

A collection of vintage items is arranged on a light-colored, textured surface. In the top left, a portion of a wooden chessboard with a checkered pattern and several chess pieces is visible. Below the chessboard, there are two medals: one with a red ribbon and a circular emblem, and another with a blue ribbon and a circular emblem. A pair of round, gold-rimmed glasses with thin temples is positioned diagonally across the center. In the bottom left corner, a small, round, silver-colored compass with a white face and black markings is visible. The background is a plain, light-colored surface with a subtle texture.

Comparison of Trees

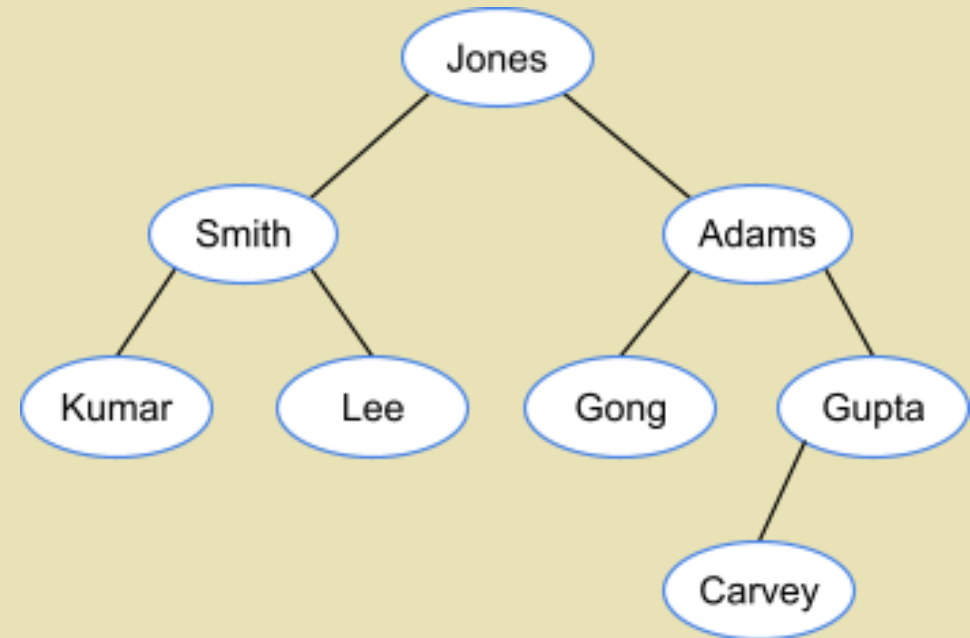
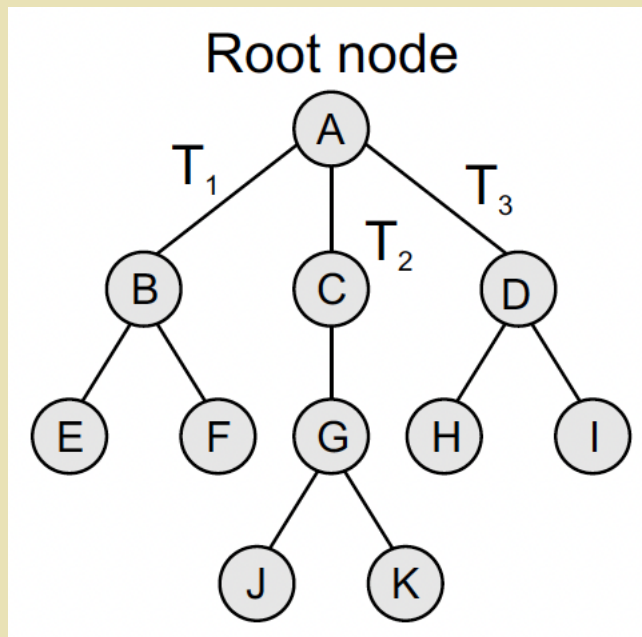
Notes by Yan Yan



