Overview of Trees

A quick overview of trees, its types, and some important formulas to compute height and number of nodes in a tree.

We'll cover the following

Binary Trees

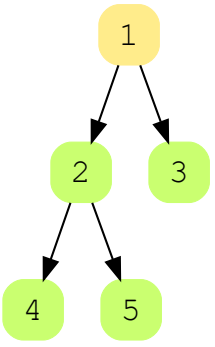
Definition: A tree where each vertex has two children at most.

Types: *Perfect, Full, Complete, Skewed*

Total number of nodes: $2^{(h+1)} - 1$

Total number of leaf nodes: $2^h or \frac{(n+1)}{2}$

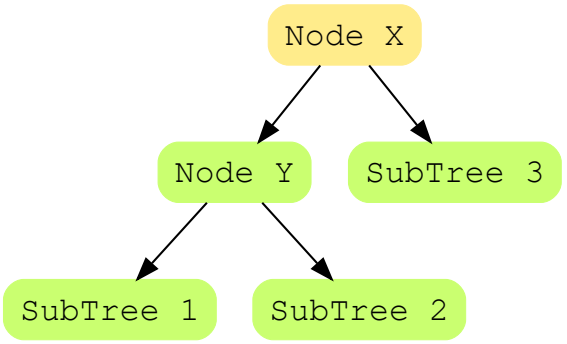
Height: $log_2(n+1) - 1$



Binary Search Trees

Definition: Every node has a value greater than/equal to all the node values in its left sub-tree and has a value less than all the node values in its right sub-tree. Mathematically,

$$Keys(SubTree1) < Keys(Y) < Keys(Subtree2) < Keys(X) < Keys(SubTree3)$$

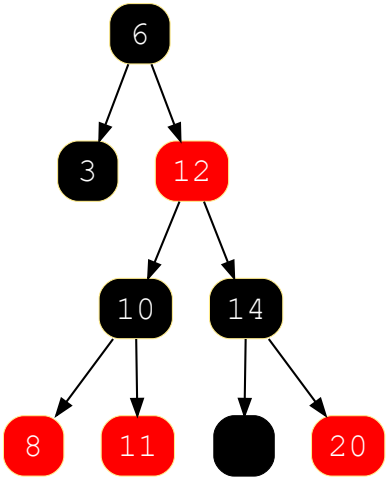


Red Black Trees

Definition: A tree where every node is colored as red or black and no two adjacent nodes have *red* color and root and null nodes are considered *black*

Height: $h <= 2log_2(n+1)$

Minimum number of nodes: $(h+1) + 2\left(\sum_{i=0}^{y})2^i - 1\right)$, where y is equal to: $floor(h/2)$



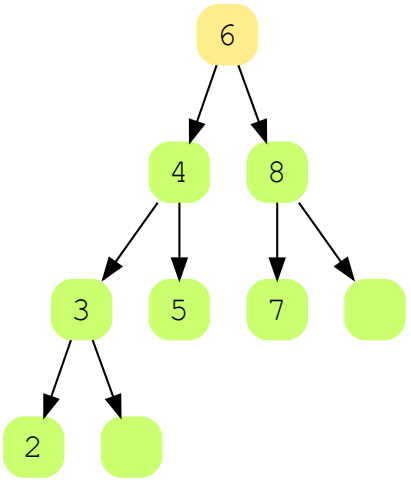
AVL Trees

Definition: For each node, height of left and right *subtree* differ by at max one

Minimum number of nodes: $N(h) = 1 + N(h-1) + N(h-2)$

Maximum number of nodes: $N - 1 + 2^{log(N-1)+2}$

Height: $O(log_2 n)$



2-3 Trees

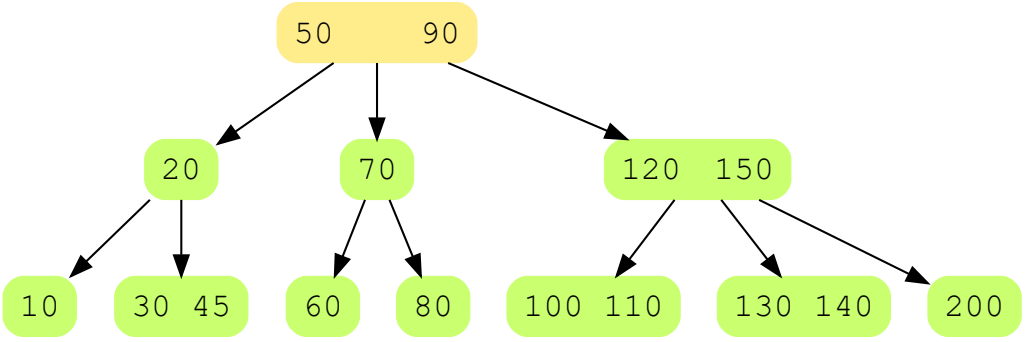
Definition: A balanced and ordered tree where each node can have two keys (X and Y) and three children at max such that:

$LChild.Key < X < MChild.Key < Y < RChild.Key $

Maximum number of nodes: $ 3^h$

Height: $log_4(n+1) - 1 < h < log_2(n+1) - 1$

Types: *2-3-4 Trees*



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2-3-4 Trees

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Challenge 1: Find minimum value in Bi...

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