DATA STRUCTURES & ALGORITHMS

Trees : BST

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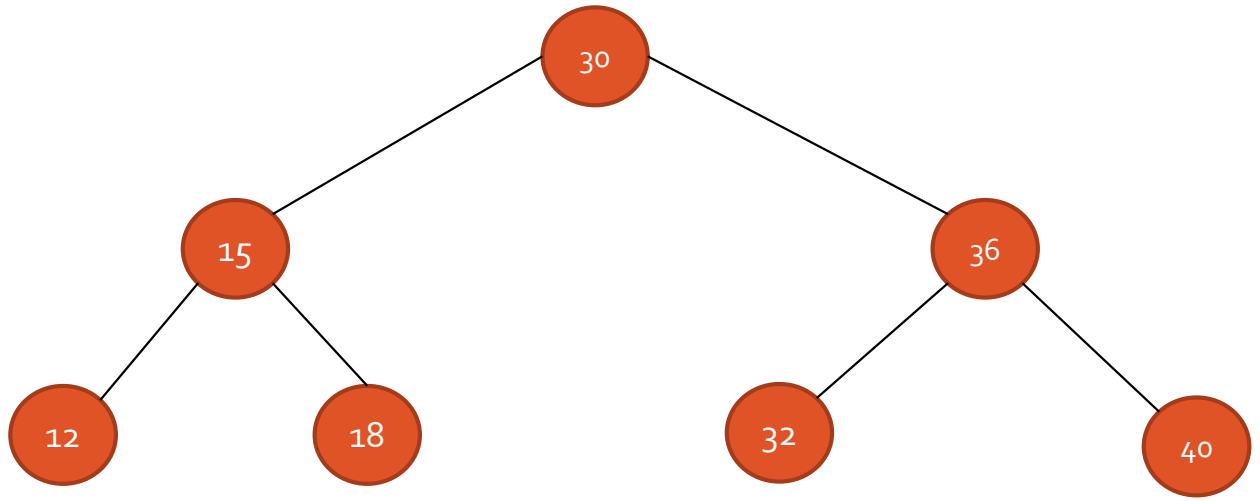
Binary Search Tree

Binary search tree is a data structure that quickly allows us to maintain a sorted list of numbers.

- The left sub-tree of a node has a key less than or equal to its parent node's key.
- The right sub-tree of a node has a key greater than to its parent node's key.



Searching and insertion in BST

Suppose an ITEM with the root node N of the tree. The following algorithm finds the location of ITEM in the binary search tree, or inserts ITEM as a new node in its appropriate place in the tree.

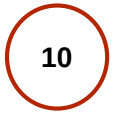
a) Compare ITEM with the root node N of the tree.
   - ITEM < N, proceed to the left child of N
   - ITEM > N, proceed to the right child of N

b) Repeat step (a) until one of the following occurs:
   - We meet a node N such that ITEM = N. In this case the search is successful.
   - We meet an empty subtree, which indicates that the search is unsuccessful, and we insert ITEM in place of the empty subtree.

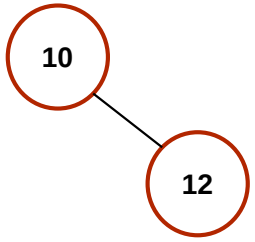
Example: Insertion in BST

10,12,5,4,20,8,7,15,13

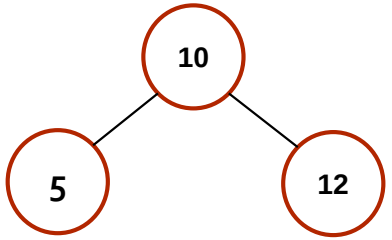
Insert 10



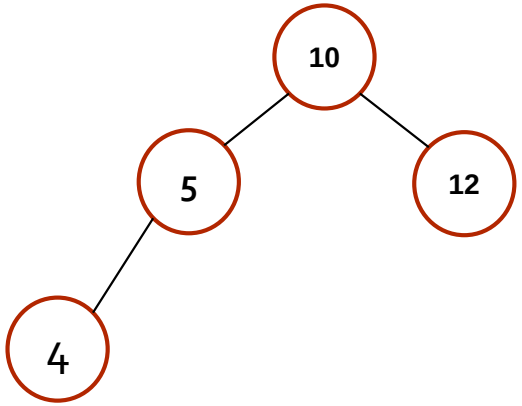
Insert 12, 12 > 10, will be added to right



