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هذا الملف للمراجعة السريعة واخذ الملاحظات عليه فقط، لانه يحتوي على اقل من 20٪ مما يتم شرحه في الفيديوهات

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Algorithms & Problem Solving
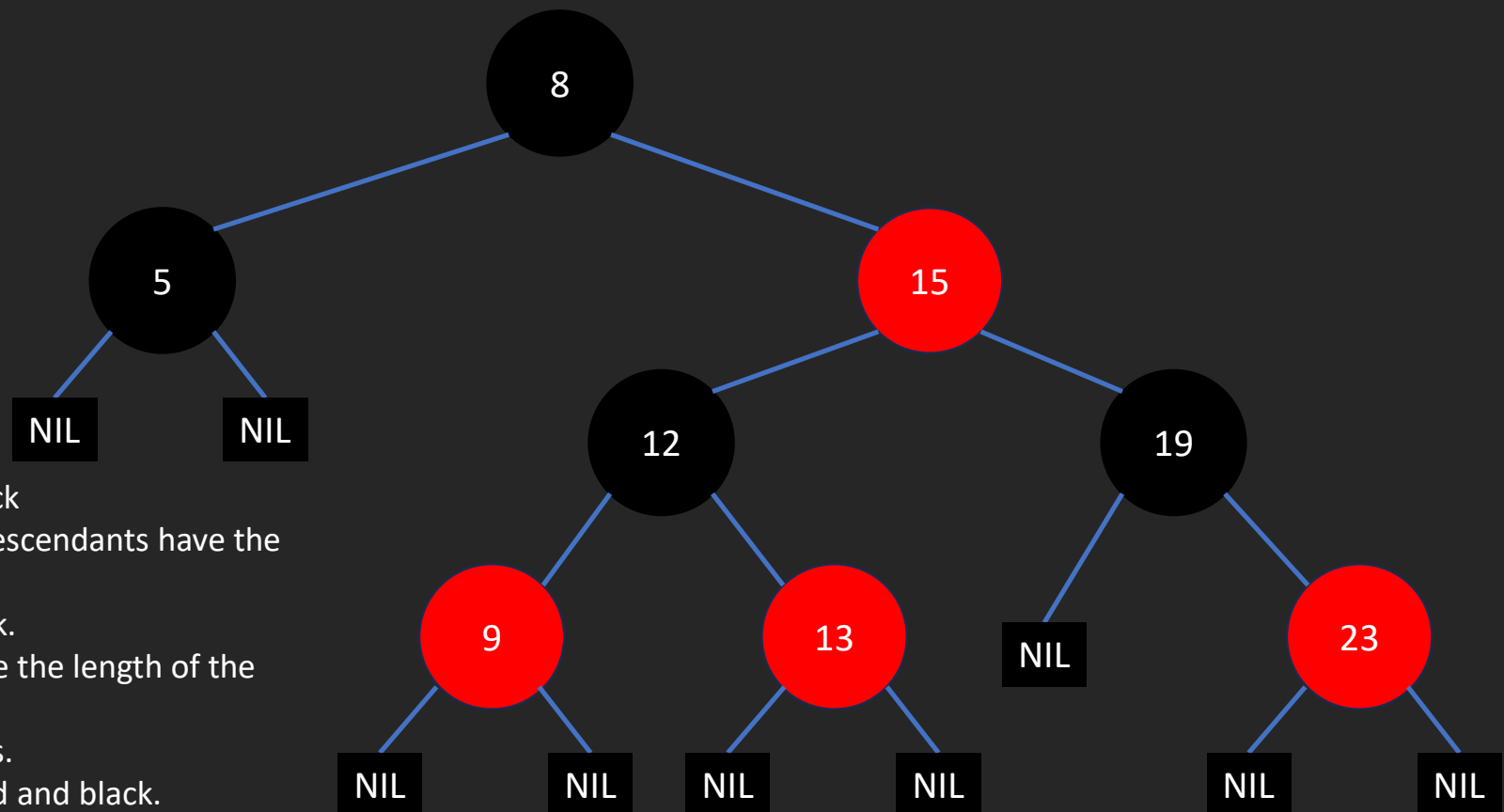## Level 6

What is Red-Black Tree?

