ADVANCED DATA STRUCTURES AND ALGORITHMS

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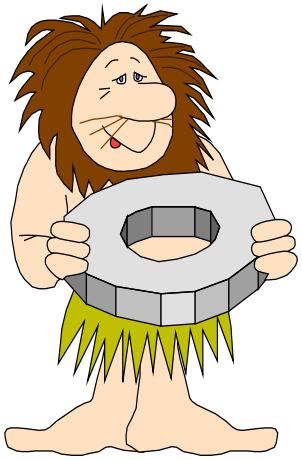
What this Lecture is about:

- Selection of Data Structure
- General trees
- Binary trees
- Game of questions
- Binary tree terminology
- Converting General Trees To Binary Trees



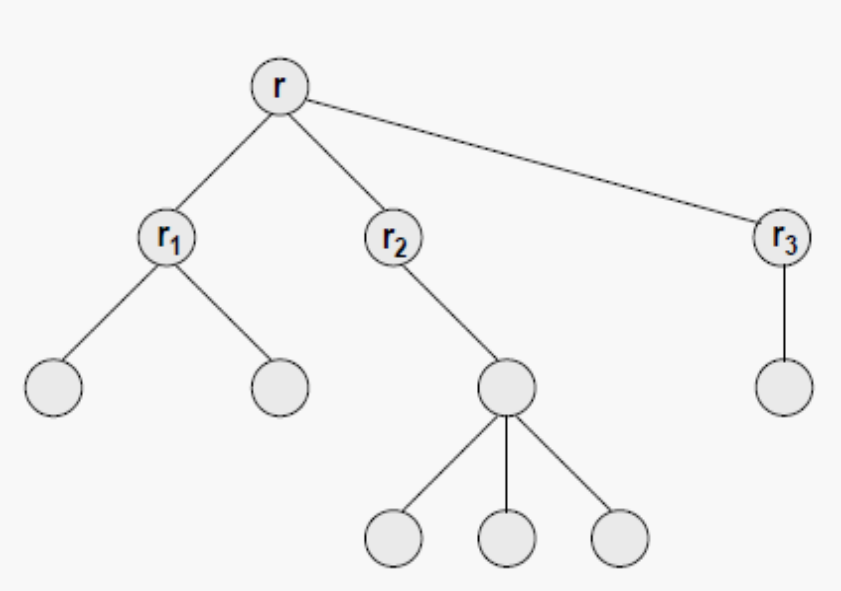
Selection of Data Structure

There are many considerations to be taken into account when choosing the best data structure for a specific program”

1. Size of data.
2. Speed and manner data use.
3. Data dynamics, as change and edit.
4. Size of required storage.
5. Fetch time of any information from data structure.

General Trees

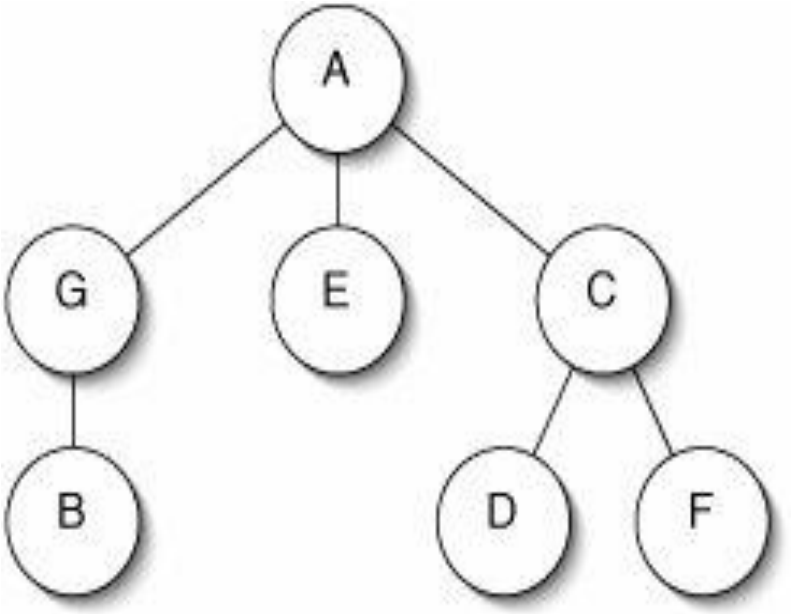
A **General Tree** **T** is a finite set of one or more nodes such that there is one designated node **r**, called the **root** of **T**, and the remaining nodes are partitioned into **n ≥ 0** disjoint subsets **T1**, **T2**, …, **Tn**, each of which is a tree, and whose roots **r1**, **r2**, …, **rn**, respectively, are children of **r**.



