

■ Tree Terminology & Properties

1. Tree Terminology

Tree: A non-linear hierarchical data structure made up of nodes. It consists of a root node and subtrees connected by edges.

Node: A fundamental unit of a tree containing data and references to child nodes.

Root: The topmost node of a tree. A tree has only one root.

Parent Node: A node that has one or more child nodes.

Child Node: A node directly connected to another node (its parent).

Leaf Node (External Node): A node with no children.

Internal Node (Non-leaf): A node that has at least one child.

Edge: The connection (link) between a parent and a child.

Siblings: Nodes that share the same parent.

Path: A sequence of nodes connected by edges, from the root to a particular node.

Height of a Node: The length of the longest path from that node to a leaf.

Depth of a Node: The number of edges from the root to that node.

Height of a Tree: The height of the root node (longest path from root to any leaf).

Level of a Node: The depth of the node + 1. Root node is at level 1.

Degree of a Node: The number of children a node has.

Degree of a Tree: The maximum degree among all nodes in the tree.

Subtree: Any node along with its descendants forms a subtree.

2. Properties of Trees

Number of Edges: A tree with n nodes always has $(n - 1)$ edges.

Minimum & Maximum Nodes: Minimum nodes in a tree of height $h = h + 1$ (skewed tree). Maximum nodes = $2^{(h+1)} - 1$ (perfect binary tree).

Height & Nodes Relationship: For a binary tree with n nodes: Minimum height = $\lceil \log_2 n \rceil$, Maximum height = $n - 1$.

Maximum Nodes at Level l : At level l , maximum nodes = $2^{(l-1)}$ (for binary tree).

Balanced vs Skewed Trees: Balanced Tree \rightarrow Subtrees have nearly equal height. Skewed Tree \rightarrow All nodes extend to one side.

Binary Tree Properties: Each node has at most two children. Maximum nodes at height $h = 2^{(h+1)} - 1$.