Tree is a non-linear data structure which organizes data in a hierarchical structure and this is a recursive definition.

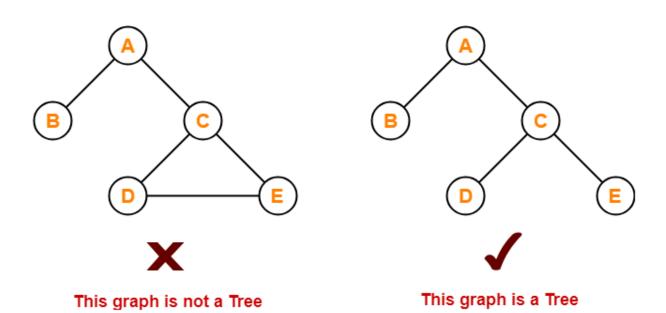
OR

A tree is a connected graph without any circuits.

OR

If in a graph, there is one and only one path between every pair of vertices, then graph is called as a tree.

Example-



Properties-

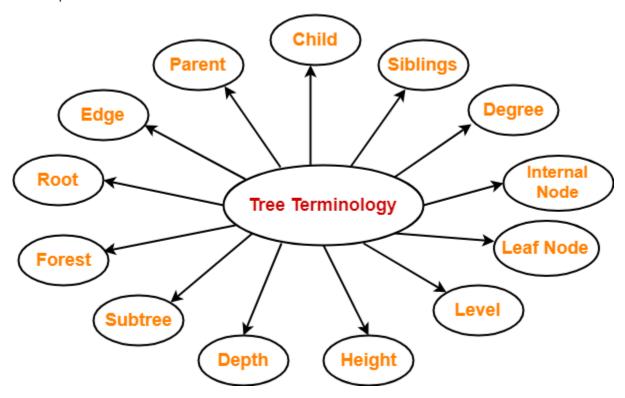
The important properties of tree data structure are-

- There is one and only one path between every pair of vertices in a tree.
- A tree with n vertices has exactly (n-1) edges.
- A graph is a tree if and only if it is minimally connected.
- Any connected graph with n vertices and (n-1) edges is a tree.

To gain better understanding about Tree Data Structure,

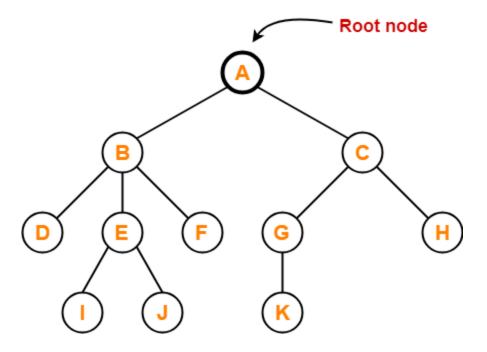
Tree Terminology-

The important terms related to tree data structure are-



1. Root-

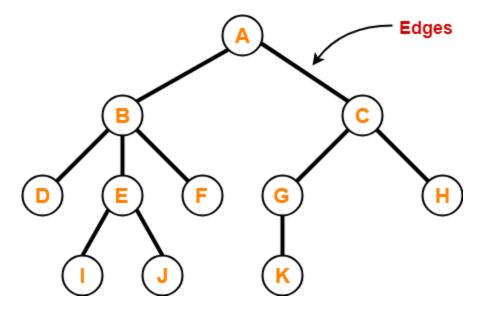
- The first node from where the tree originates is called as a **root node**.
- In any tree, there must be only one root node.
- We can never have multiple root nodes in a tree data structure.



Here, node A is the only root node.

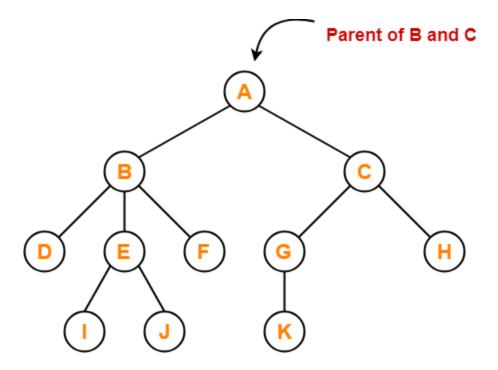
2. Edge-

- The connecting link between any two nodes is called as an edge.
- In a tree with n number of nodes, there are exactly (n-1) number of edges.



3. Parent-

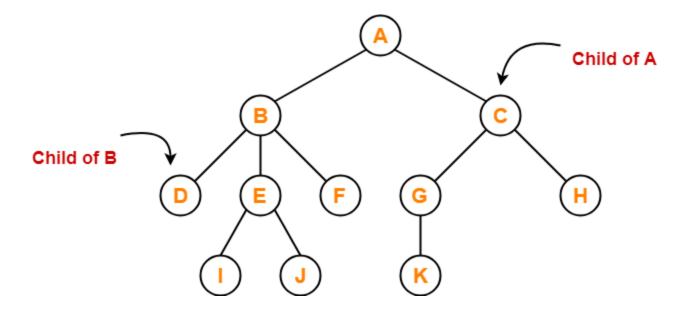
- The node which has a branch from it to any other node is called as a parent node.
- In other words, the node which has one or more children is called as a parent node.
- In a tree, a parent node can have any number of child nodes.