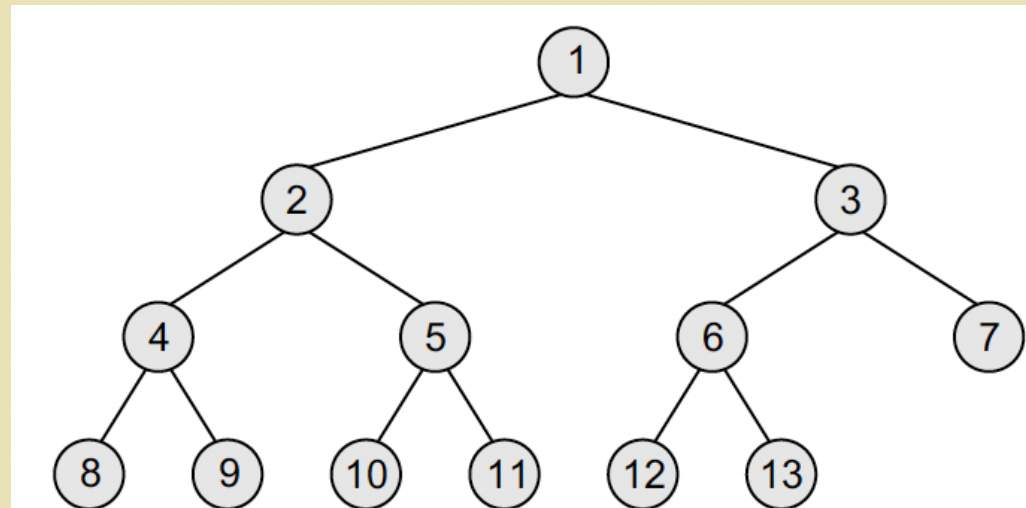
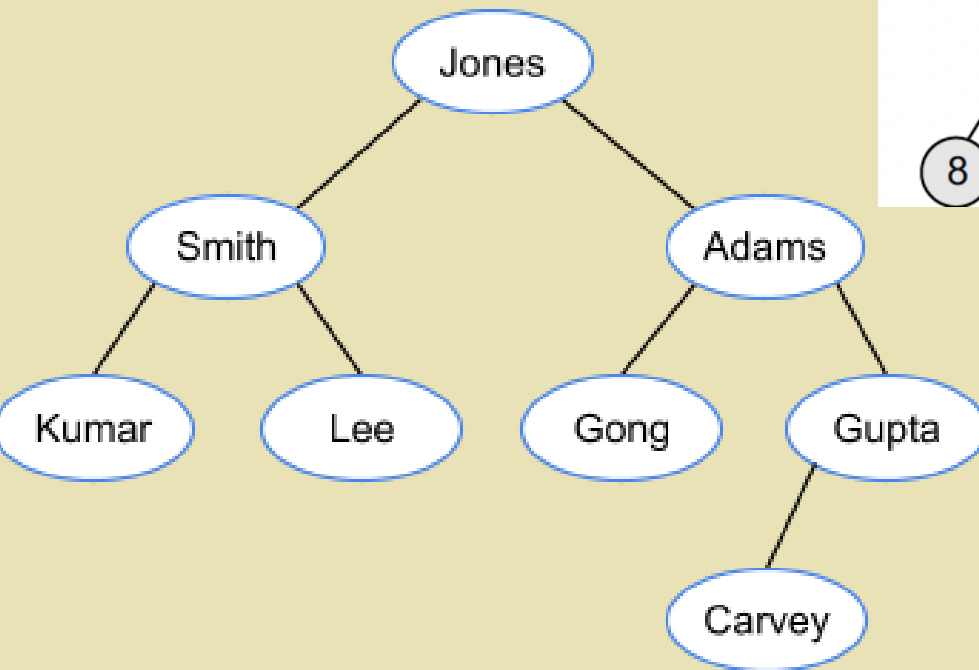
Learning Objectives

1. Describe the differences between different trees introduced
2. Remember the time complexities of common tree operations