General Trees

A general tree is a tree which each node can have an unlimited child nodes for a given node.

An example of general tree is shown in the following figure: -



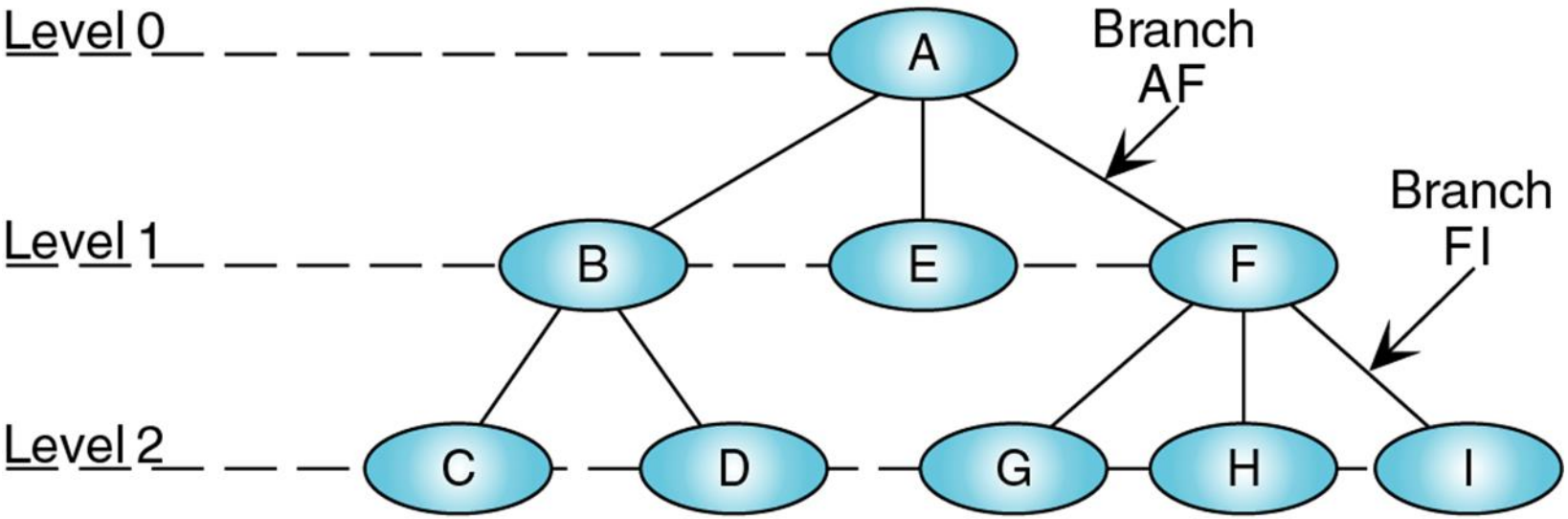
A general tree.

General Trees

The two binary trees at left are considered different:

- **One has an empty right subtree,**
- **While the other has an empty left subtree,**
- **Among general trees like the one at right, no such distinction is drawn.**
- **A general tree cannot be empty. It always has at least one node, but it might not have any subtrees.**

General Trees



Parents: A, B, F
Children: B, E, F, C, D, G, H, I
Siblings: {B,E,F}, {C,D}, {G,H,I}