- Node A is the parent of nodes B and C
- Node B is the parent of nodes D, E and F
- Node C is the parent of nodes G and H
- Node E is the parent of nodes I and J
- Node G is the parent of node K

4. Child-

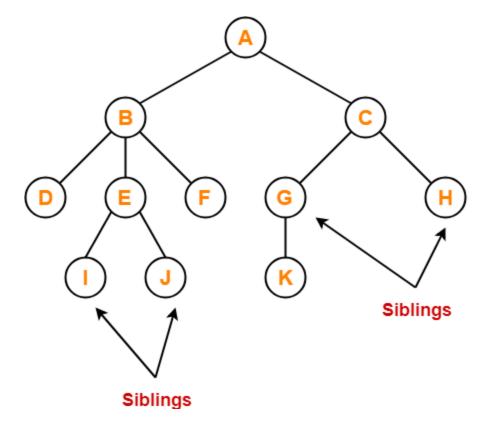
- The node which is a descendant of some node is called as a **child node**.
- All the nodes except root node are child nodes.



- Nodes B and C are the children of node A
- Nodes D, E and F are the children of node B
- Nodes G and H are the children of node C
- Nodes I and J are the children of node E
- Node K is the child of node G

5. Siblings-

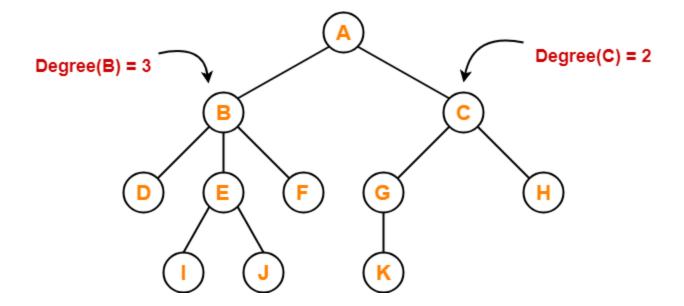
- Nodes which belong to the same parent are called as siblings.
- In other words, nodes with the same parent are sibling nodes.



- Nodes B and C are siblings
- Nodes D, E and F are siblings
- Nodes G and H are siblings
- Nodes I and J are siblings

6. Degree-

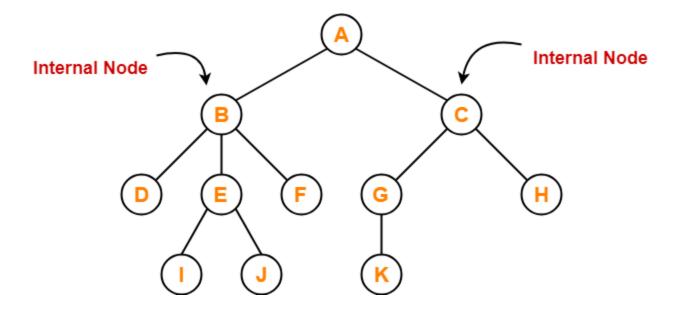
- **Degree of a node** is the total number of children of that node.
- Degree of a tree is the highest degree of a node among all the nodes in the tree.



- Degree of node A = 2
- Degree of node B = 3
- Degree of node C = 2
- Degree of node D = 0
- Degree of node E = 2
- Degree of node F = 0
- Degree of node G = 1
- Degree of node H = 0
- Degree of node I = 0
- Degree of node J = 0
- Degree of node K = 0

7. Internal Node-

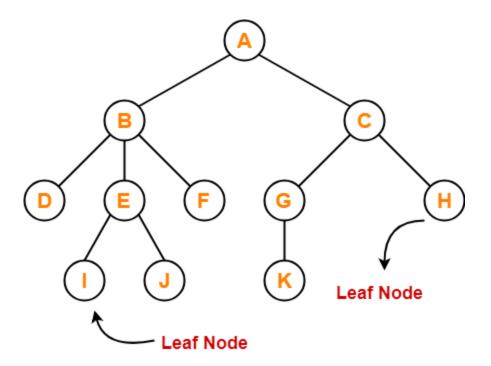
- The node which has at least one child is called as an **internal node**.
- Internal nodes are also called as non-terminal nodes.
- Every non-leaf node is an internal node.



Here, nodes A, B, C, E and G are internal nodes.