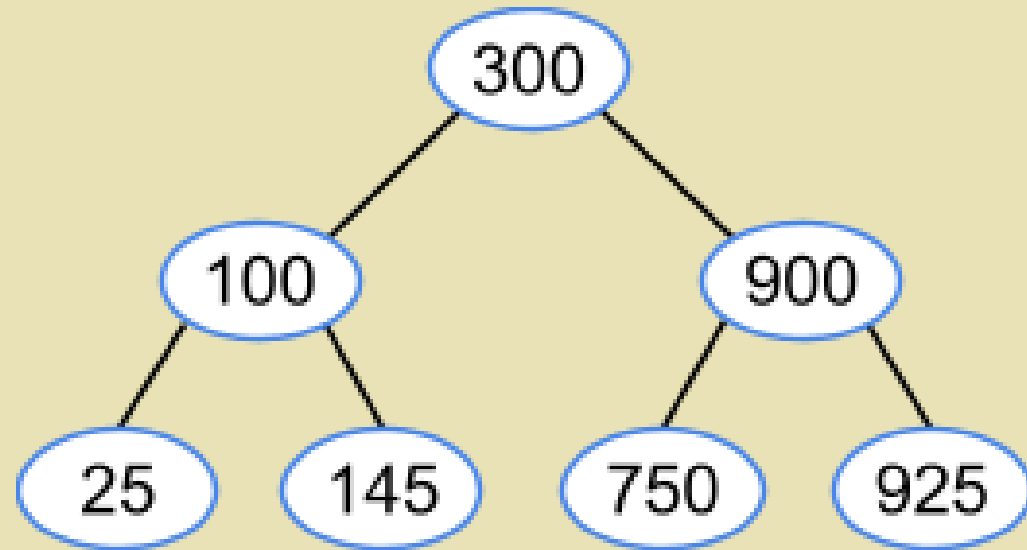
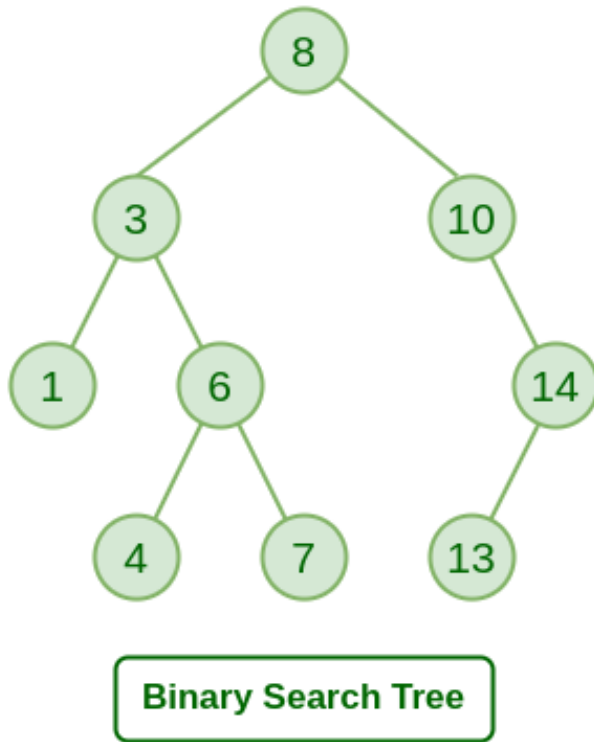
Tree v.s. Binary Tree



Binary Tree v.s. Complete Binary Tree

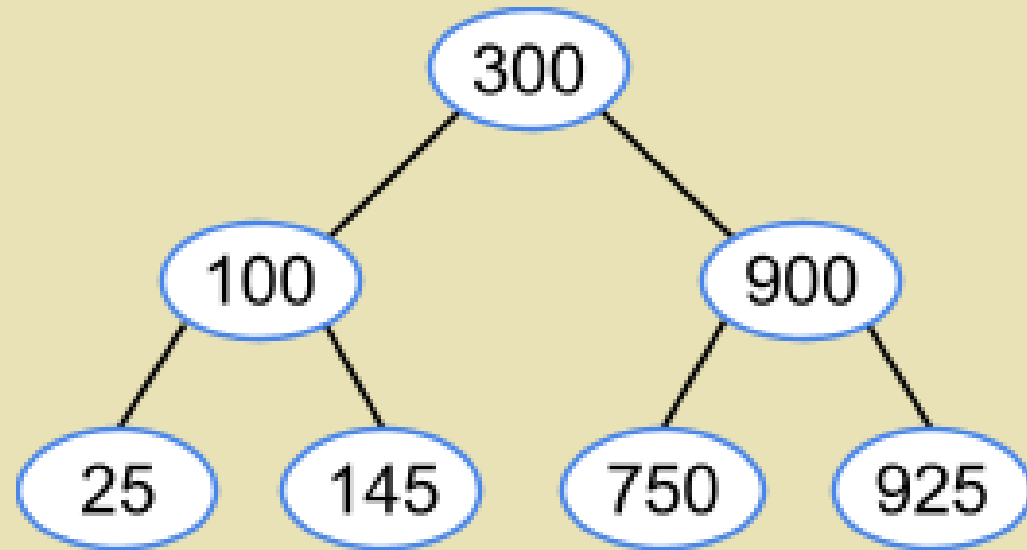
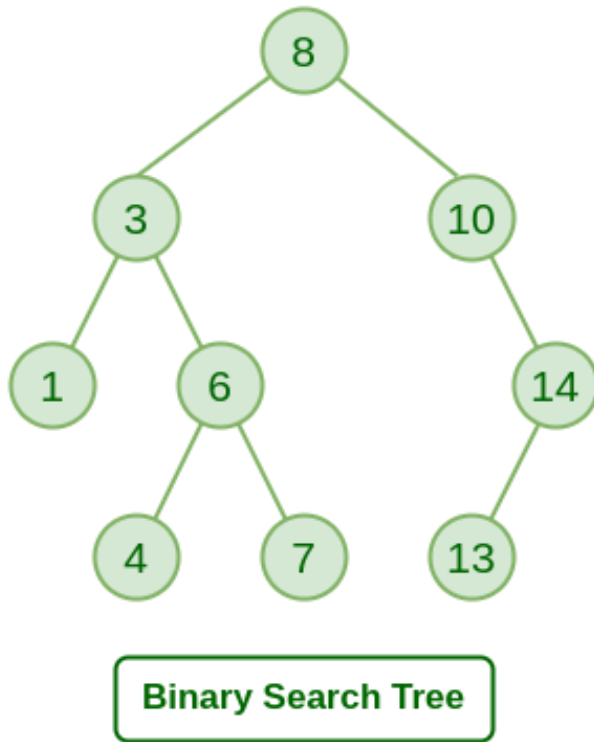


