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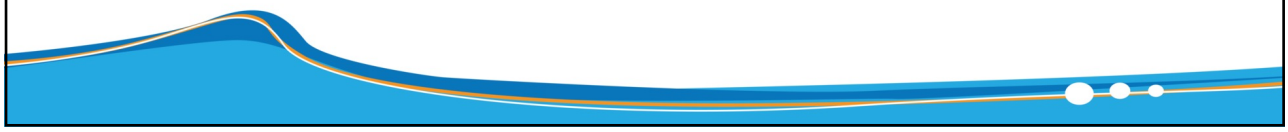
Tree Structures



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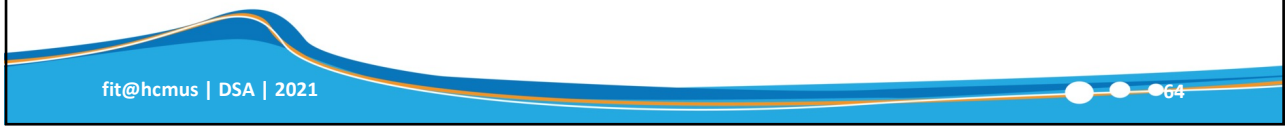
AVL Tree



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AVL Tree

- Named for inventors, (Georgii) **A**delson-**V**elsky and (Evgenii) **L**andis
- Invented in 1962 (paper "*An algorithm for organization of information*").
- AVL Tree is a **self-balancing** binary search tree where
  - for ALL nodes, the difference between height of the left subtrees and the right subtrees **cannot be more than one**.

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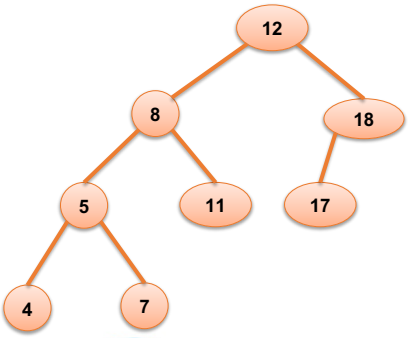
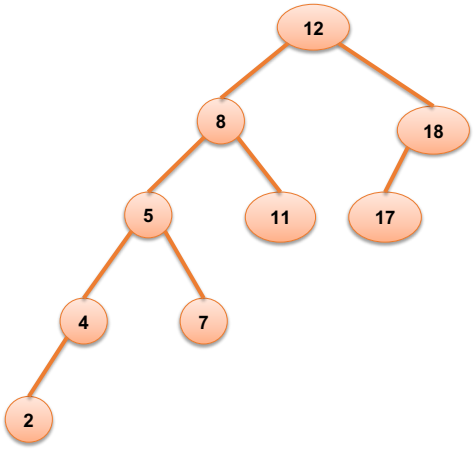
AVL Tree

Which is the AVL Tree?





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AVL Tree

- A balanced binary search tree
  - Maintains height close to the minimum
  - After insertion or deletion, check the tree is still AVL tree – determine whether any node in tree has left and right subtrees whose heights differ by more than 1
- Can search AVL tree almost as efficiently as minimum-height binary search tree.

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Cases of Un-balanced Nodes

- Left-Left case
- Left-Right case
- Right-Right case
- Right-Left case

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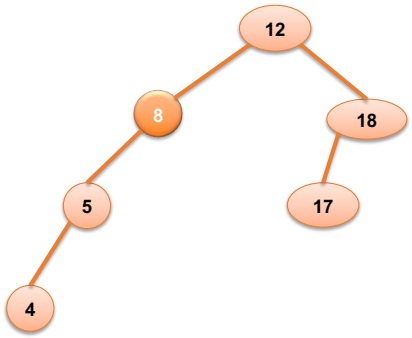
Cases of Un-balanced Nodes

- Left-Left case



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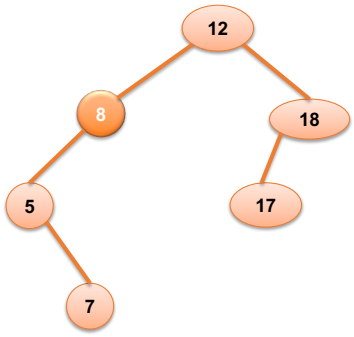
Cases of Un-balanced Nodes