Insert 5, 5 < 10, will be added to left

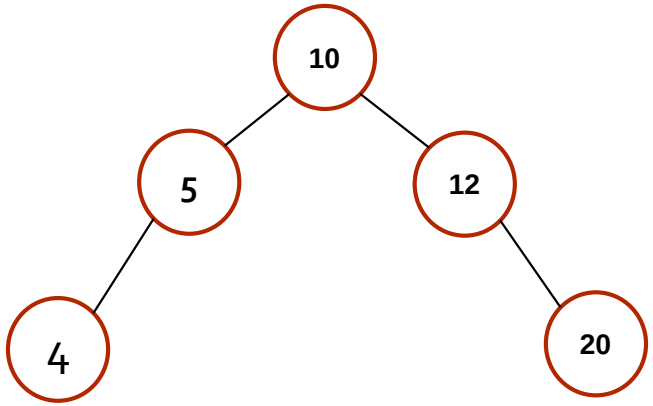


Insert 4, 4 < 10 & 4 < 5, will be added to left

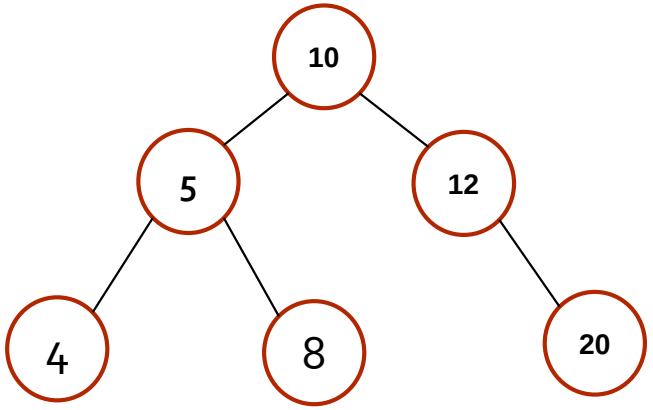


Example: Insertion in BST

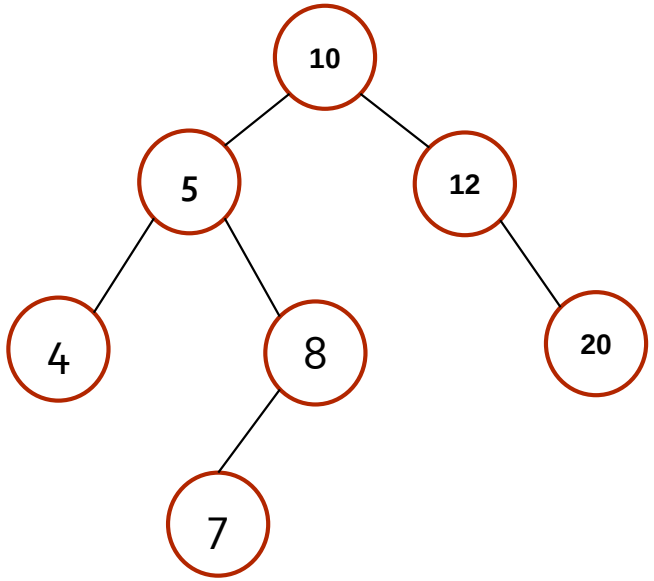
10,12,5,4,20,8,7,15,13



Insert 20, 20 > 10 & 20 > 12 , will be added to right



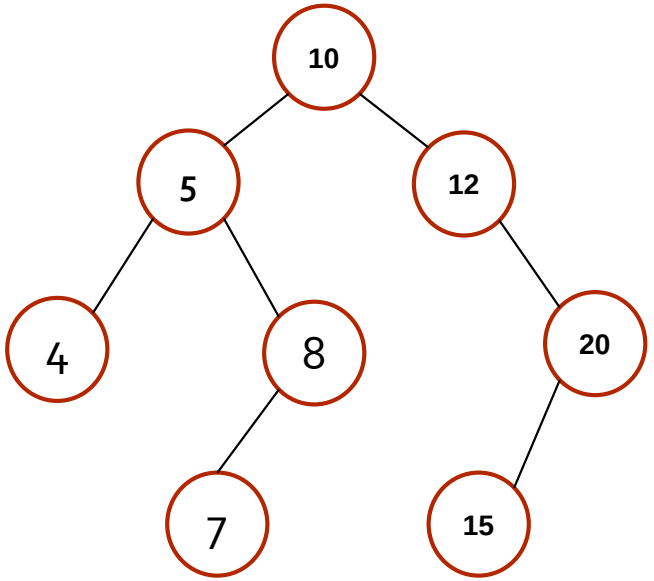
Insert 8, 8 < 10 & 8 > 5 , will be added to right



