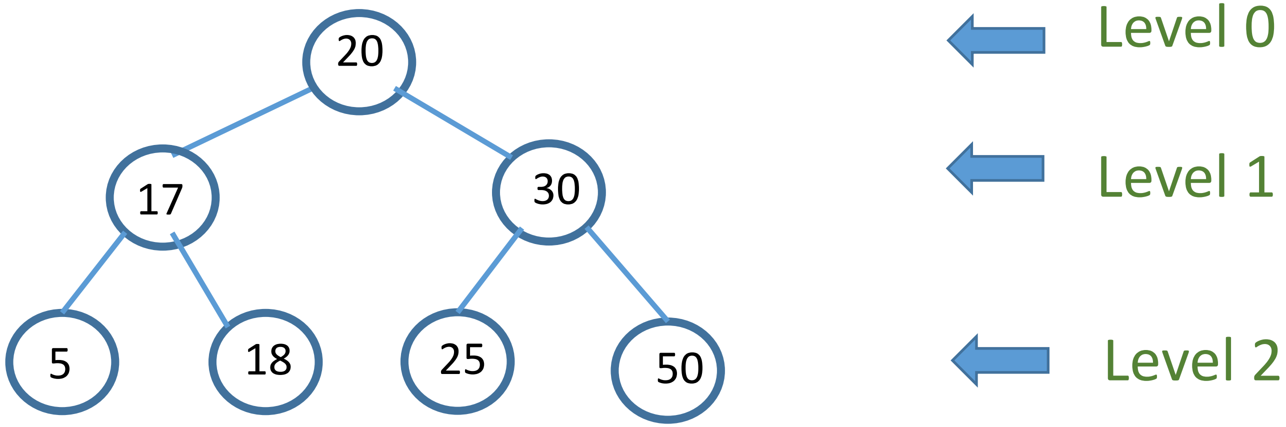
Process continues until the queue is empty – at which point, the level-order traversal is complete.

Types of Binary Trees

1. Complete
2. Almost complete
3. Full

Complete Binary Tree

- A *complete* binary tree is one in which:
  - ✓ Every non-leaf node has two non-empty subtrees, and
  - ✓ All leaves are at the same level.

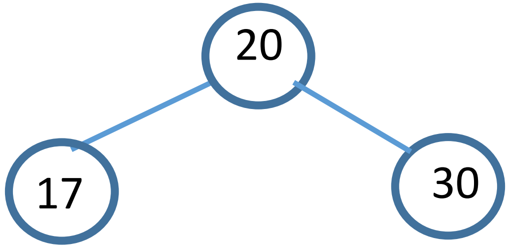


Complete Binary Tree

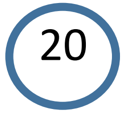
- Which of the following binary trees are complete?

- ✓ Every non-leaf node has two non-empty subtrees, and
- ✓ All leaves are at the same level.

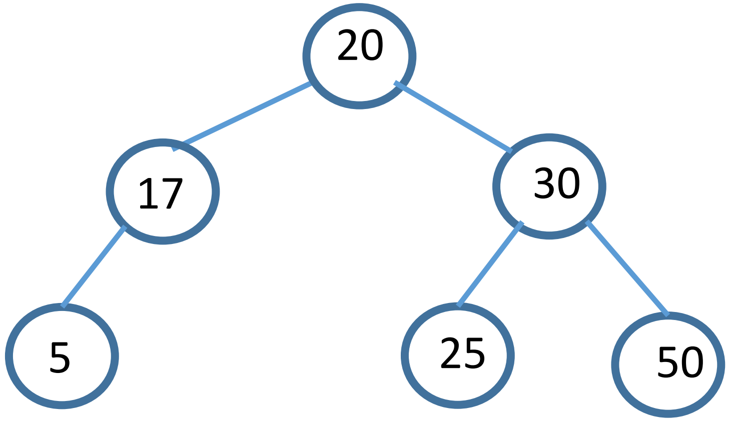
(a)



