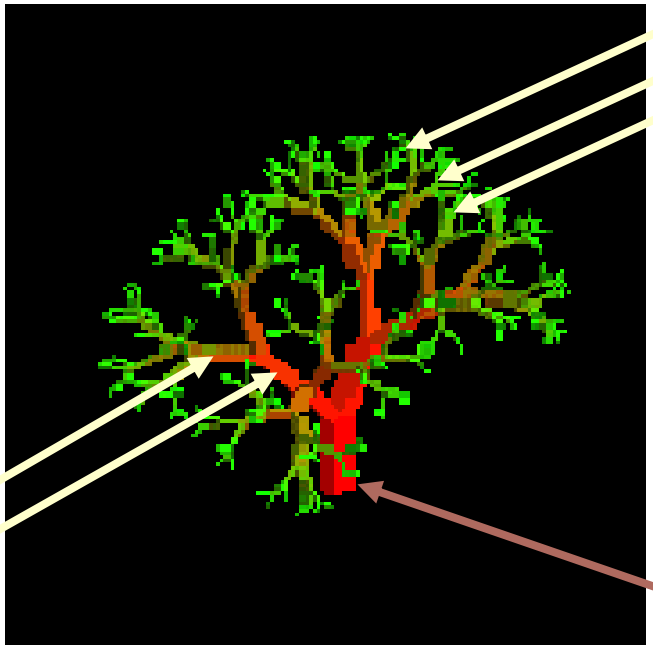
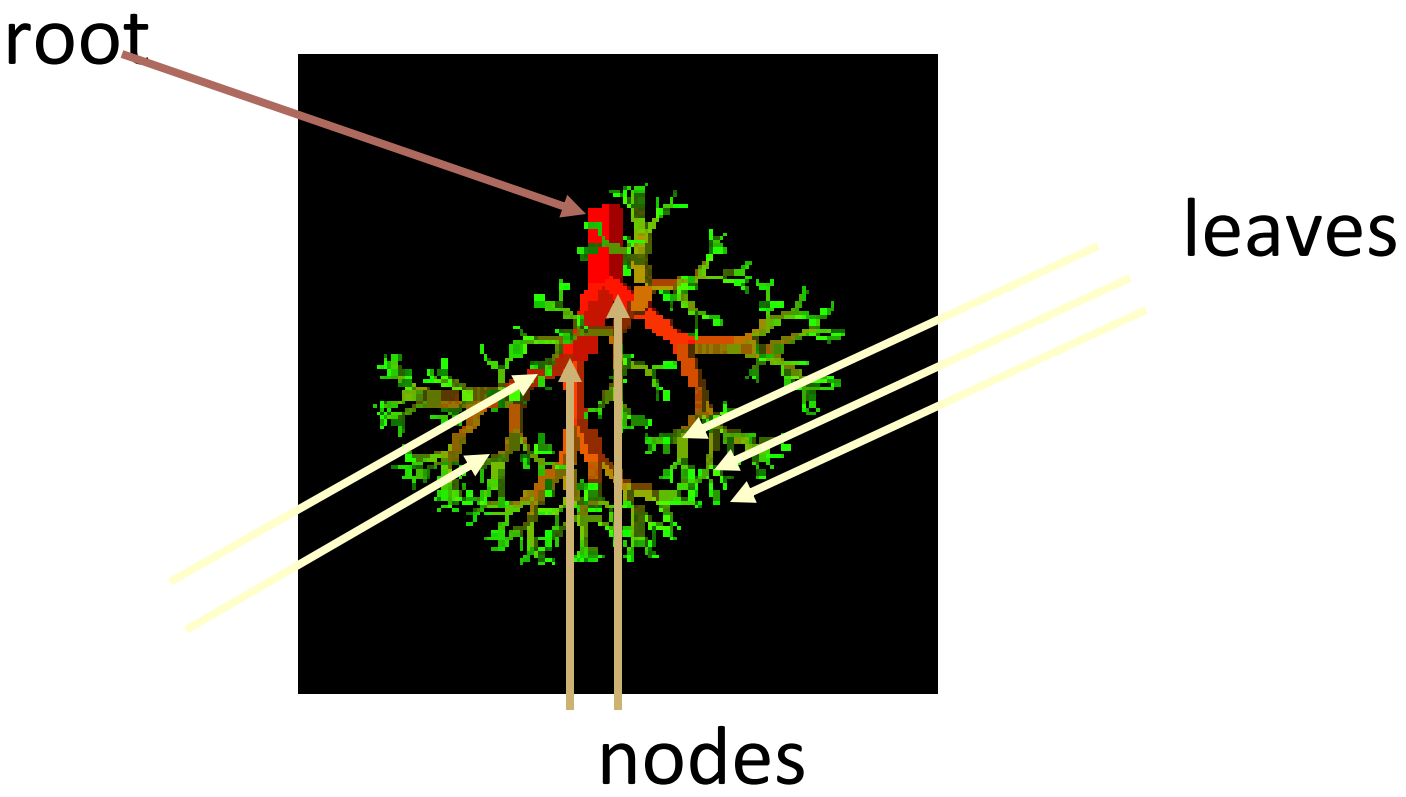
Trees and Binary Trees

