# The Tree ADT

# Objectives

- Define trees as data structures
- Define the terms associated with trees
- Discuss tree traversal algorithms
- Discuss a binary tree implementation
- Examine a binary tree example

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# Trees

- A ***tree*** is a ***nonlinear*** abstract data type that stores elements in a hierarchy.
- ***Examples*** in real life:
  - Family tree
  - Table of contents of a book
  - Class inheritance hierarchy in Java
  - Computer file system (folders and subfolders)
  - Decision trees

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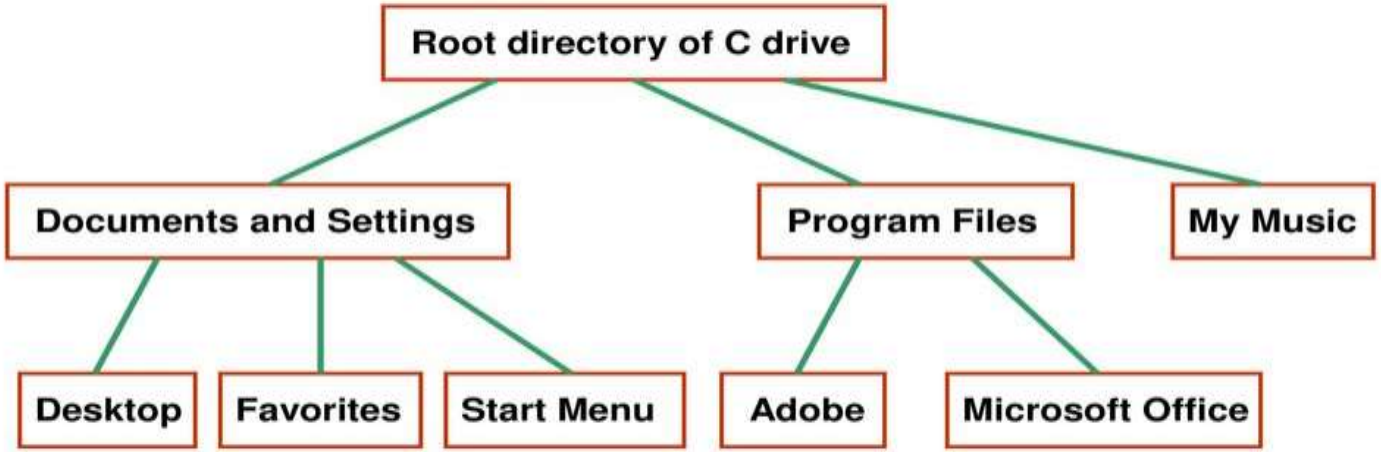
# *Example*: Computer File System

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# Tree Definition

- ***Tree**:* a set of elements that either
  - it is empty
  - or, it has a distinguished element called the ***root*** and zero or more ***trees*** *(called* ***subtrees*** *of the root)*
- What kind of definition is this?
  - What is the base case?
  - What is the recursive part?