8. Leaf Node-

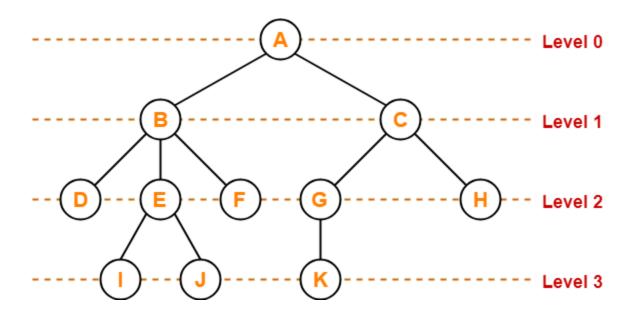
- The node which does not have any child is called as a **leaf node**.
- Leaf nodes are also called as **external nodes** or **terminal nodes**.



Here, nodes D, I, J, F, K and H are leaf nodes.

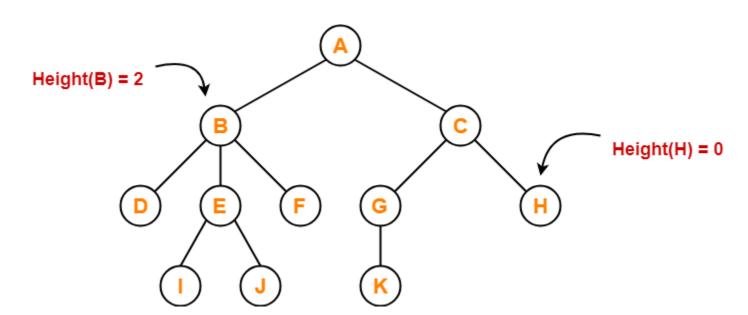
9. Level-

- In a tree, each step from top to bottom is called as level of a tree.
- The level count starts with 0 and increments by 1 at each level or step.



10. Height-

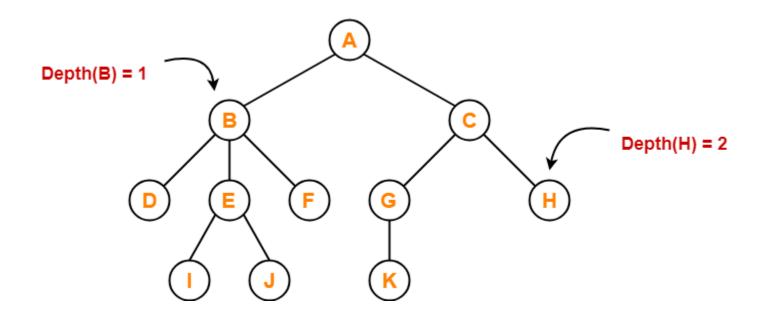
- Total number of edges that lies on the longest path from any leaf node to a particular node is called as height of that node.
- **Height of a tree** is the height of root node.
- Height of all leaf nodes = 0



- Height of node A = 3
- Height of node B = 2
- Height of node C = 2
- Height of node D = 0
- Height of node E = 1
- Height of node F = 0
- Height of node G = 1
- Height of node H = 0
- Height of node I = 0
- Height of node J = 0
- Height of node K = 0

11. Depth-

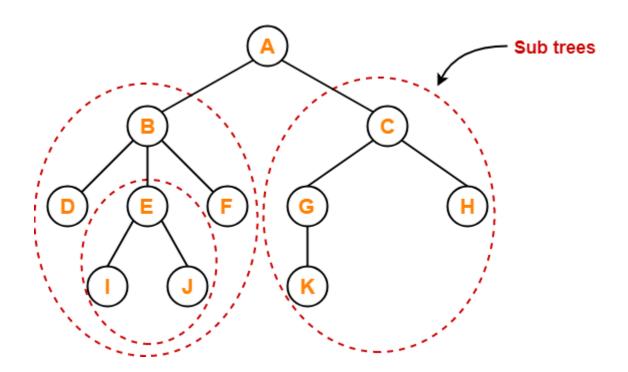
- Total number of edges from root node to a particular node is called as **depth of that node**.
- **Depth of a tree** is the total number of edges from root node to a leaf node in the longest path.
- Depth of the root node = 0
- The terms "level" and "depth" are used interchangeably.



- Depth of node A = 0
- Depth of node B = 1
- Depth of node C = 1
- Depth of node D = 2
- Depth of node E = 2
- Depth of node F = 2
- Depth of node G = 2
- Depth of node H = 2
- Depth of node I = 3
- Depth of node J = 3
- Depth of node K = 3

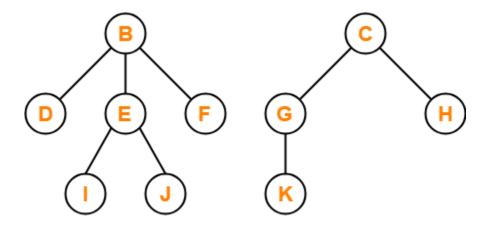
12. Subtree-

- In a tree, each child from a node forms a **subtree** recursively.
- Every child node forms a subtree on its parent node.



13. Forest-

A forest is a set of disjoint trees.



Forest