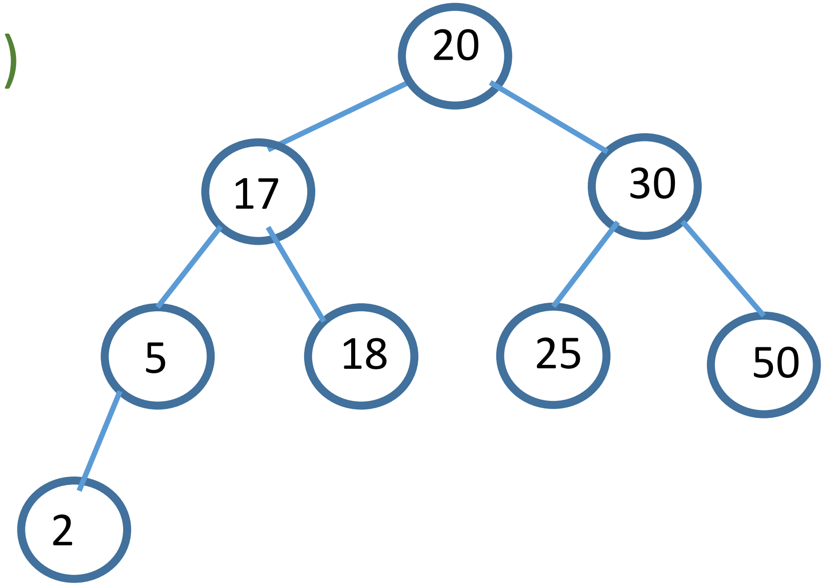
(b)



(c)

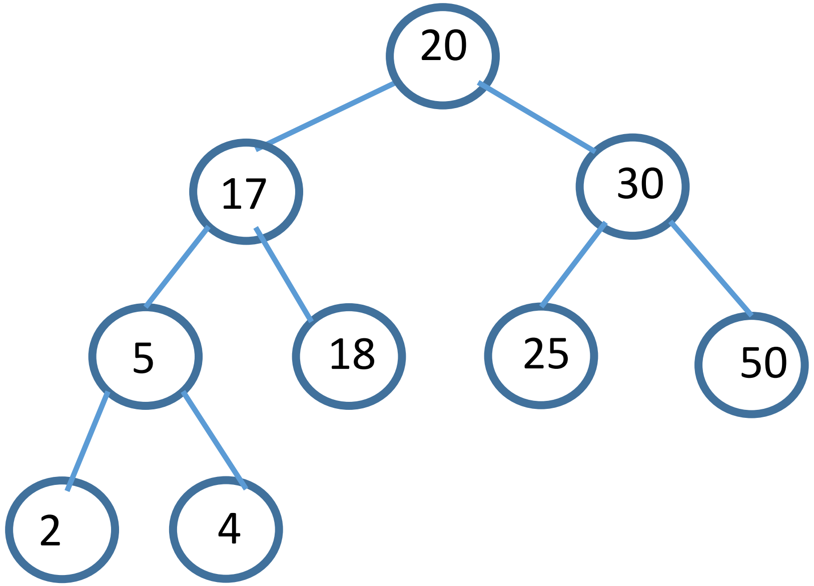


(d)



Almost Complete Binary Tree

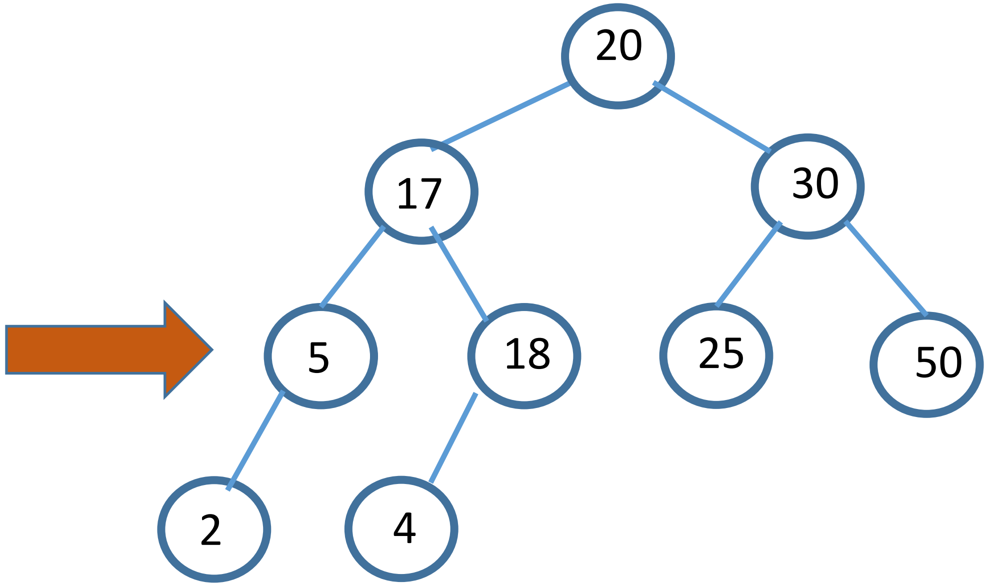
- An *almost complete* binary tree is one in which:
  - ✓ All levels, except possibly the lowest, are completely filled.
  - ✓ The nodes at the lowest level (all leaves) are as far left as possible.