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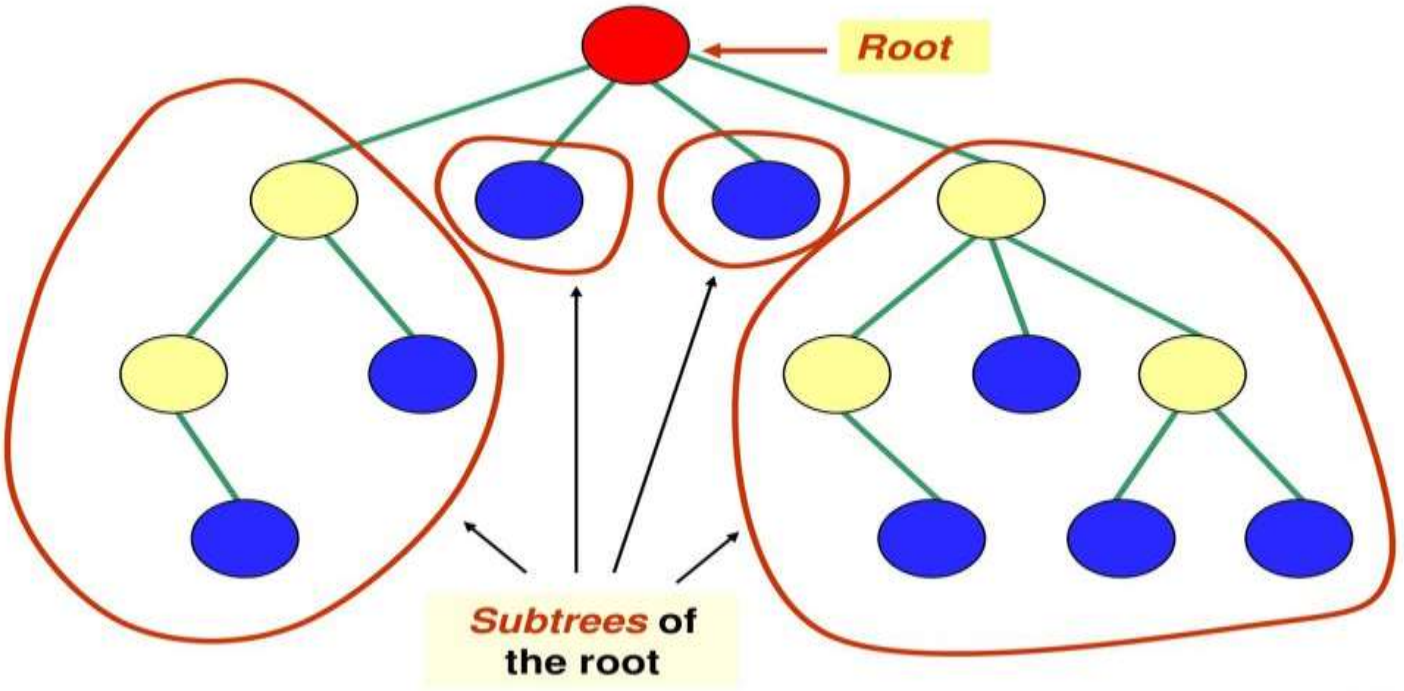
# Tree Definition

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# Tree Terminology

- ***Nodes***: the elements in the tree
- ***Edges***: connections between nodes
- ***Root***: ***the*** distinguished element that is the origin of the tree
  - There is only one root node in a tree
- ***Empty tree*** has no nodes and no edges

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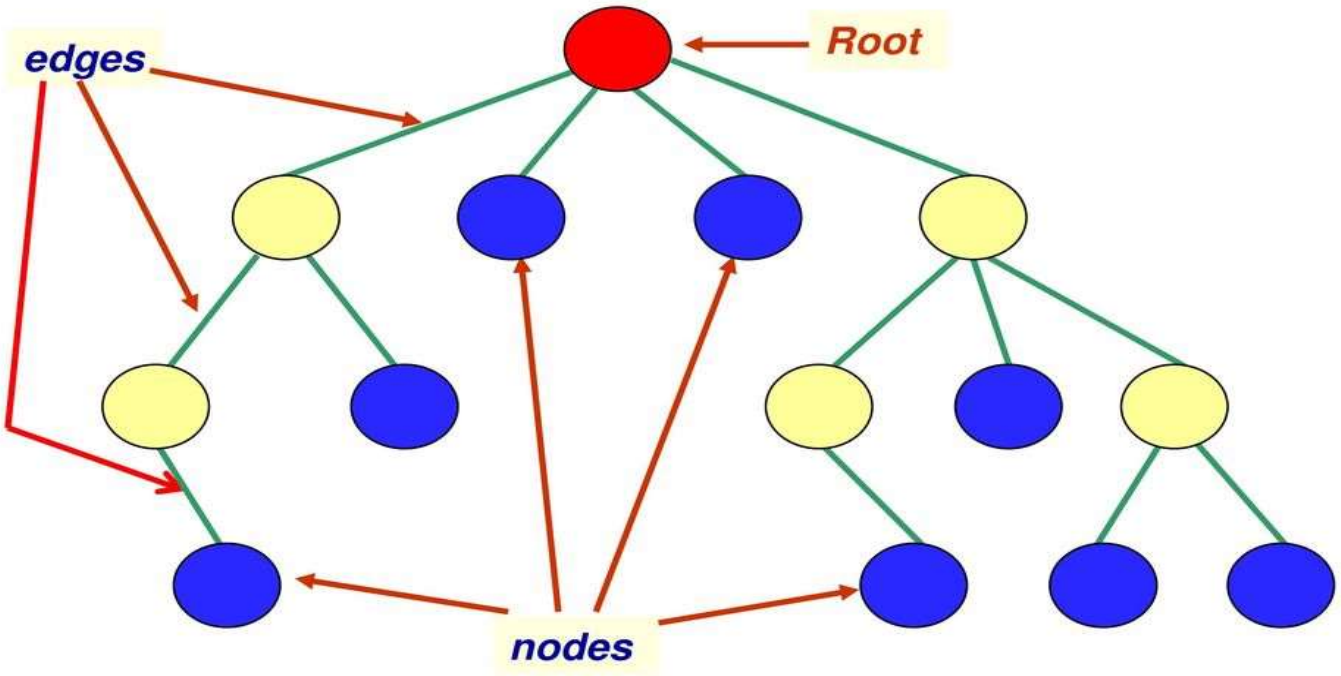
# Tree Terminology