- Left-Right case



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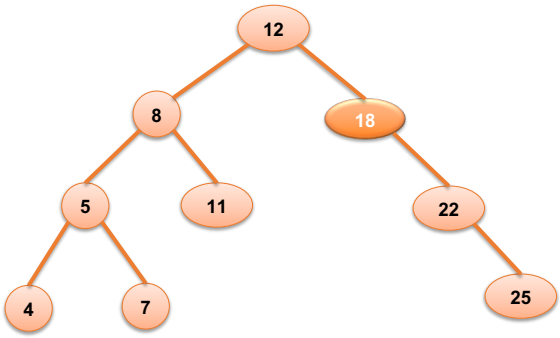
Cases of Un-balanced Nodes

- Right-Right case



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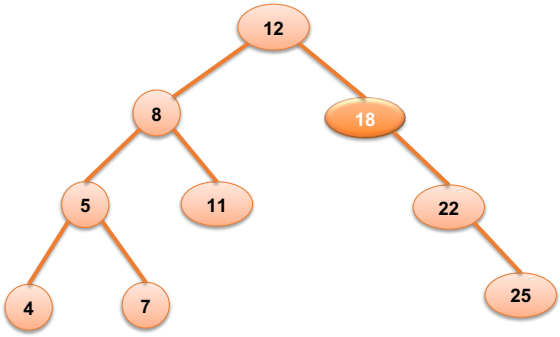
Cases of Un-balanced Nodes

- Right-Right case



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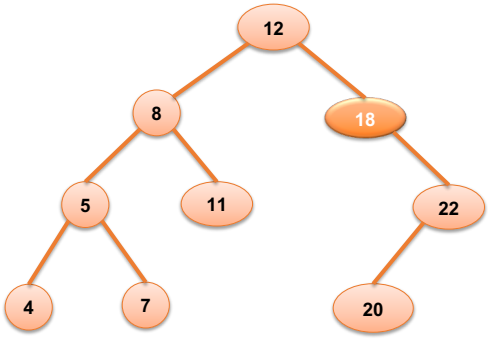
Cases of Un-balanced Nodes

- Right-Left case



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Un-balanced Resolving

- Right-Right case:
  - Left rotation at un-balanced node.
- Right-Left case:
  - Right rotation at un-balanced node's right child.
  - Left rotation at un-balanced node.

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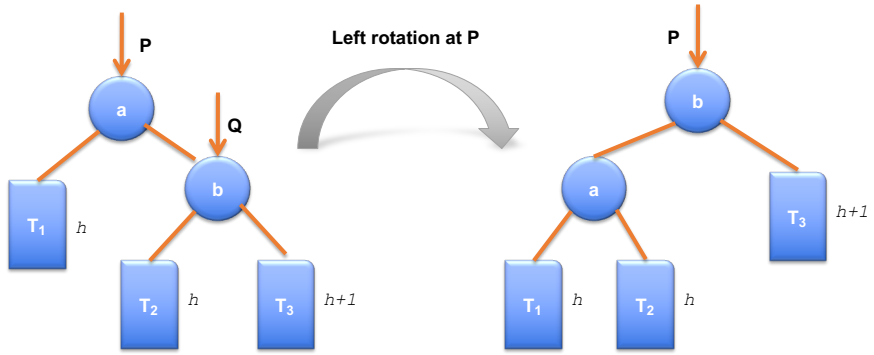
Un-balanced Resolving

- Right-Right case:



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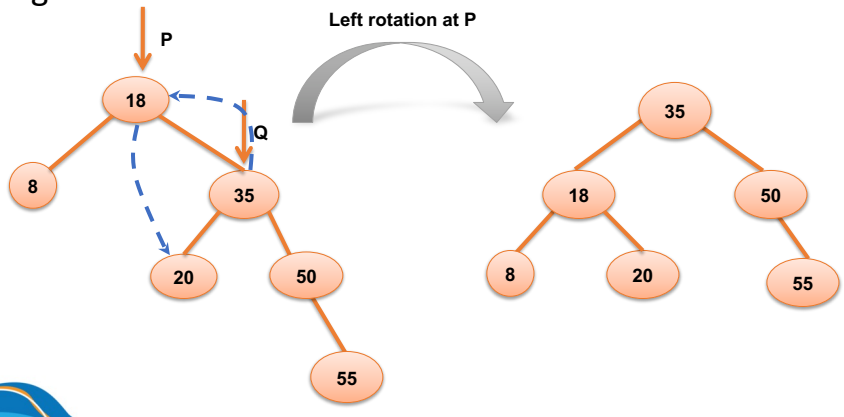
Un-balanced Resolving

- Right-Right case:



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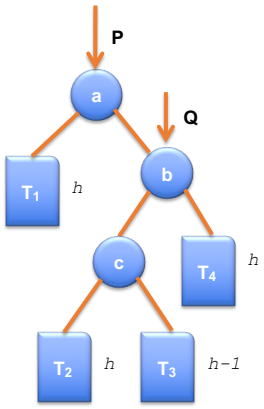
Un-balanced Resolving

- Right-Left case:
  - Right rotation at Q
  - Left rotation at P



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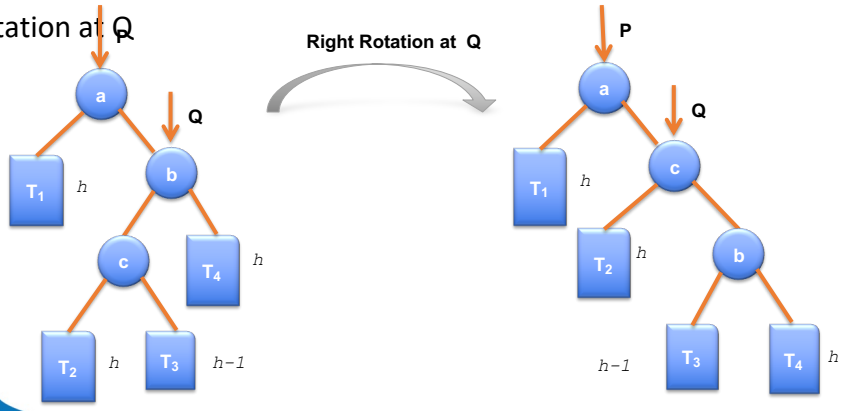
Un-balanced Resolving

- Right-Left case:
  - Right rotation at Q



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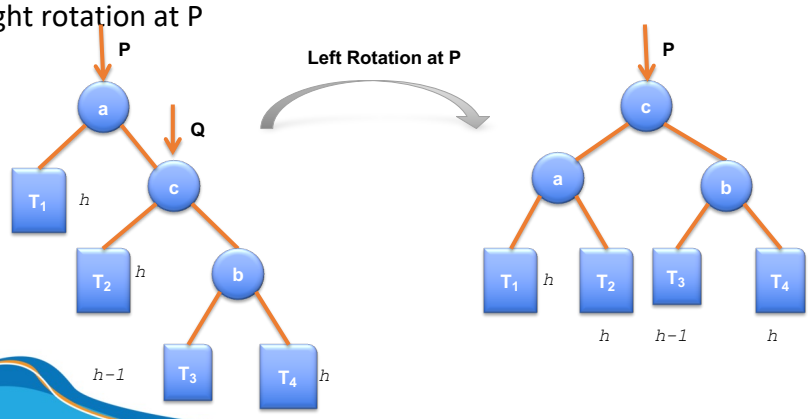
Un-balanced Resolving