Nature View of a Tree

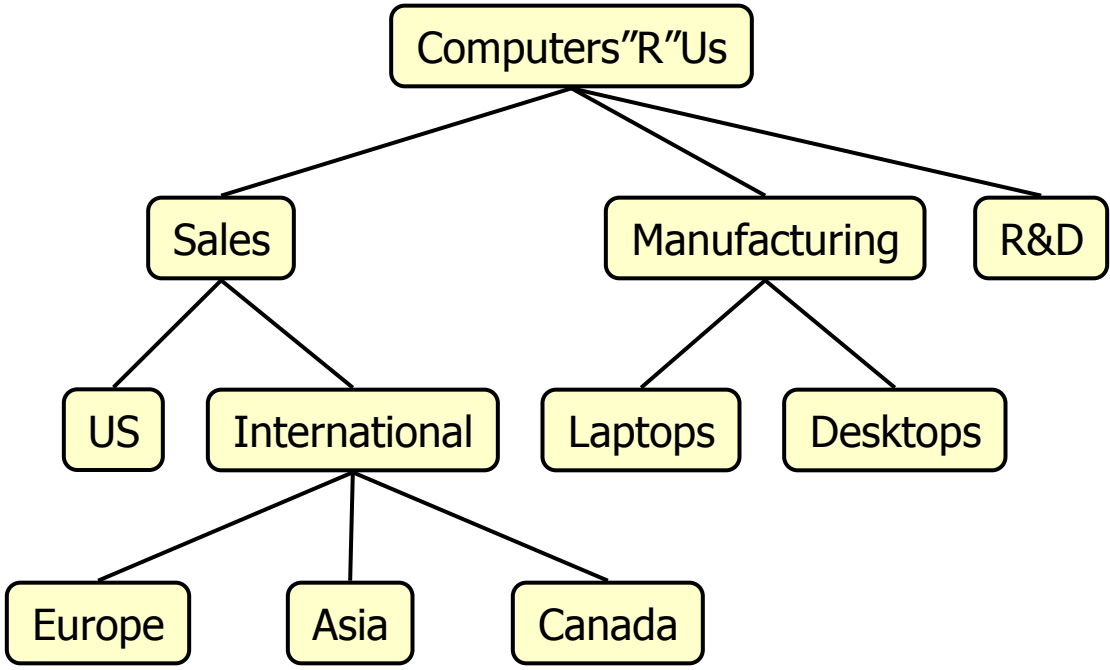


Computer Scientist's View



Tree Definition

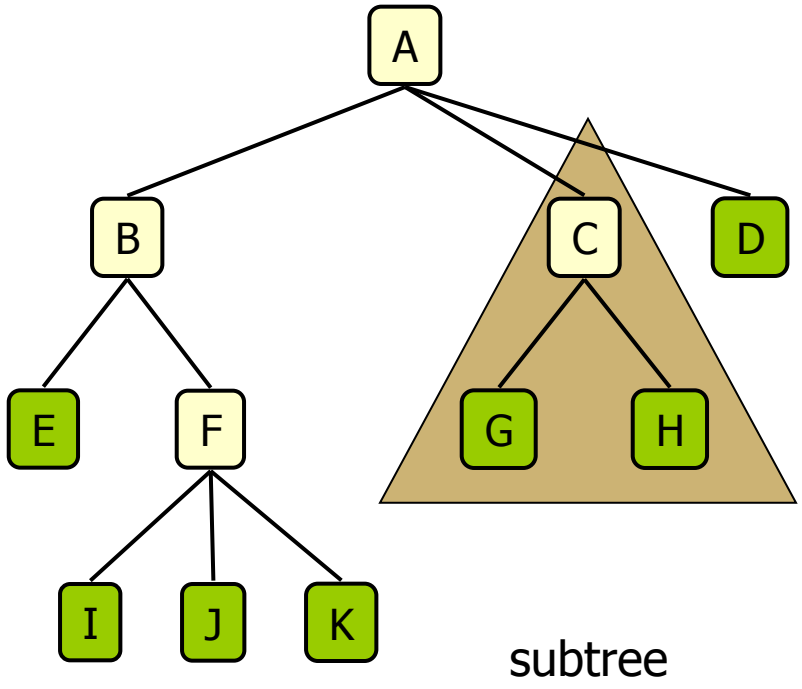
- A tree is a finite nonempty set of elements or nods.
- Nodes are connected by edges.
- Each node contains a value or data, and it may or may not have a child node .