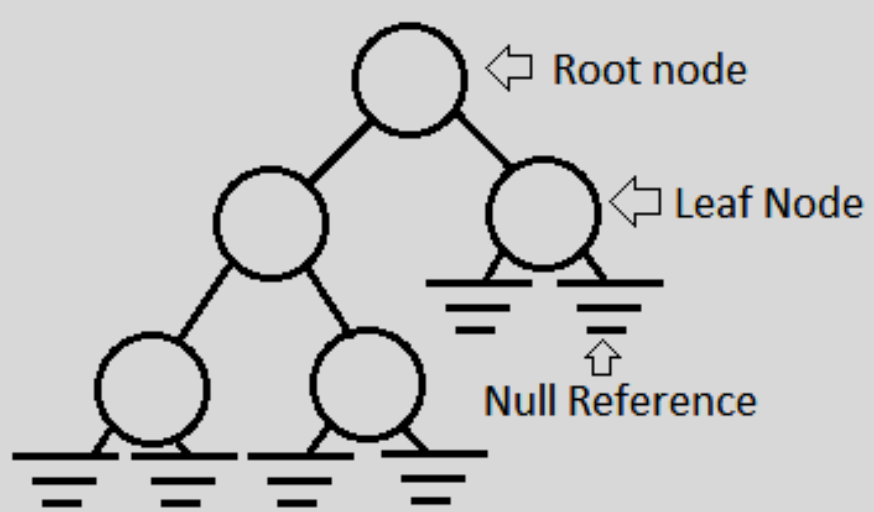
Leaves C,D,E,G,H,I
Internal nodes B,F

Binary Trees

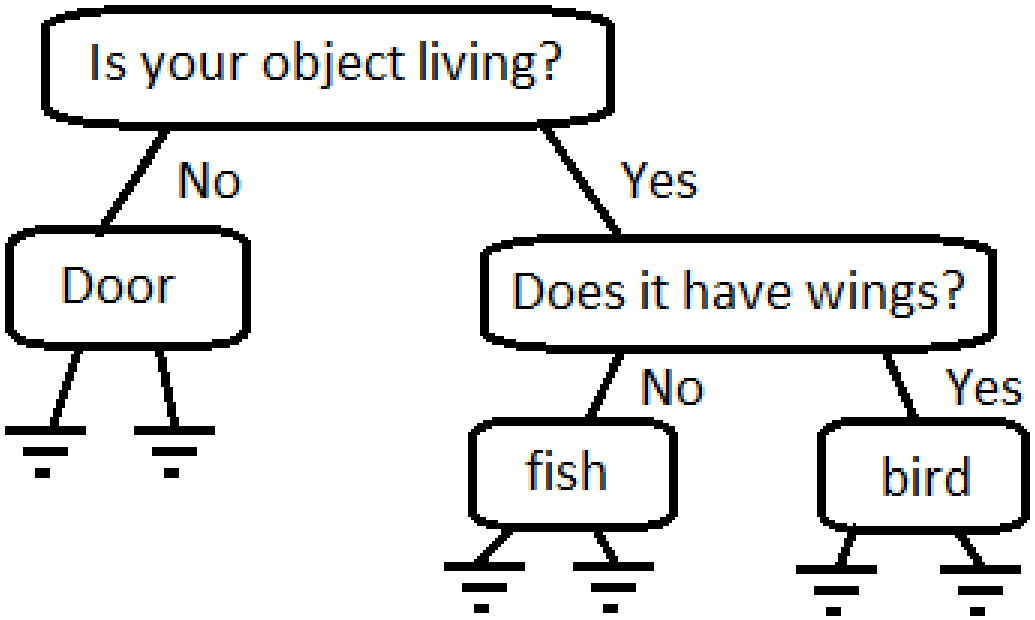
There is a considerable amount of terminology regarding trees. We will introduce it in the context of the game of Questions.

The Game of Questions to Build a Binary Trees

Each node will contain a question and two links to other nodes. If 'yes' is entered for a question, yes Node will be referenced. When the referenced node is a leaf node, the computer will make a guess on the object.



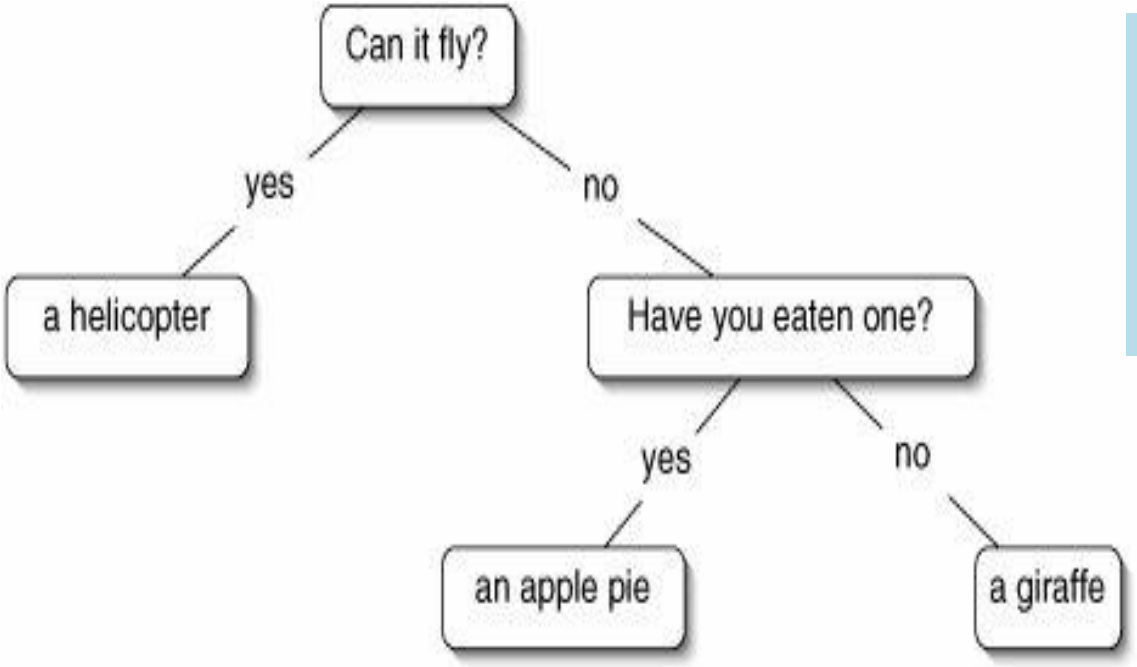
The Game of Questions to Build a Binary Trees



