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AVL Trees Notes for GATE

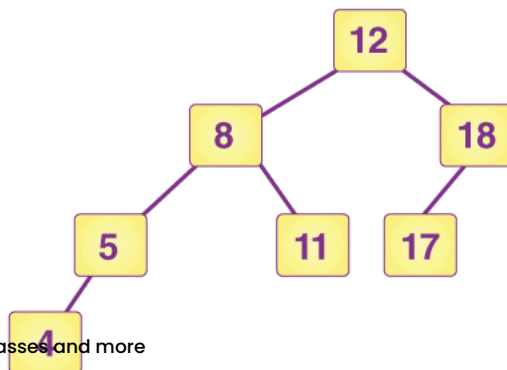
AVL Tree is an essential topic under one of the most important chapters of Computer Science i.e. Data Structure. And, when it comes to a competitive examination like GATE, you have to dive deep into this topic to understand it thoroughly. In this article, we have comprised all the pointers related to the AVL Tree. We hope these notes for CSE topics will help you understand this topic in a better way.

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What is an AVL Tree?

The term AVL tree was introduced by Adelson-Velsky and Landis. It is a balanced binary search tree and is the first data structure like this. In the AVL tree, the heights of the subtree cannot be more than one for all nodes.



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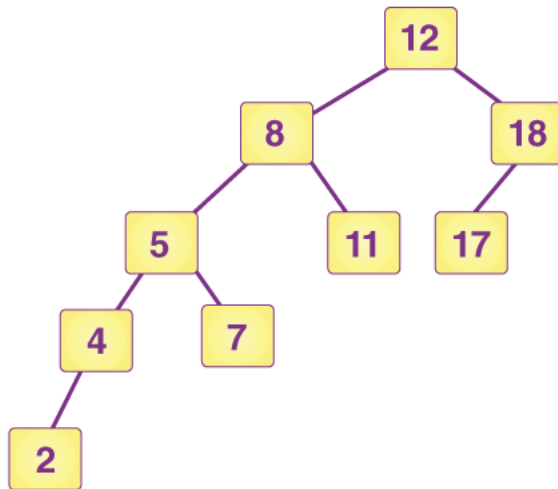
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The above tree is not an AVL tree. And, the reason is simple. Here, the heights of the left and right subtrees are higher than 1.

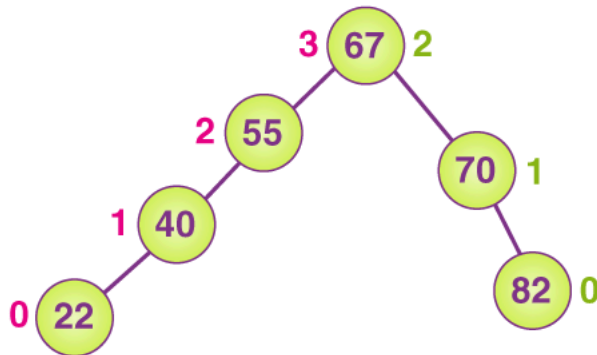
Balance Factor in AVL Tree

In the AVL tree, the term balance factor is very important.

Balance Factor = height(left-subtree) – height(right – subtree)

The balanced factor should be -1, 0 or +1. Otherwise, the tree will be considered an unbalanced tree.

Example Of AVL Tree & Balance Factor:



In the above example, the height of the left subtree is 3 and the height of the right subtree is 2. That means the balance factor is ≤ 1 therefore the tree is supposed to be balanced.

Why Do We Need an AVL Tree?

To reduce the issue of time complexity in a binary search tree, the AVL tree was introduced by Adelson-Velski & Landis. It is a self-balancing tree that helps in reducing the complexity issue.

Operations on AVL Tree

The AVL tree is a balancing binary tree, and therefore it follows the same operations we perform in the binary search tree.

1. Insertion
2. Deletion

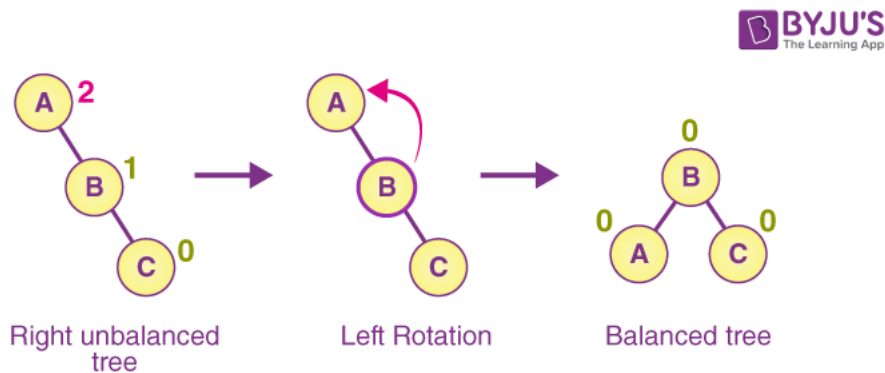
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tree by just swapping the left and right subtrees of the unbalanced node. However, there are chances that it may point to a violation in the balance factor, in this case, it may require doing a left or right rotation to balance the tree for the given node.