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# Level of a Node

- ***Level of a node:*** number of ***edges*** between root and the node
- It can be defined ***recursively***:
  - Level of root node is ***0***
  - Level of a node that is not the root node is ***level of its parent + 1***
- ***Question****: What is the level of a node in terms of path length?*
- ***Question****: What is the height of a tree in terms of levels?*

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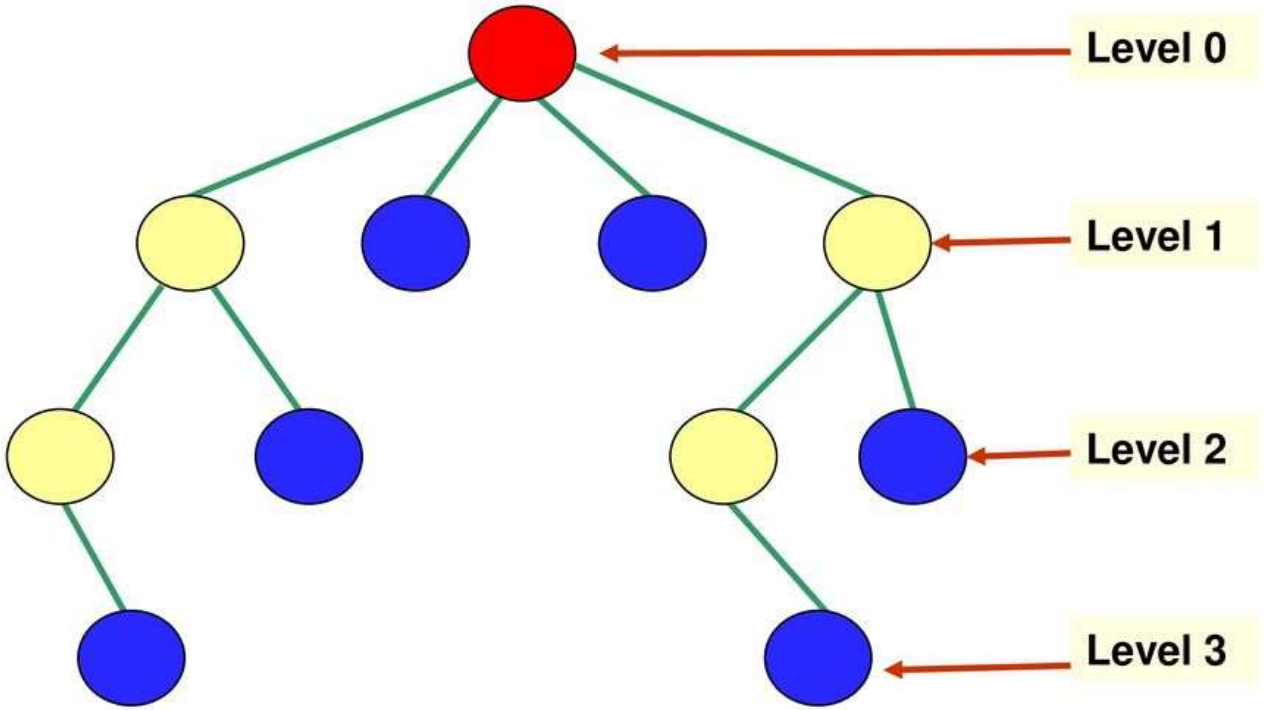
# Level of a Node