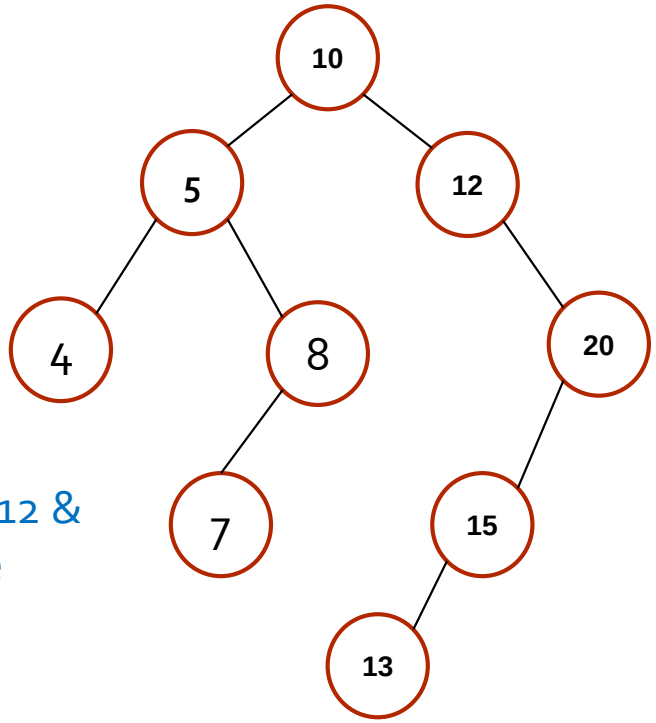
Insert 7, 7 < 10 & 7 < 8, will be added to left