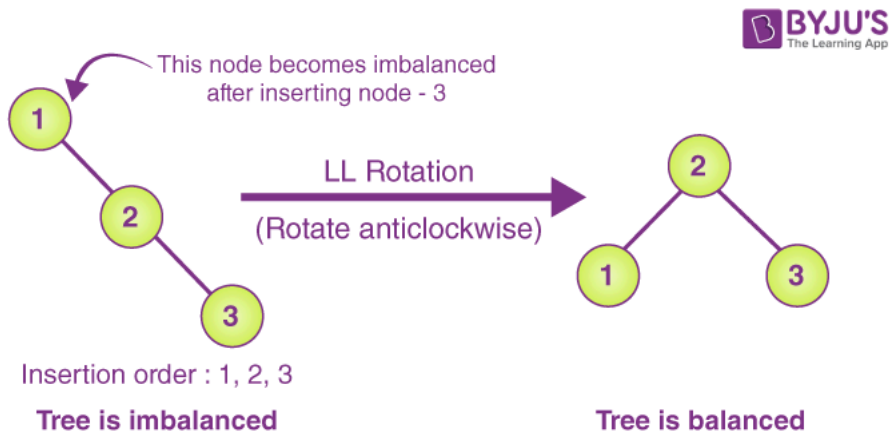
Deletion: The process of deletion is the same as it is executed in a binary search tree. It can affect the balance factor of the tree, therefore, we need to utilize different types of rotations to balance the tree.

AVL Rotation

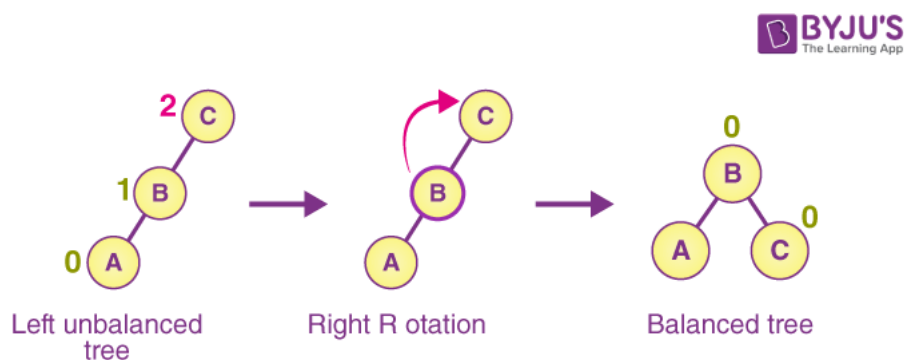
- Left rotation
- Right rotation
- Left-Right rotation
- Right-Left rotation