BST and Balanced BST



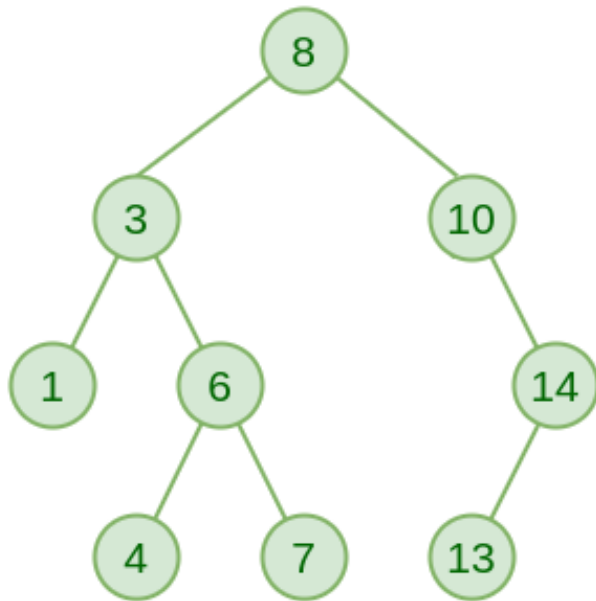
BST may not be a balanced tree

BST and AVL Tree

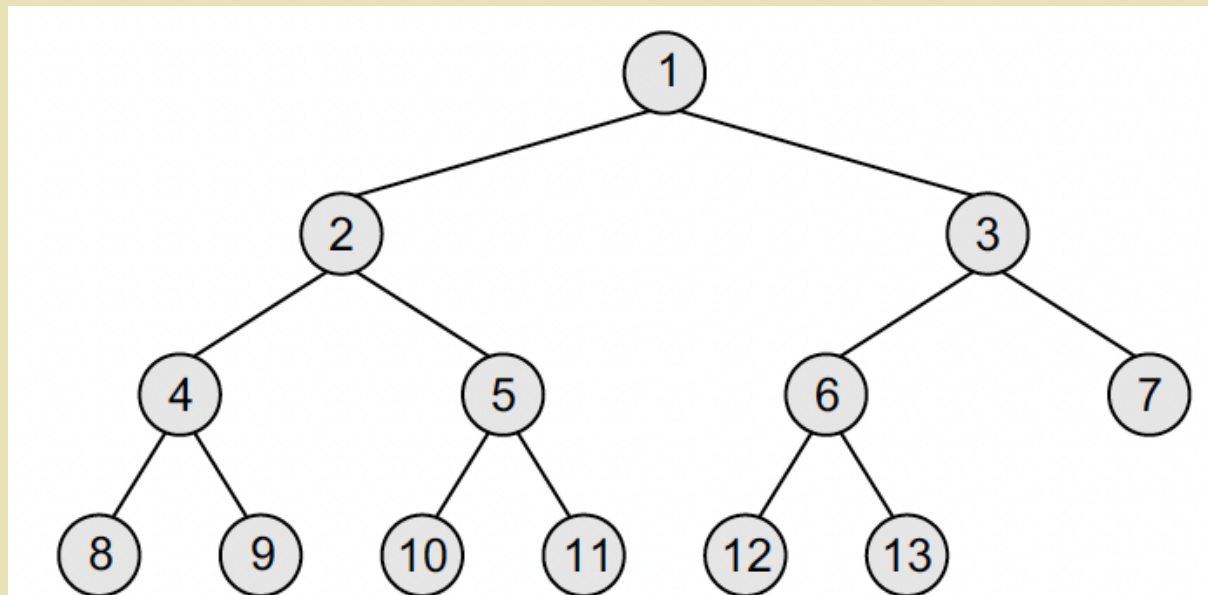