Is your object living?
No → Door
Does it have wings?
No → Fish
Yes → Bird

The Game of Questions to Build a Binary Trees

The Game of Questions binary decision tree



Can it fly?
Yes → a helicopter
Have you eaten one?
Yes → an apple Pie
No → a giraffe

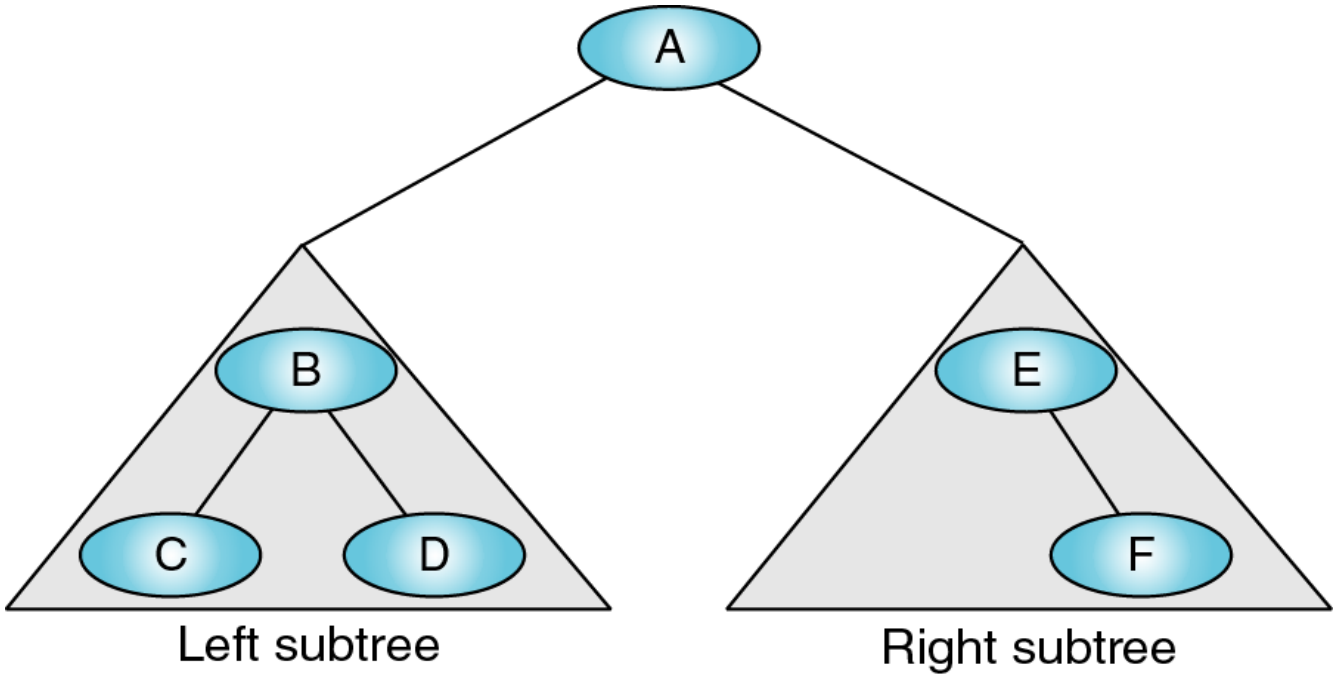
Binary Tree Terminology

Formally, a binary tree is either:

A. Empty, or
B. A node with a left subtree and a right subtree. Each of these subtrees is itself a binary tree.
C. The most important feature distinguishing binary trees from more **general trees** is that, in a **binary tree**, **no node can have more than two children.**