- It is an abstract model of a hierarchical structure (non- linear).
- consists of nodes with a parent-child relation.



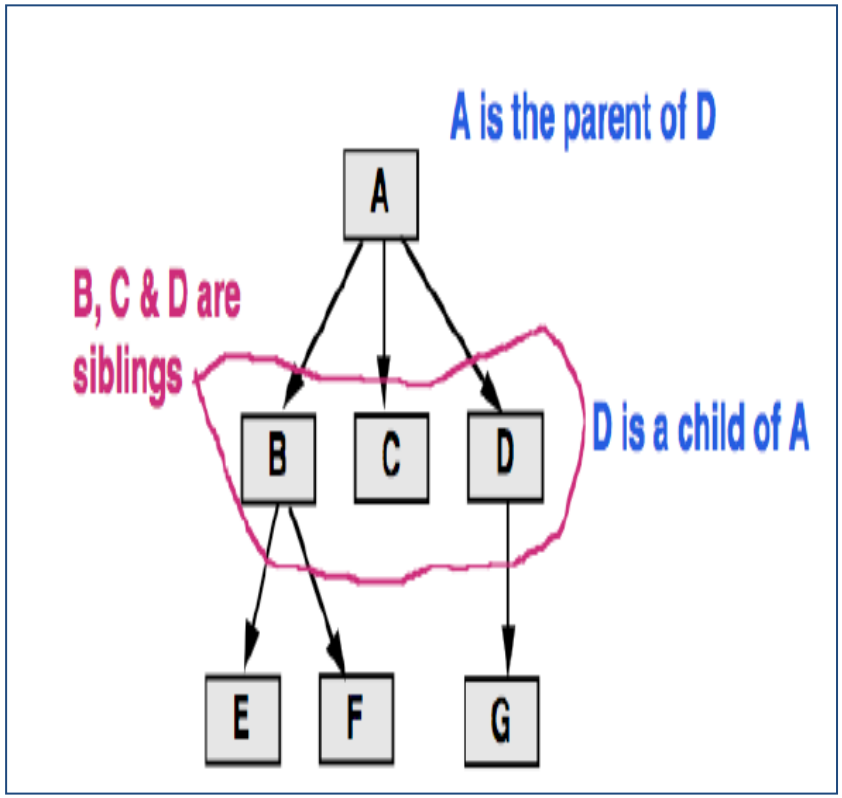
- Applications:
  - Organization charts
  - File systems
  - Programming environments