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Example

- Node is either red or black
- Root Node & Leaves (Nil) are black
- All paths from a node to it's nil descendants have the same number of black nodes.
- Red nod children are always black.
- The longest path is no more twice the length of the shortest path
  - Shortest path is black nodes.
  - Longest path alternating red and black.

What is Red-Black Tree?

- A Red-Black Tree is a type of self-balancing binary search tree, a data structure used in computer science to organize pieces of comparable data, such as numbers.

- Each node in a Red-Black Tree contains an extra bit for denoting the color of the node, either red or black. This color attribute is essential for balancing the tree during insertions and deletions.

- This balance ensures that the tree remains efficient for operations like insertion, deletion, and lookup, which all have time complexity of O(log n) in the worst case.

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Why Red Black Trees?

Red Black Trees are crucial because they provide a good balance between the complexity of operations and the performance guarantees.

They are used in various real-world applications, including:

- Implementing associative arrays.

- Building memory-efficient maps and sets in programming languages like C++, Java, and others.

- Maintaining a sorted stream of data.

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Properties of Red Black Trees

Every node in a Red Black Tree has a color, either red or black. The tree must satisfy these five essential properties:

1. Color Property: Every node is either red or black.
2. Root Property: The root of the tree is always black.
3. All leaves (NIL nodes) are black.
4. Red Property: If a red node has children, then both are black (no two red nodes appear in a sequence).
5. Depth Property: Every path from a node to its descendant NULL nodes has the same number of black nodes.

These properties ensure that the tree remains approximately balanced, with no path more than twice as long as any other, keeping operations efficient.

Less strict than AVL Tree with Less Rotations.

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Operations in Red Black Tree

Search

Insertion

Deletion

Require Rotations

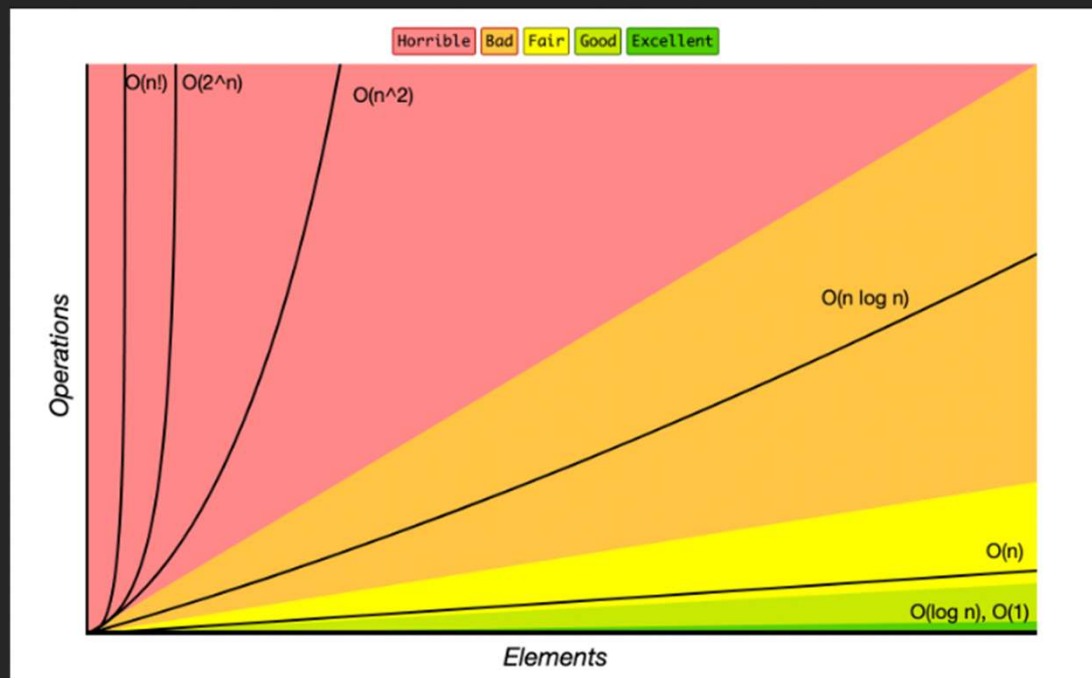Mohammed Abu-Hadhoud
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Red-Black Tree.

- All Operations Worst Case is O(Log n).

Which is better AVL Tree or RedBlack Tree?

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Thank You

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