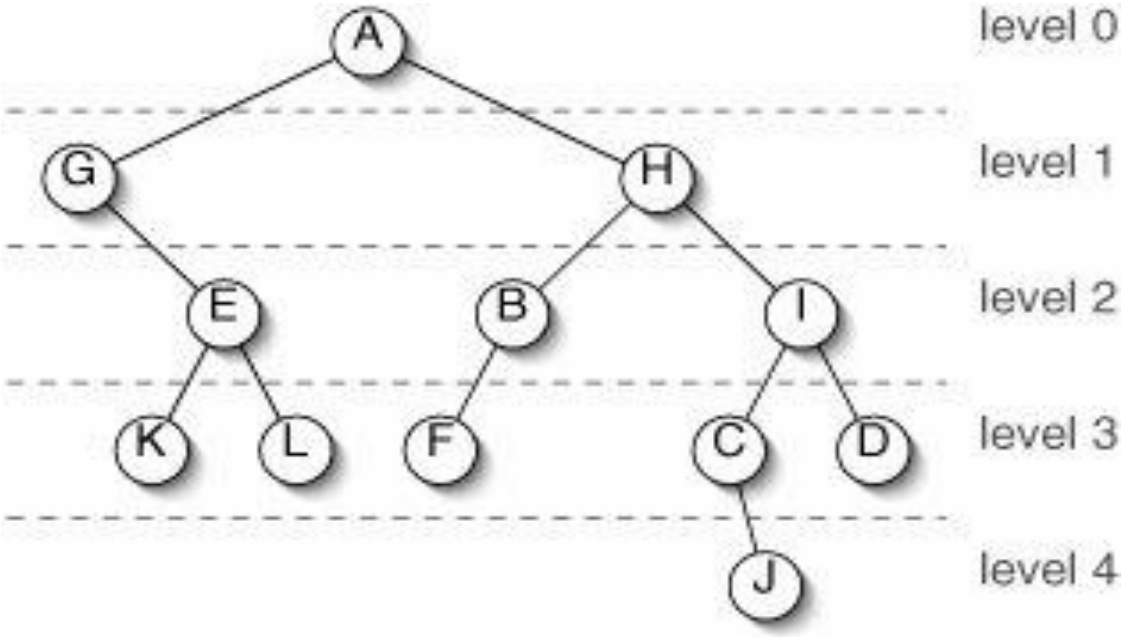
Binary Trees

A **binary tree** is a tree in which no node can have more than two subtrees.



Binary Tree Terminology

More information about some of the nodes is given in the Figure.

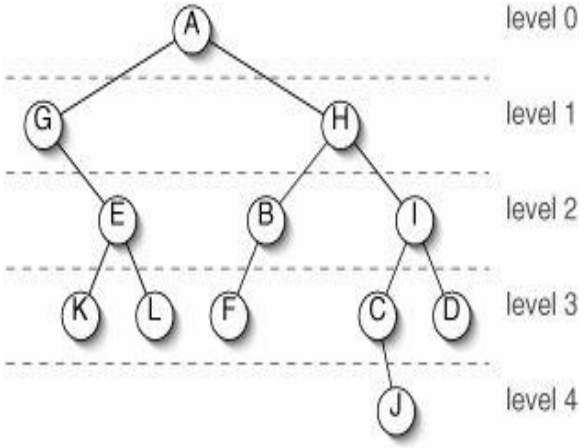


A binary tree with the nodes divided into levels.

Binary Tree Terminology

Information about some of the nodes of a binary tree with the nodes divided into levels.

Node	Parent	Children	Sibling	Depth
A		G, H		0
B	H	F	I	2
C	I	J	D	3
D	I		C	3
E	G	K, L		2