Tree Terminology

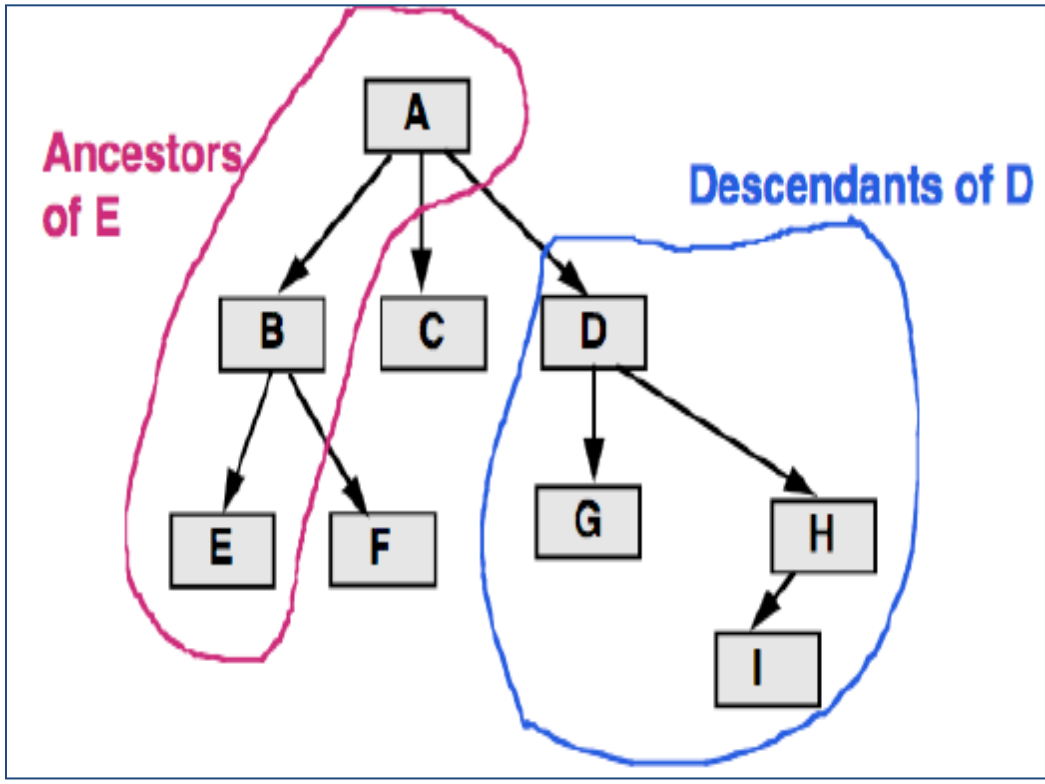
- **Parents:**
  - The root has no parent.
  - Every other node has exactly one parent.
- **Root**: node without parent (A), the higher node a of the tree is the root .
- **Siblings**: nodes share the same parent
- **Internal node**: node with at least one child (A, B, C, F)
- **leaf :** node without children (E, I, J, K, G, H, D).
- Branch: The link between a parent and its child.
- **Ancestors** of a node: parent, grandparent, grand-grandparent, etc.
  - The root of the tree is the ancestor of all nodes in the tree.
- **Descendant** of a node: child, grandchild, grand-grandchild, etc.
- **Depth** of a node: number of ancestors
- **Height** of a tree: maximum depth of any node
- **Degree** of a node: the number of its children
- **Degree** of a tree: the maximum number of its node.
- **Subtree**: tree consisting of a node and its descendants