Almost Complete Binary Tree

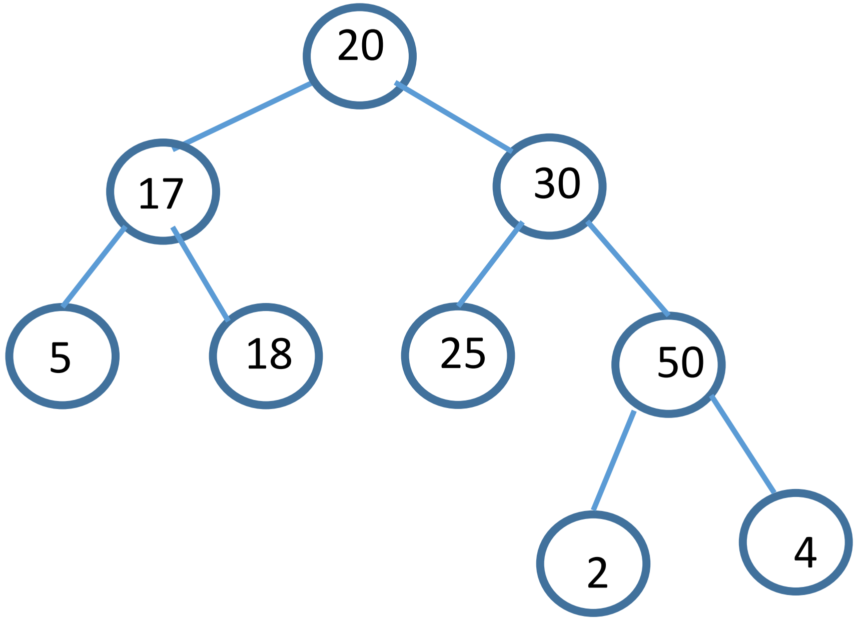
- Is the following binary tree almost complete?

Problem here!



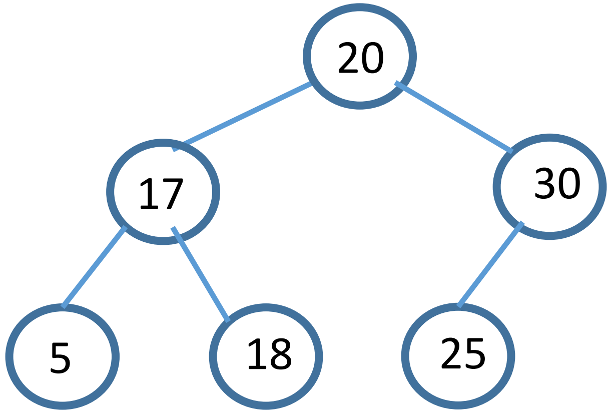
Full Binary Tree

- A *full* binary tree is one in which:
  - ✓ Every non-leaf node has exactly two non-empty subtrees.



Full Binary Tree

- Is the following binary tree full?



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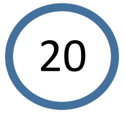
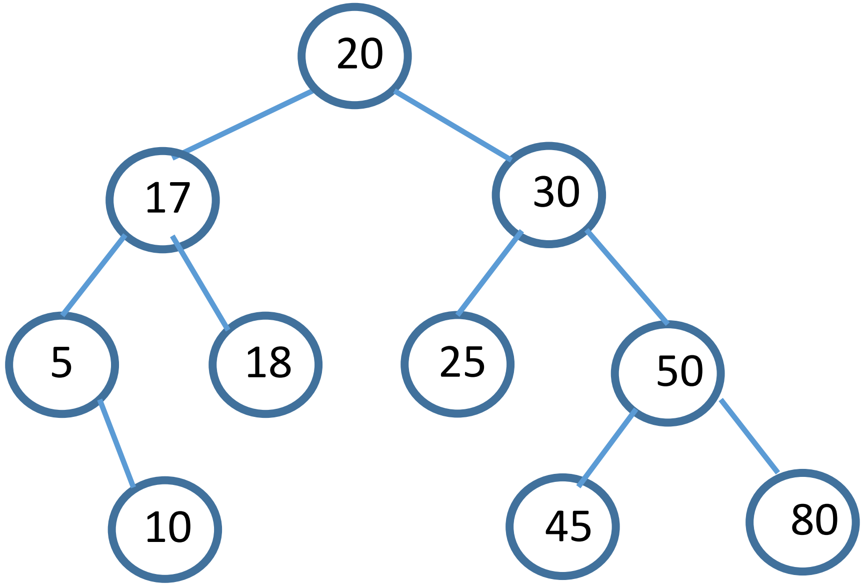


Performance Analysis of a Binary Search Tree



- How does it compare to linked list?
- How does it compare to array?