AVL Tree

BST v.s. Heap



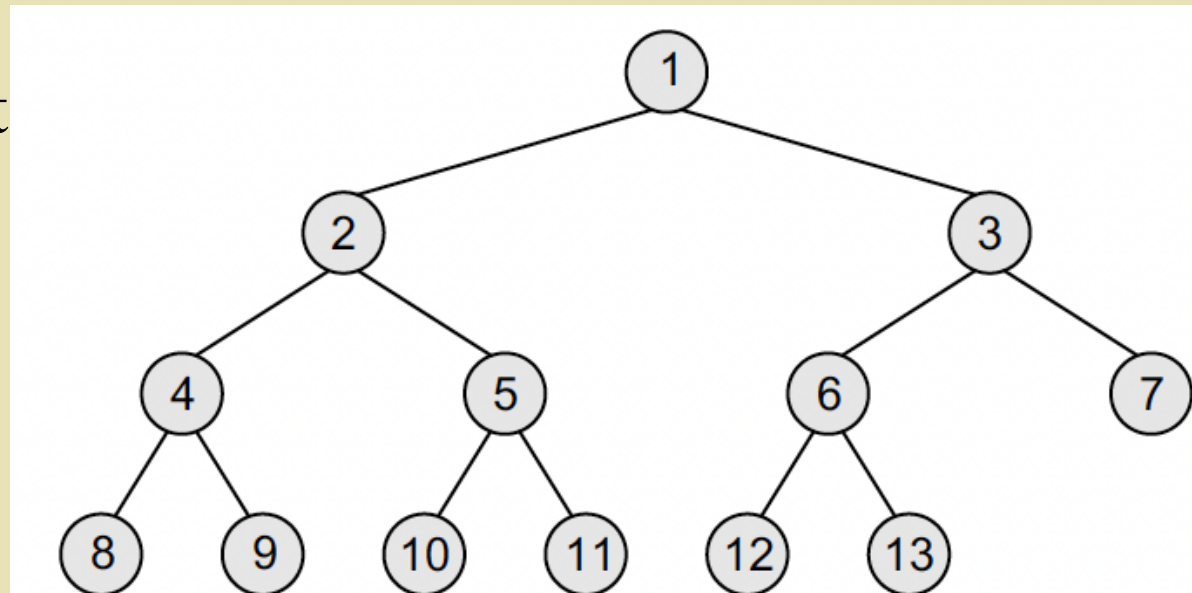
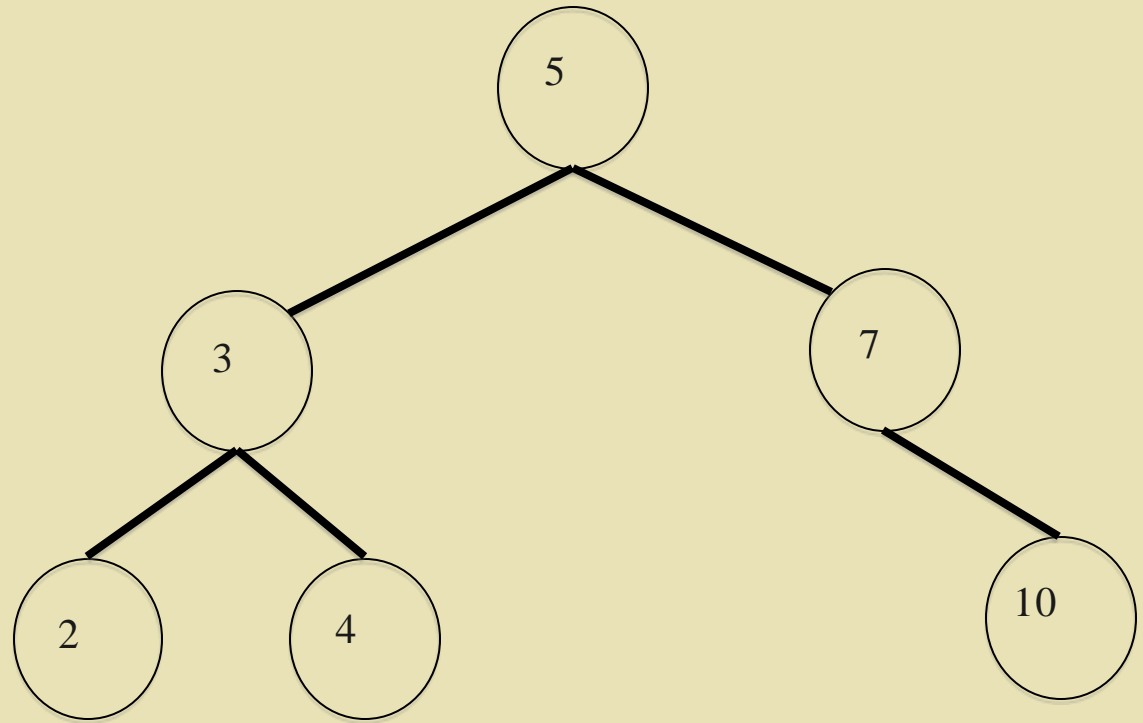
Binary Search Tree