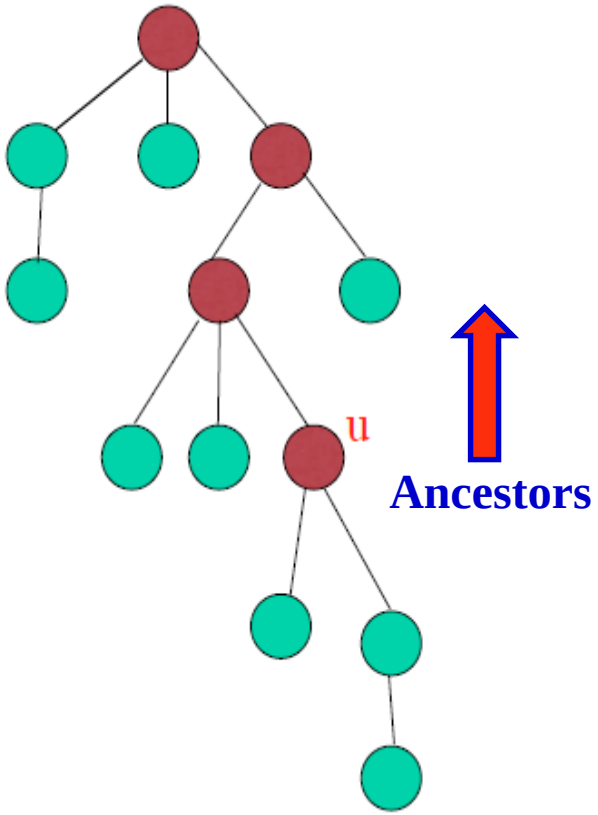


Binary Tree Terminology

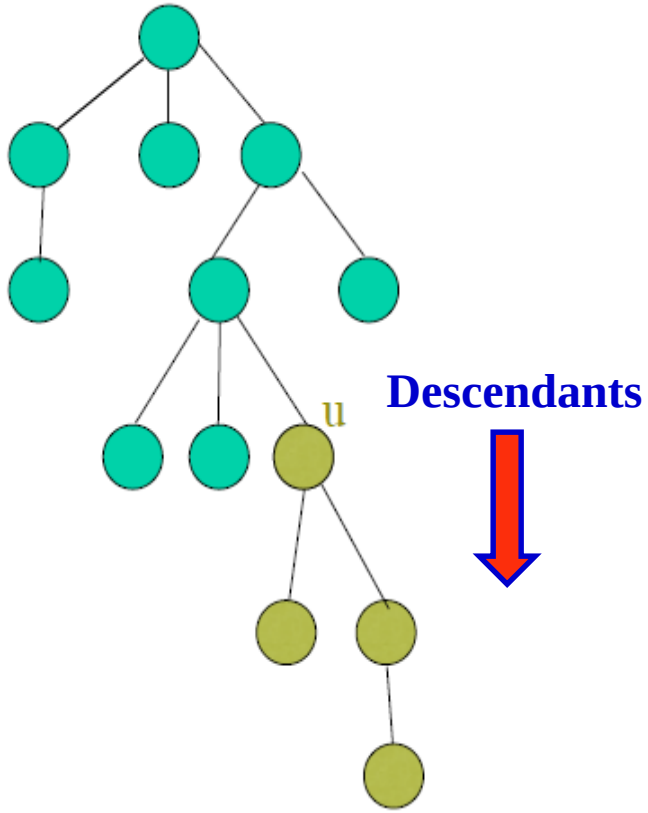
In Figure, the ancestors of L are E, G, and A. A node's proper ancestors are all of its ancestors except itself.

- Siblings: two nodes that have the same parent are called siblings
- Internal nodes
  - nodes that have children
- External nodes or leaves
  - nodes that don't have children
- Ancestors: a node reachable by repeated proceeding from child to parent.
- Descendants: a node reachable by repeated proceeding from parent to child.