- Right-Left case:
  - Right rotation at P



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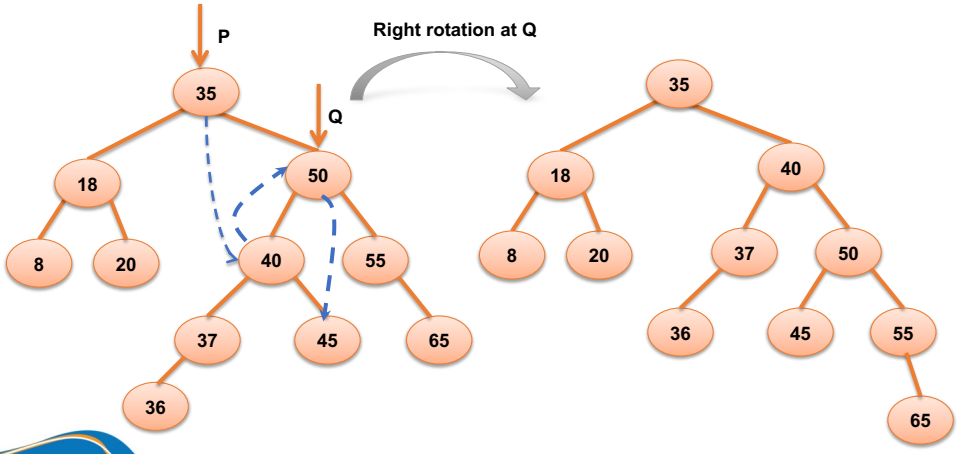
Un-balanced Resolving



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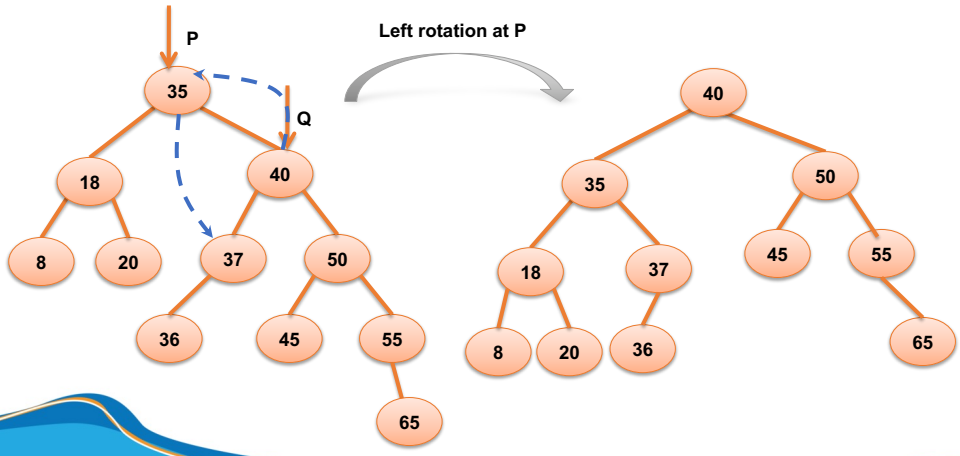
Un-balanced Resolving



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Un-balanced Resolving

- Left-Left case:
  - Right rotation at un-balanced node.
- Left-Right case:
  - Left rotation at un-balanced node's left child.
  - Right rotation at un-balanced node.

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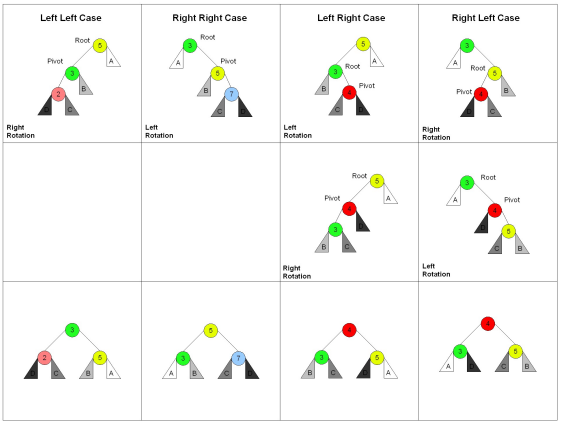
Un-balanced Resolving

There are 4 cases in all, choosing which one is made by seeing the direction of the first 2 nodes from the unbalanced node to the newly inserted node and matching them to the top most row.

Root is the initial parent before a rotation and **Pivot** is the child to take the root's place.



Source: Wikipedia