BST may not be a complete tree

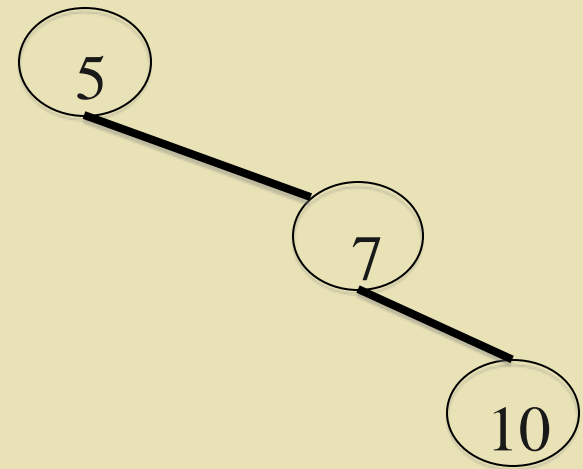
AVL Tree v.s. Heap

- ◆ Both balanced
- ◆ Heap is completed
- ◆ Max-heap: parent \geq children
- ◆ AVL tree: left child $<$ parent $<$ right child



Complexity

- ◆ BST: worst-case time complexity of insert/delete/search operations is $O(h)$, where h is the height of the Binary Search Tree.
 - In the worst case, we may have to travel from the root to the deepest leaf node. The height of a skewed tree may become n and the time complexity of insertion operation may become $O(n)$.





Complexity

- ◆ AVL tree: time complexity of insert/delete/search operations is $O(\log(n))$, where n is the number of nodes.
 - insertion only requires only one rebalance, deletion can require many but still no more than the tree's height
- ◆ Heap: time complexity of insert/delete/search operations is $O(\log(n))$, where n is the number of nodes.
 - $O(\text{number of swap}) = O(\text{height of tree})$

Heap

Tree

Usually, Heap is of two types, Max-Heap and Min-Heap.

A tree can be of various types for eg. binary Tree, BST(Binary Search tree), AVL tree, etc.

Heap is ordered.

Binary Tree is not ordered but BST is ordered.

Insert and remove will take $O(\log(N))$ time in the worst case.

Insert and remove will take $O(N)$ in the worst case in case the tree is skewed.

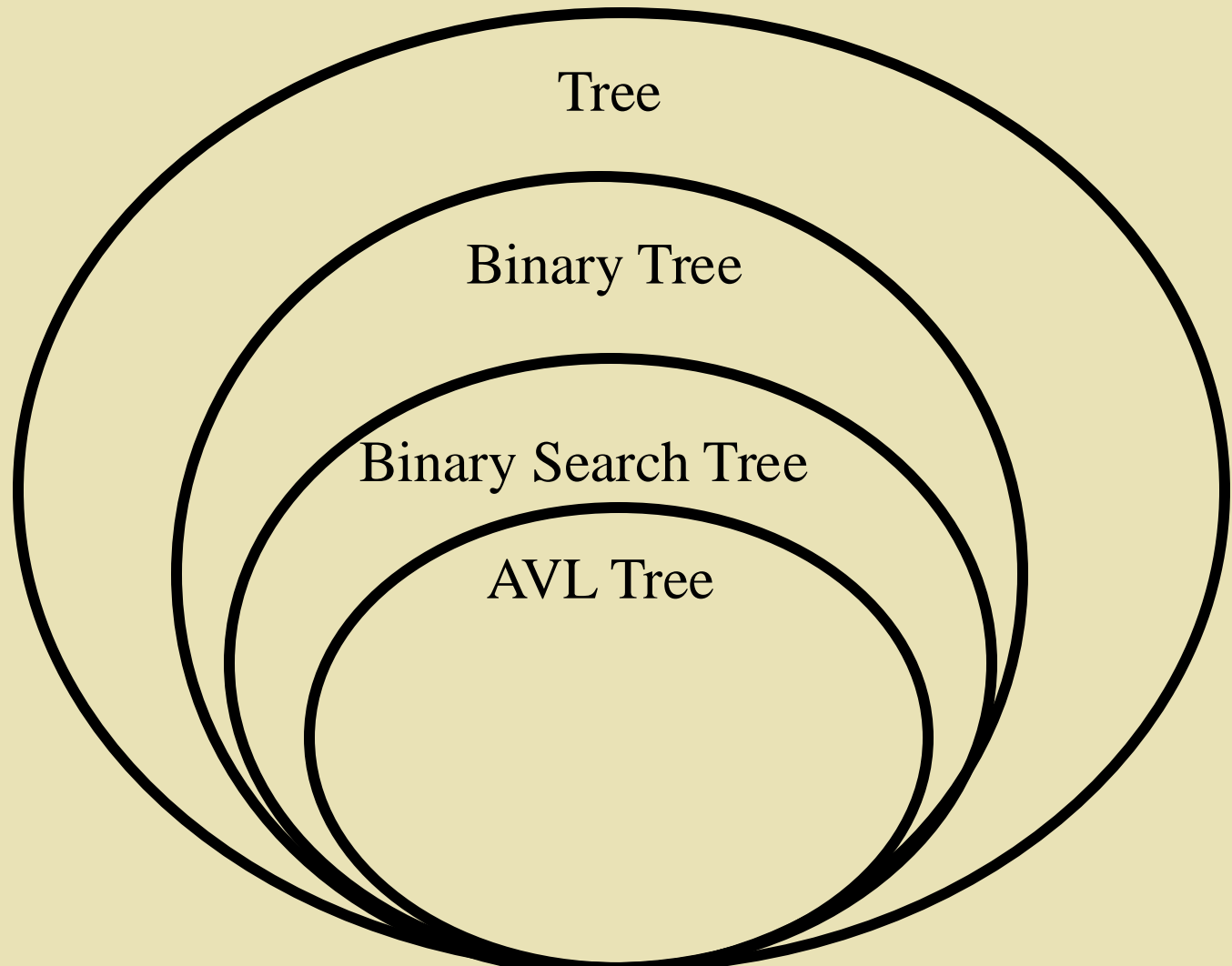
Finding Min/Max value in Heap is $O(1)$ in the respective Min/Max heap.