Binary Tree Terminology

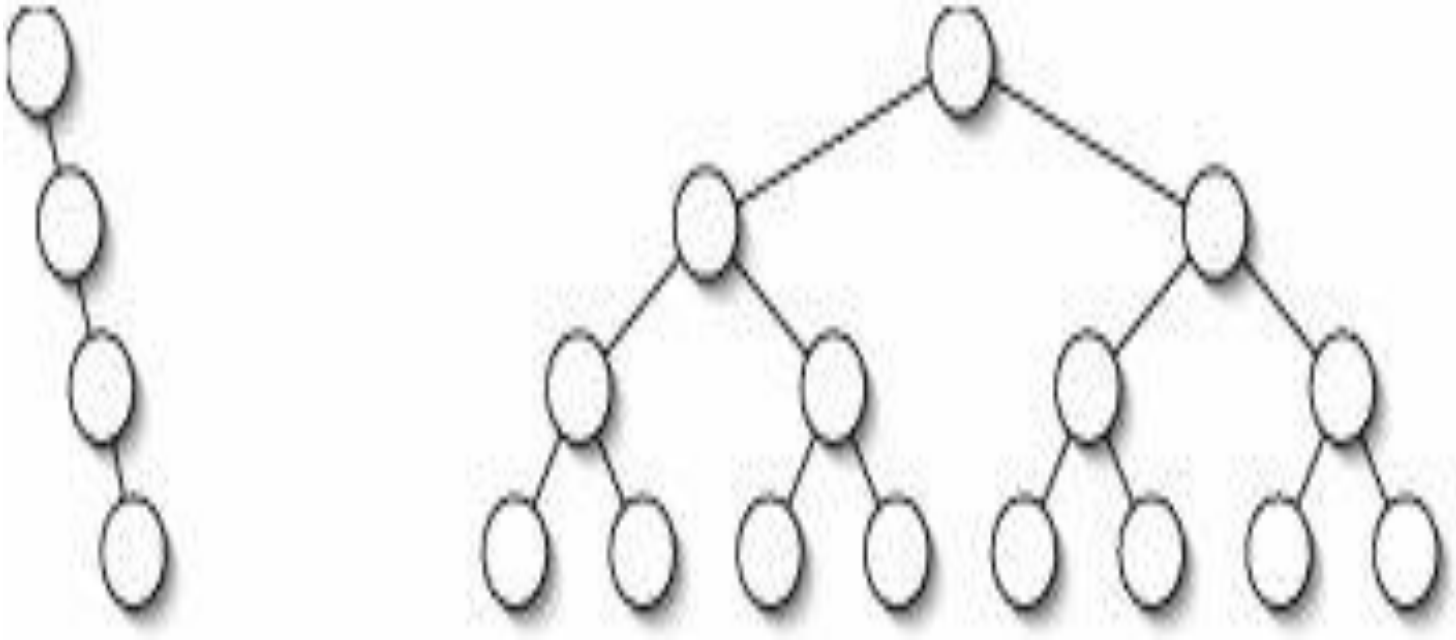


Ancestors of u



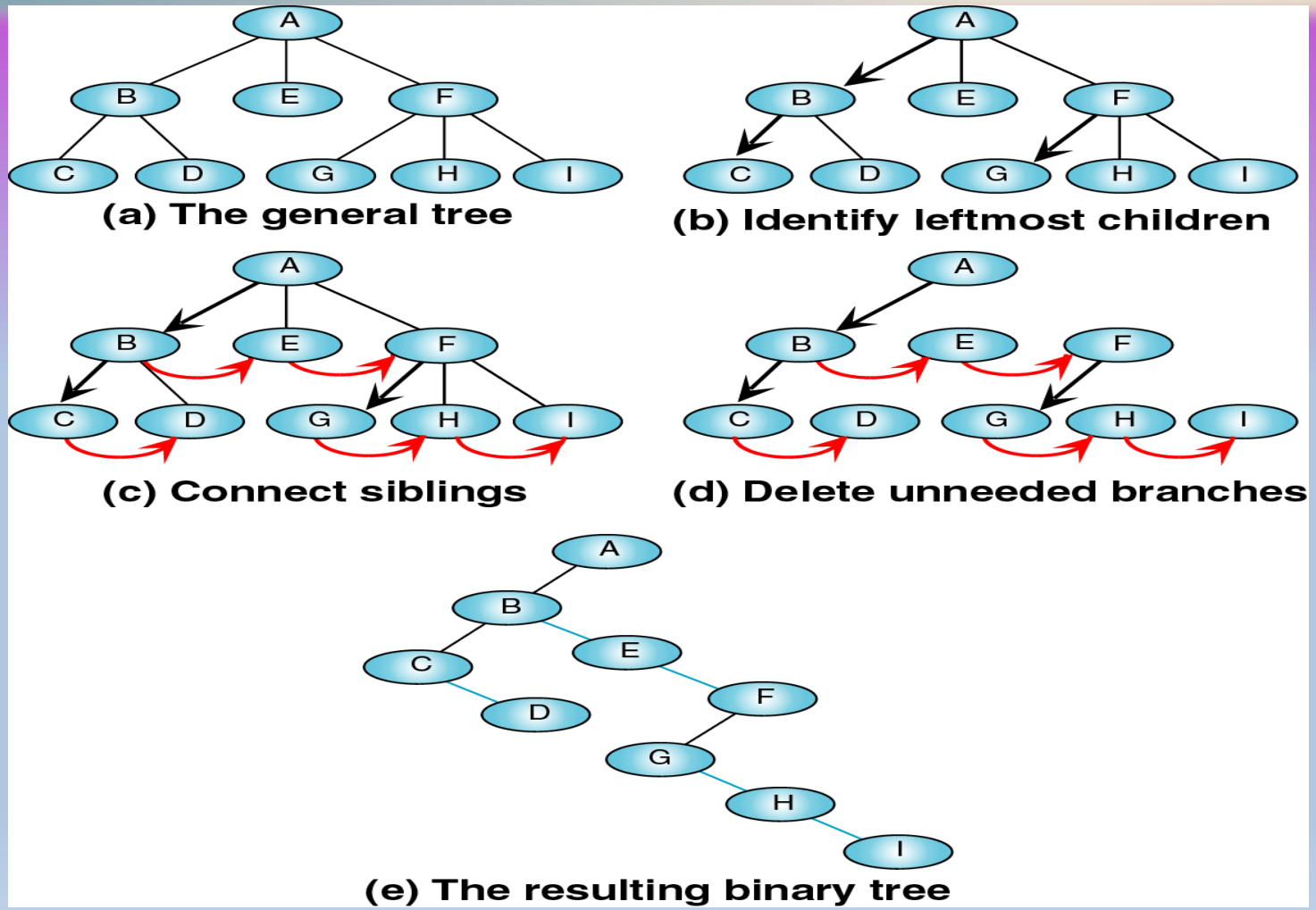
Descendants of u

Binary Tree Terminology

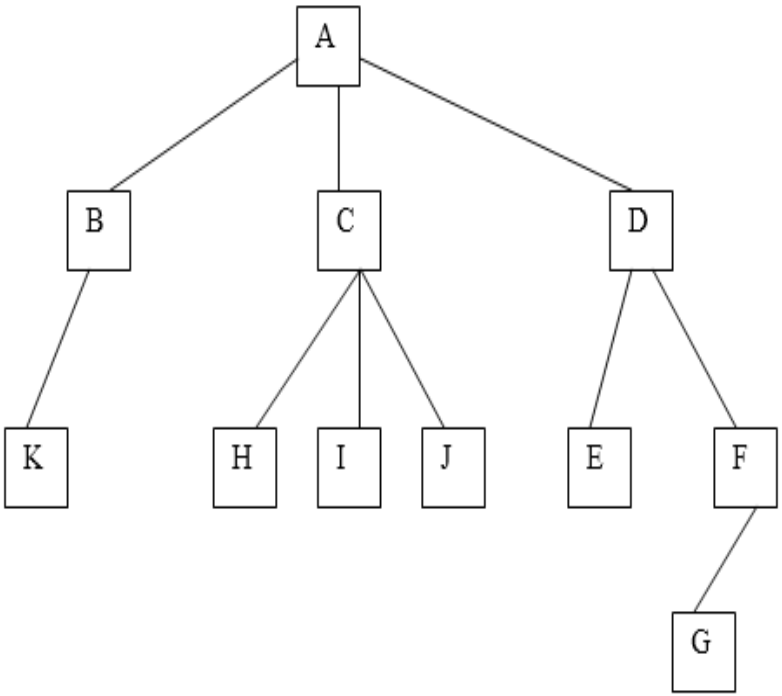


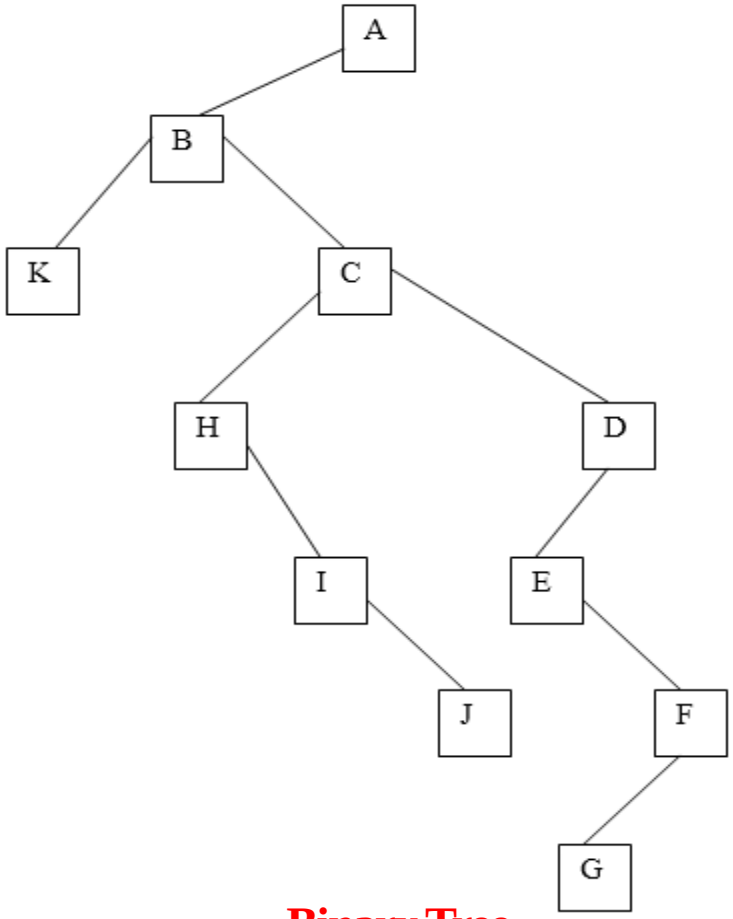
A linear tree (left) and a perfect binary tree (right). Both of these trees are of height 3.

Converting General Trees To Binary Trees



Creating a Binary Tree from a General Tree





General Tree

Binary Tree

Thank you

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