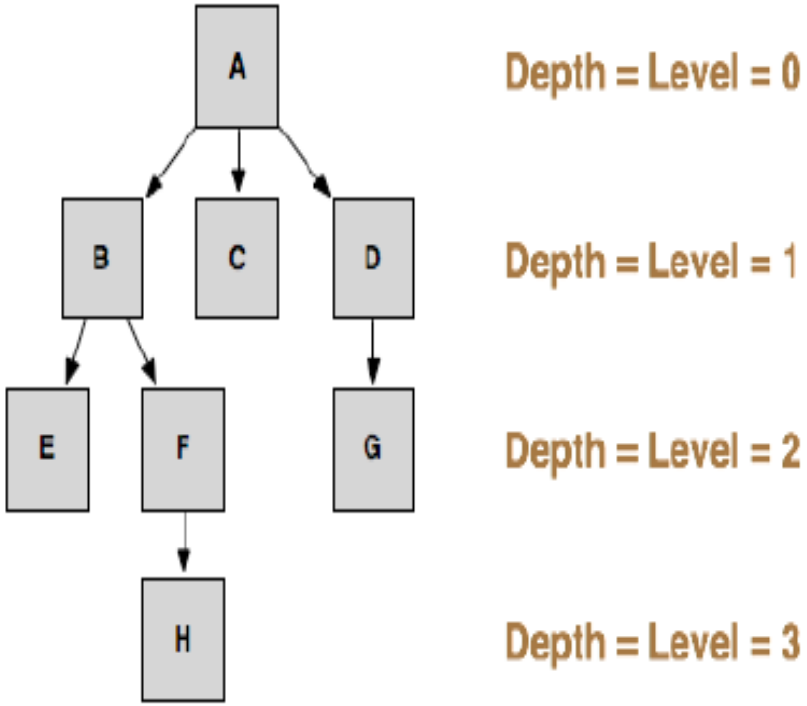
Example of (Parent, child, siblings)



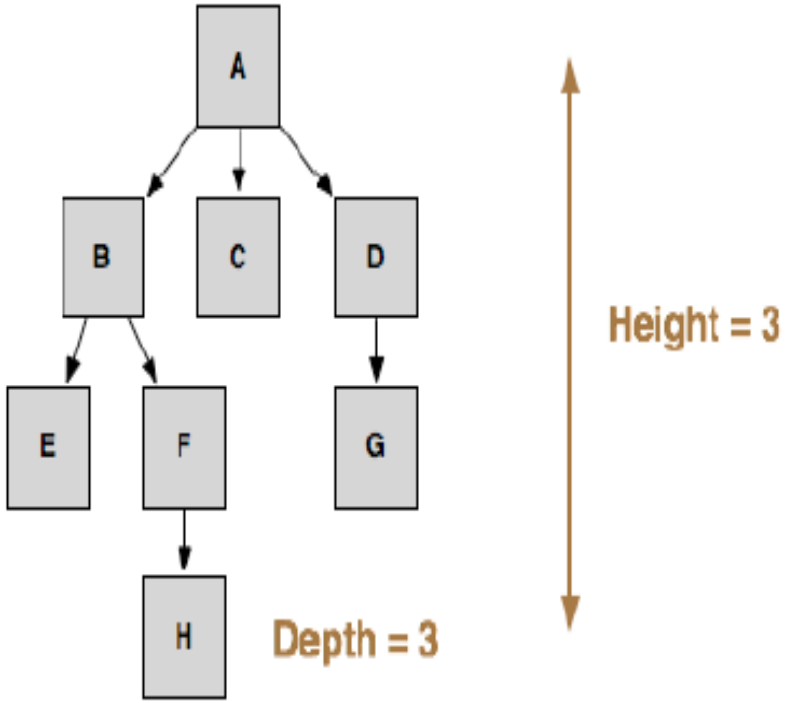
Example of (Ancestors, Descendants)



Example of (Depth)



Example of (High)