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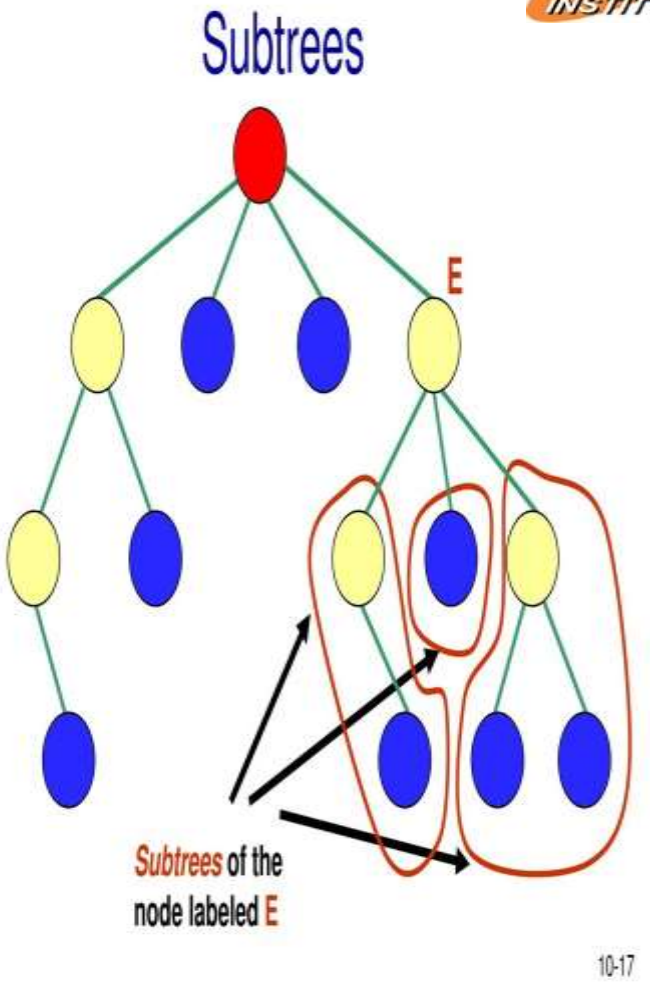
# Subtrees

- ***Subtree*** of a node: consists of a child node and all its descendants
  - A subtree is itself a tree
  - A node may have many subtrees



# Binary Trees

- ***General tree***: a tree each of whose nodes may have any number of children
- ***n-ary tree***: a tree each of whose nodes may have no more than ***n*** children
- ***Binary tree***: a tree each of whose nodes may have no more than ***2*** children
  - ***i.e.*** a binary tree is a tree with ***degree (arity) 2***
  - The children (if present) are called the ***left child*** and ***right child***

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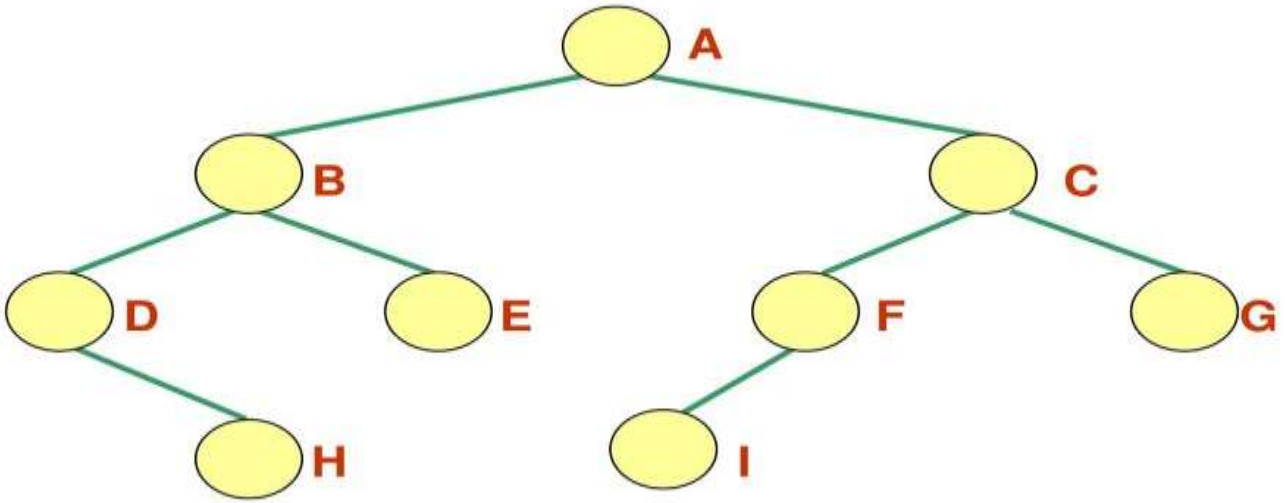
# Binary Tree

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