1. Left Rotation: When we perform insertion at the left subtree, then it is a left rotation.



1. Right Rotation: When we perform insertion at the right subtree, then it is a right rotation.

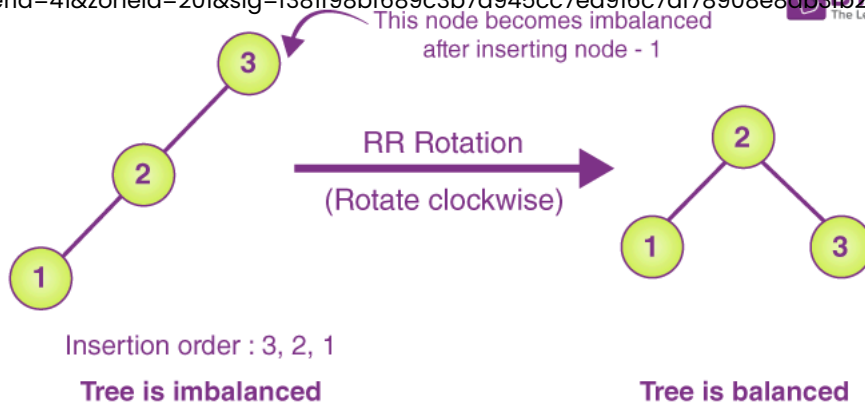


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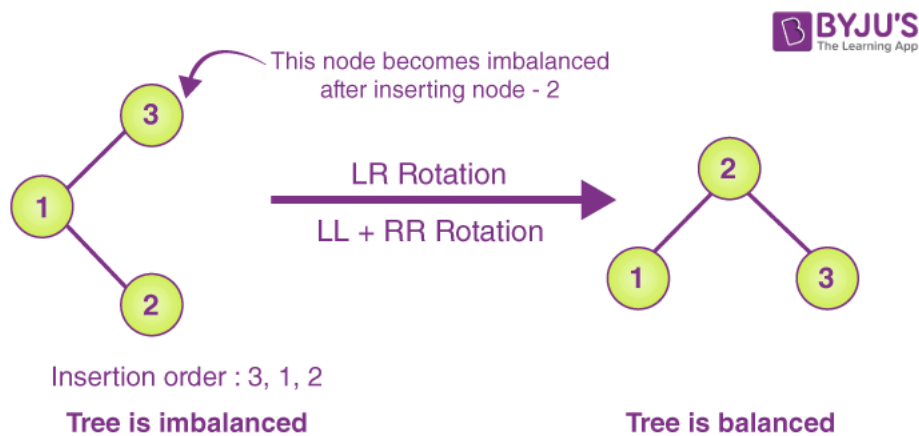
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1. Left-Right Rotation



1. Right-Left Rotation

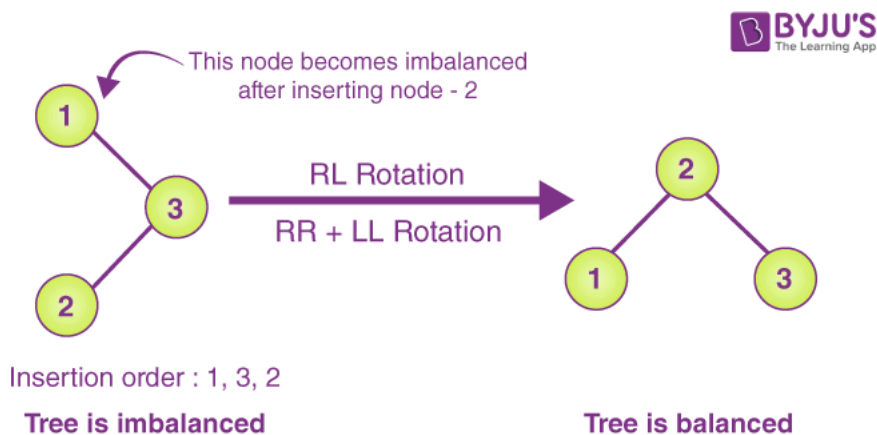


Figure: Right-Left Rotation



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Algorithm	Average case	Worst case
Space	$O(n)$	$O(n)$
Search	$O(\log n)$	$O(\log n)$
Insert	$O(\log n)$	$O(\log n)$
Delete	$O(\log n)$	$O(\log n)$

Practice Problem – AVL Tree

Q. What is the maximum height of any AVL-tree with 7 nodes? Assume that the height of a tree with a single node is 0.

- (A) 2
- (B) 3
- (C) 4
- (D) 5

Frequently Asked Questions Related to AVL Tree

Q1 What is the formula for the balance factor in an AVL tree?

Balance Factor = height(left-subtree) - height(right-subtree)

Q2 What does AVL stand for?

In Computer Science, AVL stands for Adelson-Velski & Landis. This is because the AVL tree was introduced by these two inventors.

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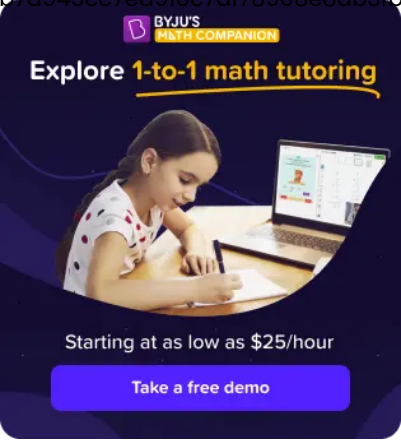
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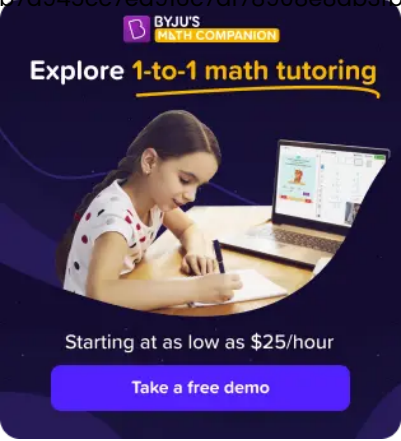
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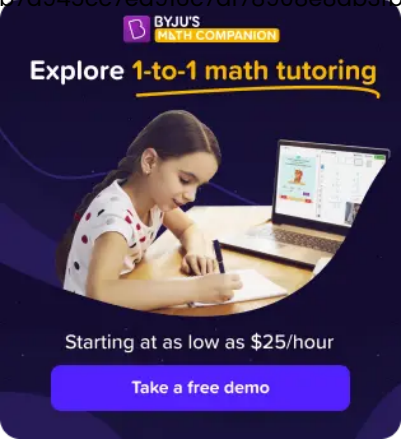


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