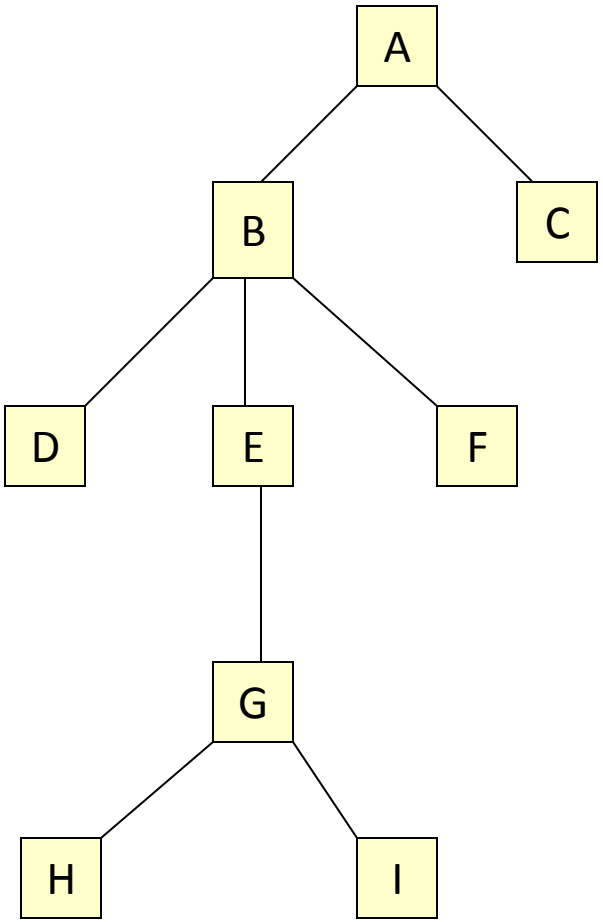
Height of a tree – The longest path length rom the root to a leaf.

- **Non empty tree: Height = max depth**

node depth – the path length from the root

- **The root is level 0 and depth**
- **Other nodes depth is 1 + depth of parent**