Example: Insertion in BST

10,12,5,4,20,8,7,15,13



Insert 15, 15 > 10 & 15 > 12 & 15 < 20, will be added to left



Insert 13, 13 > 10 & 13 > 12 & 13 < 20 & 13 < 15, will be added to left

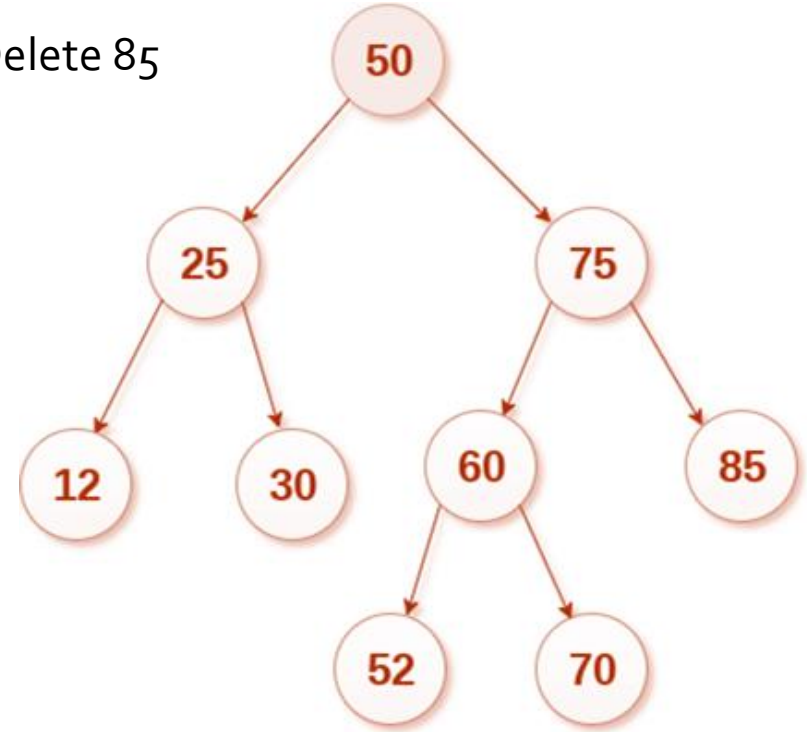
Deleting in a BST

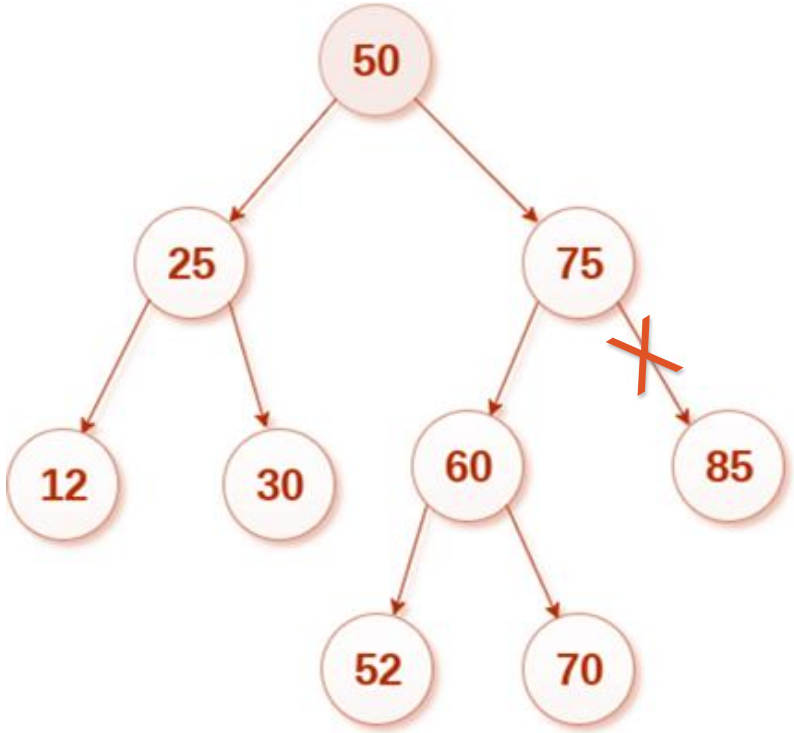
a) Find the desired element.
   - It does not exist
   - It exists in the left subtree
   - It exists in the right subtree

b) Replace the desired element with its successor (if any)
   - Node is a leaf node – Remove the node
   - Node has left/right subtree – Successor of the node replace the node.
   - Node has both left and right subtrees – Successor which can replace the node, can either be the largest value in the left subtree or the smallest value in the right subtree.

