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Red-Black Tree

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Red-Black Tree

- Invented in 1972 by Rudolf Bayer.
- Red-Black tree is a binary search tree with the following rules:
  - Every node has a color either **red** or **black**.
  - The root of the tree is always **black**.
  - There are no two adjacent **red** nodes (A **red** node cannot have a **red** parent or **red** child).
  - Every path from a node (including root) to any of its descendants NULL nodes has the same number of **black** nodes.
  - All leaf nodes are **black** nodes.

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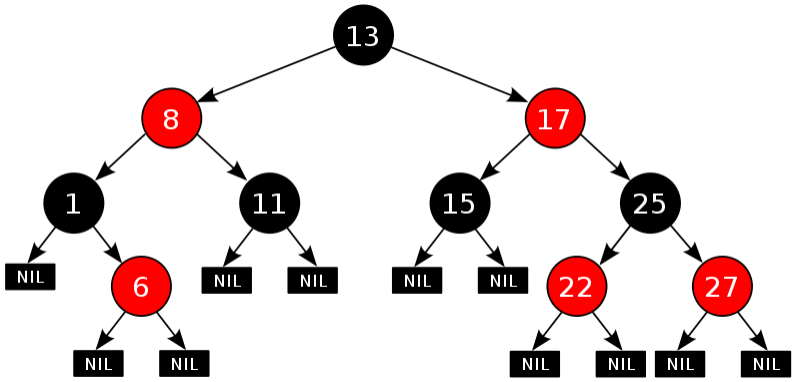
Red-Black Tree



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AA Tree

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AA Tree

- Invented by **A**rne **A**nderson in a work published in 1993 (Balanced Search Tree Made Simple).

- Two concepts:
  - Level:
    - Number of LEFT links from that nodes to a NULL node.
  - Horizontal link:
    - The link between parent and its child node having the same level.

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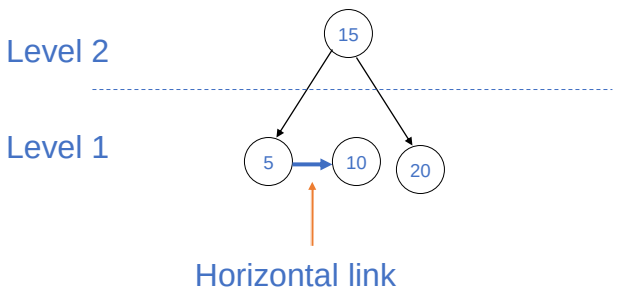
AA Tree



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AA Tree

- AA tree is a binary search tree with the following rules:
  - The level of every leaf node is one.
  - The level of every left child is exactly one less than that of its parent.
  - The level of every right child is equal to or one less than that of its parent.

    Horizontal link must be a RIGHT link.
  - The level of every right grandchild is strictly less than that of its grandparent.

    There is no two consecutive horizontal links.
  - Every node of level greater than one has two children.

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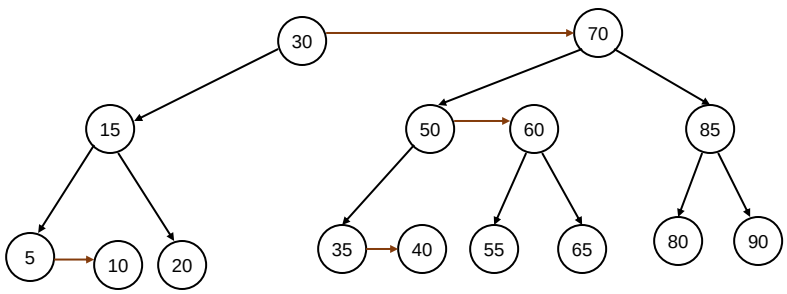
AA Tree



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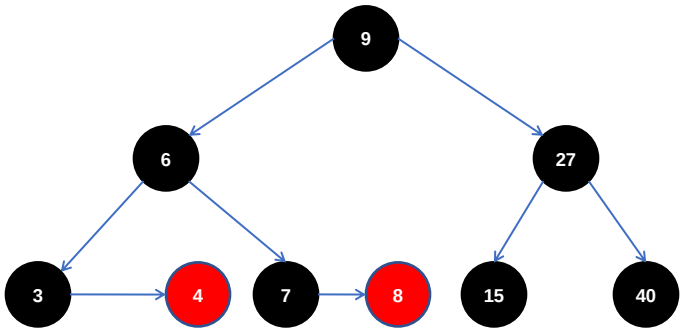
AA Tree and Red-Black Tree



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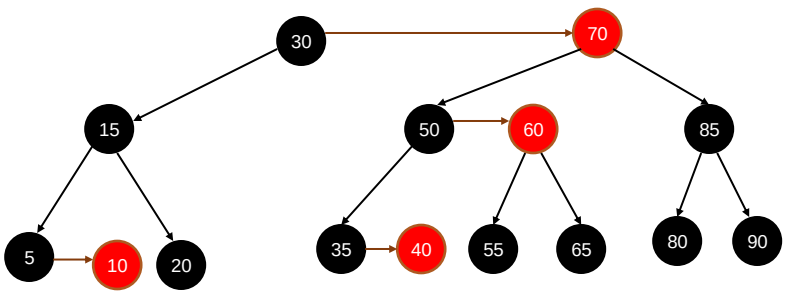
AA Tree and Red-Black Tree



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