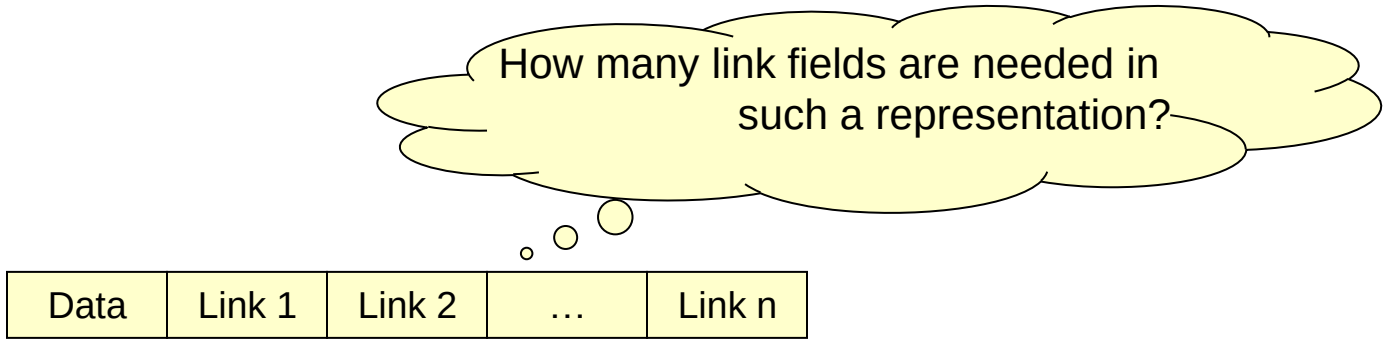
Tree Properties



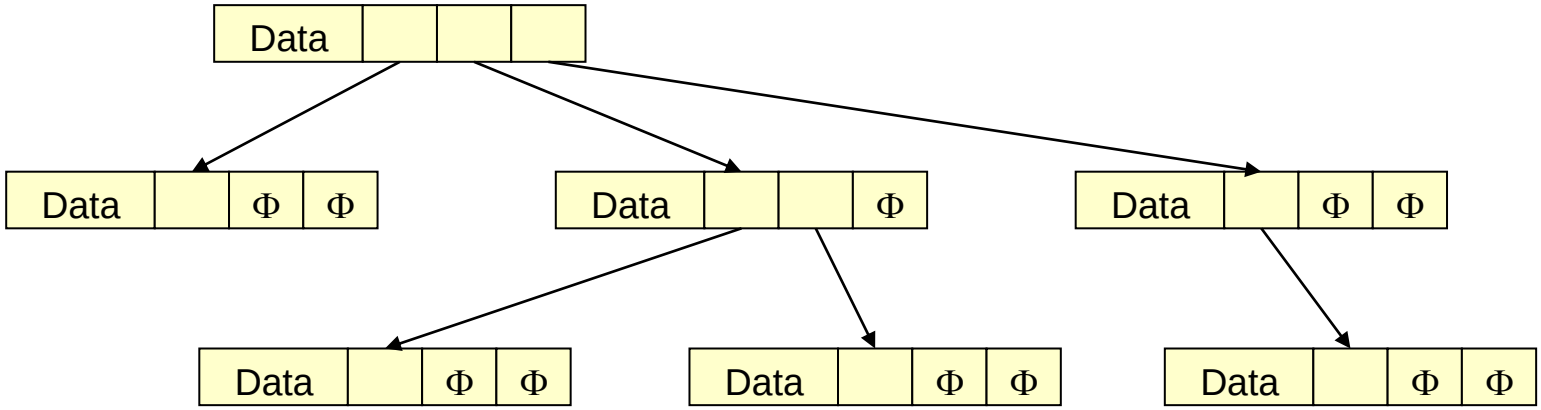
Property	**Value**
Number of nodes	
Height	
Root Node	
Leaves	
Interior nodes	
Ancestors of H	
Descendants of B	
Siblings of E	
Right subtree of A	
Degree of this tree	

Representation of Tree Node

- List Representation
  - (A (B (E (K, L), F), C (G), D (H (M), I, J)))
  - The root comes first, followed by a list of links to sub-trees