Deleting in a BST

Delete 85

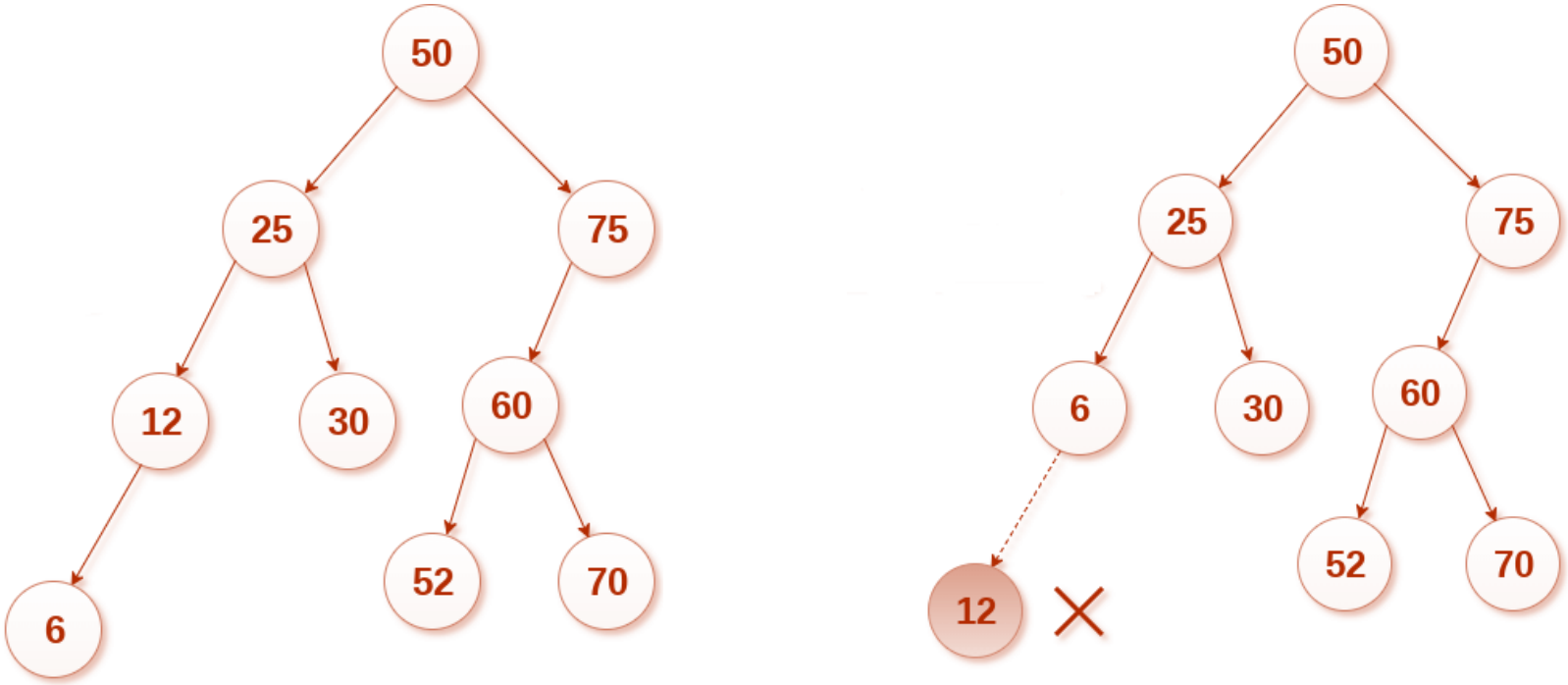




Node is a leaf node – Remove the node

Deleting in a BST

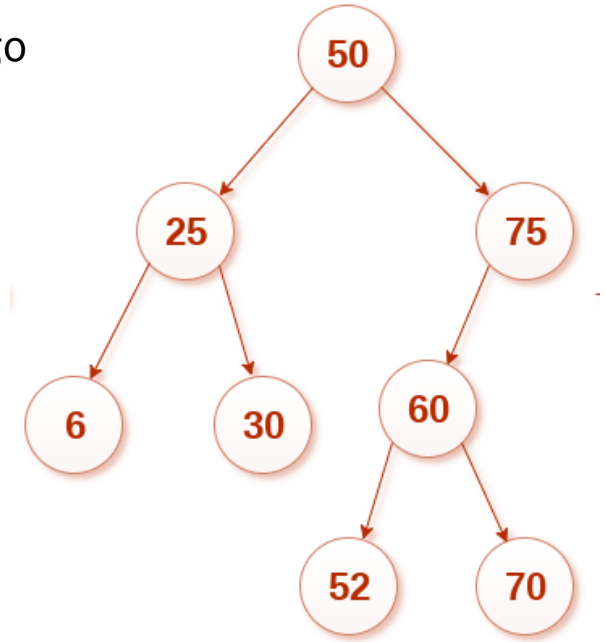
Delete 12

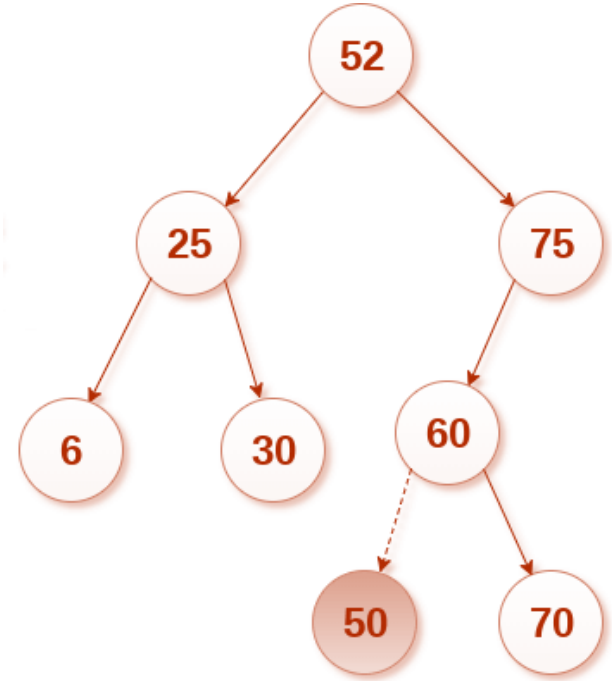


Node has left/right subtree – Successor of the node replace the node.

Deleting in a BST

Delete 50





Node has both left and right subtrees – Successor which can replace the node, can either be the largest value in the left subtree or the smallest value in the right subtree.

Complexity

	Binary search tree
Access	O(n)
Search	O(n)
Deletion	O(n)
Insertion	O(n)

Binary Search Tree

What happens when you Insert elements in ascending order?????

Example

Insert: 1, 2, 4, 6, 8 into an empty BST

Issue: *Lack of Balance*

Solution: *Balanced binary search trees (BBST)*