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Assignment 2 (Binary Search Tree)

1. Explain the differences between linear and non-linear data structures!

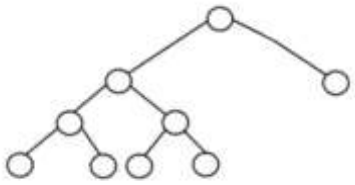
Linear Data Structures	Non-linear Data Structures
The data items are organized sequentially or linearly where each data elements are attached to its previous and next adjacent.	The data items are not organized sequentially, and they are attached in hierarchically manner.
Single level is involved.	Multiple levels are involved.
Its implementation is easier.	Its implementation is more complex.
Data elements can be traversed in a single run only.	Data elements can't be traversed in a single run only.
Memory is not utilized in an efficient way.	Memory is utilized in an efficient way.
Examples: array, linked list, stack, queue, etc.	Examples: trees and graphs

2. Describe the following terminology in a tree: base root, key, edge, siblings, parent, child, and leaf!

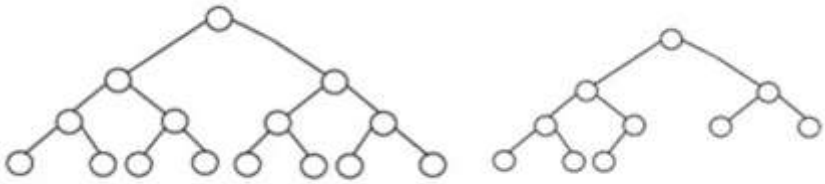
   - Node at the top is called as **base root**.
   - The main value of a node is called **key**.
   - A line connecting the parent to the child is **edge**.
   - Nodes that have the same parent are called **siblings**.
   - A node that has a child is called **parent**.
   - A node that has a parent is called **child**.
   - Nodes that do not have children are called **leaf**.

3. Explain the following types of binary trees: full, complete, and perfect!

   - Full binary tree is a binary tree that has either **zero children** or **two children**.



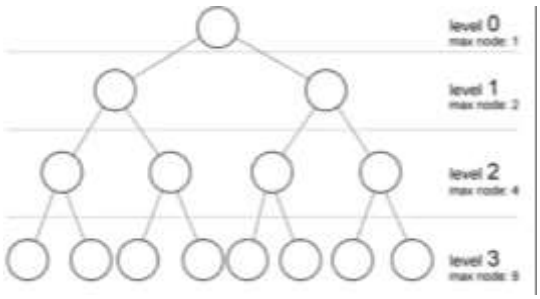
- Complete binary tree is a binary tree where all the tree levels are **filled entirely with nodes**, except the lowest level of the tree.



- Perfect binary tree is a binary tree where all internal nodes have **strictly two children** and every **leaf node** are at **the same level** within a tree.

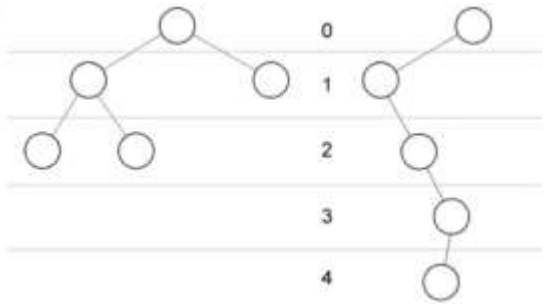
4. What makes a tree balanced?
   - A tree is called balance if the height of the left and the right subtree vary by at most one.

5. Explain the four properties of a binary tree!
   - Maximum number of nodes on level **k** is 2^k.
   - Maximum number of nodes on a binary tree is 2^{h+1}-1.



   - Minimum height of a binary tree of *n* nodes is $^2\log(n)$.

- Maximum height of a binary tree of *n* nodes is n-1.



6. Explain the intuition of implementing a binary tree using an array!
   - If the implementation of the Binary tree uses an array, the size is static, but we no longer need to use the left and right pointers, we can use indexing instead. For the index itself, there are several formulas that can be used to call the index :
   - Root will always be at index 0.
   - Left child index = 2p + 1 , with p as the parent index.
   - Right child index = 2p + 2 , with p as the parent index.
   - Parent index = (p-1) / 2 , with p as the child index.

7. Explain the differences between inorder successor and inorder predecessor!
   - Inorder successor is the maximum value in the left subtree.
   - Inorder predecessor is the minimum value in the right subtree.

8. Draw the following binary search tree step by step (14 pictures):