Finding Min/Max value in BST is $O(\log(N))$ and Binary Tree is $O(N)$.

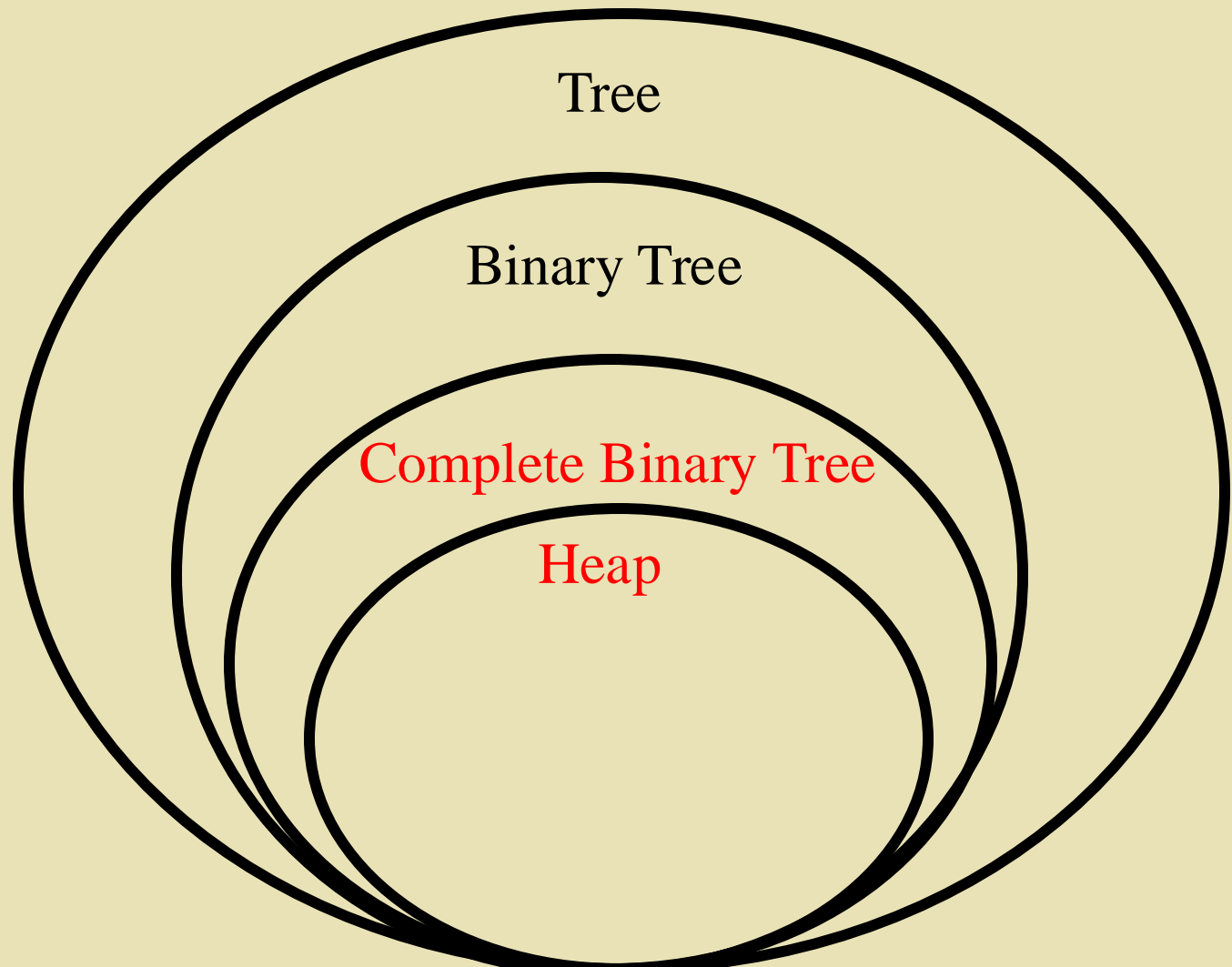
Heap can be built in linear time complexity.