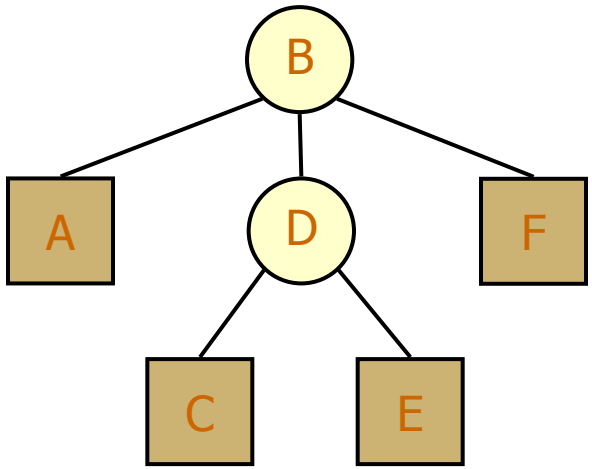


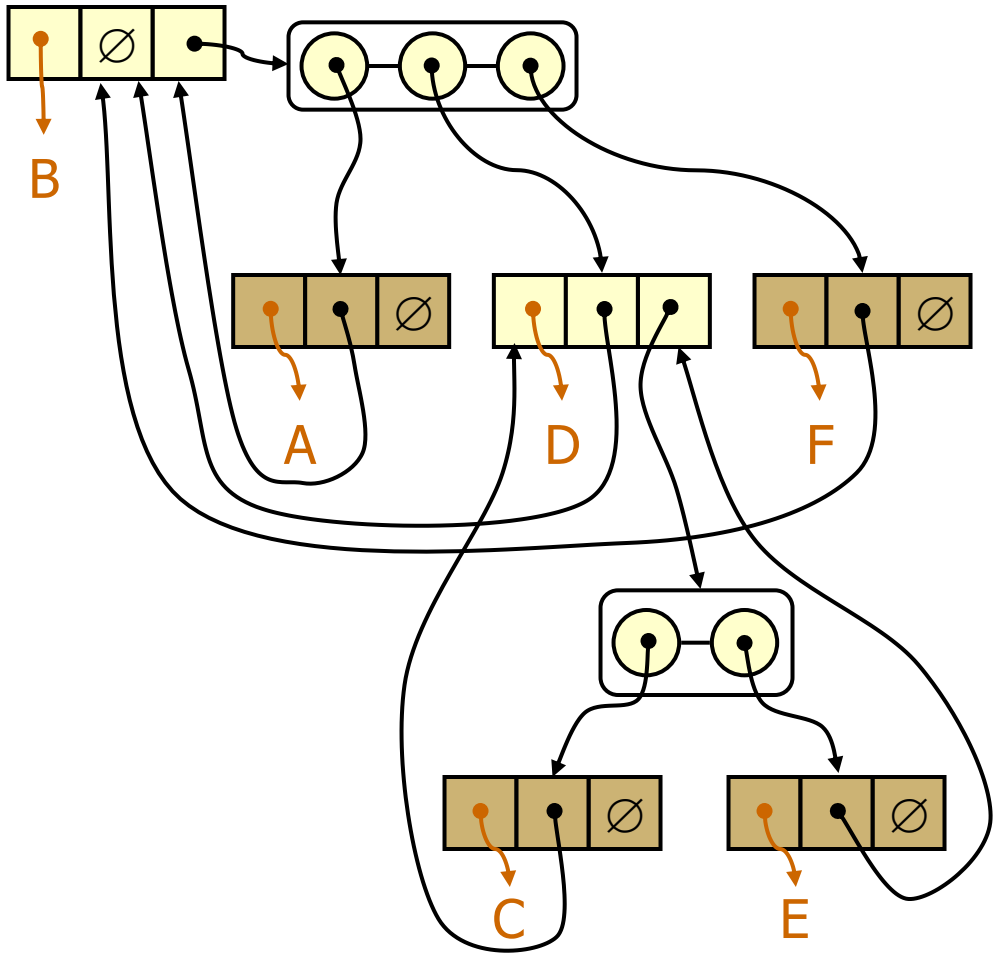
- Every tree node:
  - object – useful information
  - children – pointers to its children



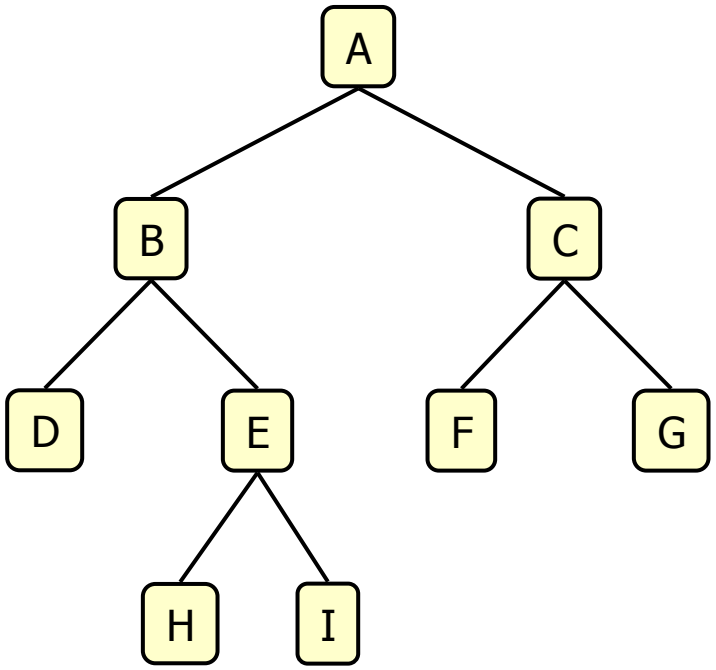
A Tree Representation

- A node is represented by an object storing
  - Element
  - Parent node
  - Sequence of children nodes





Binary trees



- Binary tree is a specific type of tree
- "In computer science, a binary tree is a tree data structure in which each node has at the most two children, which
- are referred to as the left child and the right child."
- Properties:
  - Each internal node has at most two children (degree of two)
    - Each node is called the parent of its children
  - The children of a node are an ordered pair
  - We call the children of an internal node left child and right child
  - a binary tree is either:
    - a tree consisting of a single node, OR
    -a tree whose root has an ordered pair of children, each of which is a binary tree
  - A node with no children is called a leaf.
  - Left child is always less that its parent, while right child is greater than its parent

- Applications:
  - arithmetic expressions
  - decision processes
  - searching