



# Data Structures and Algorithms

## CS F211



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# AVL trees

# Genesis of different types of BST's



- What is the height of a Binary Search Tree ?
- What is the worst case time complexity of Search, Insert, Delete, Tree\_minimum, Tree\_maximum, Successor, Predecessor functions in a BST ?

# AVL Trees



**Height Balance Property**: For every node  $v$  to  $T$ , the height of the children of  $v$  can differ by at most 1.

**Balance Factor of a Node  $v$ :**

$BF(v) = \text{Height of left subtree of } v \text{ (including itself)} - \text{height of right subtree of } v \text{ (including itself)}.$

*Q. What is the set of value which  $BF(v)$  can take?*

# AVL Trees



- Suppose we have three keys: 30, 40, 50. Draw all possible BST's with these keys.

# AVL Tree Example



**Construct an AVL tree if the following keys are inserted in order:**

**10, 5, 1, 8, 9, 7, 20**

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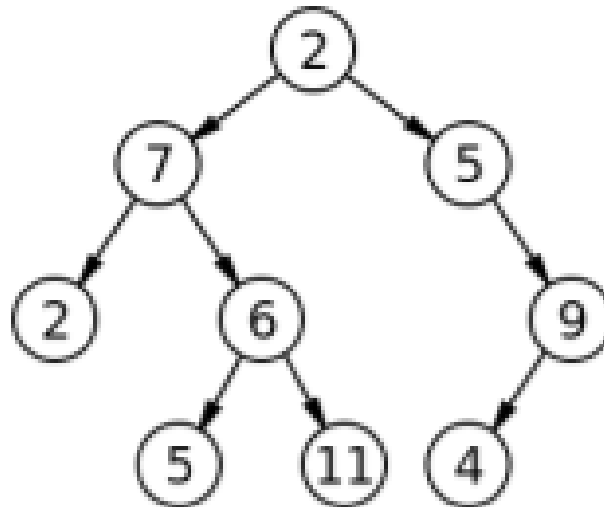


# AVL Trees



**Theorem:** Prove that the height of AVL tree with  $N$  nodes is  $O(\log N)$ .

Let  $N(h)$  denote the minimum number of nodes in an AVL tree of height  $h$ .



# AVL Tree Height ?



Note that AVL trees with a minimum number of nodes are the worst case examples of AVL tree. To bound the height of AVL trees, bound the height of these worst case examples.