BST: $O(N * \log(N))$ and Binary Tree: $O(N)$.

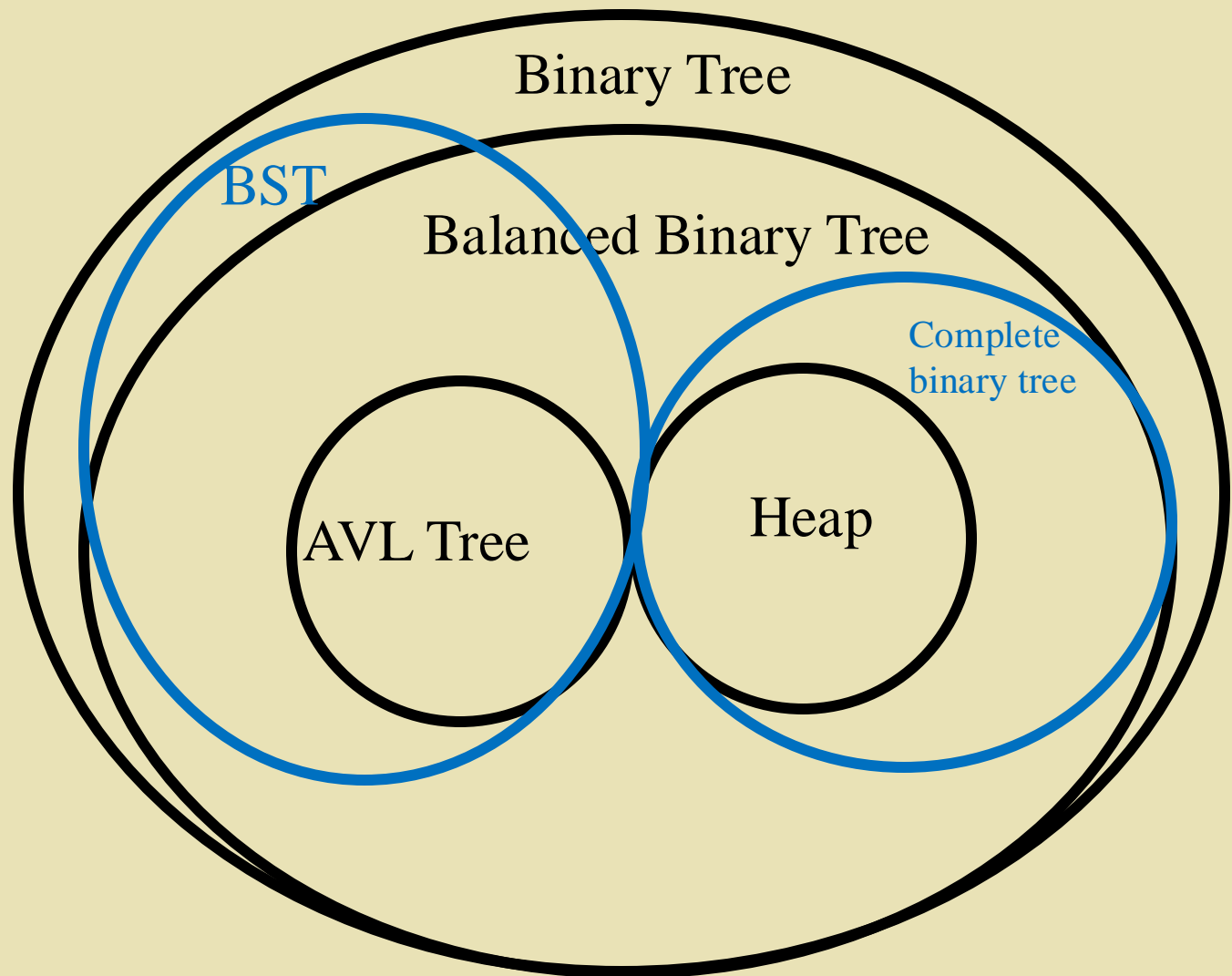
Comparisons



Comparisons



Comparisons





References and Useful Resources

- ◆ Binary search tree and heap differences
<https://www.geeksforgeeks.org/difference-between-binary-search-tree-and-binary-heap/>
- ◆ Compare Heap and Tree
<https://www.geeksforgeeks.org/comparison-between-heap-and-tree/>

That's
about this
lecture!

