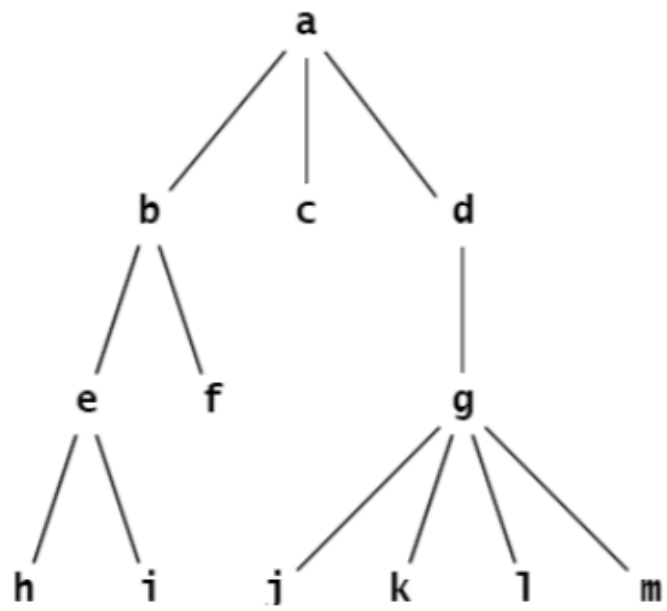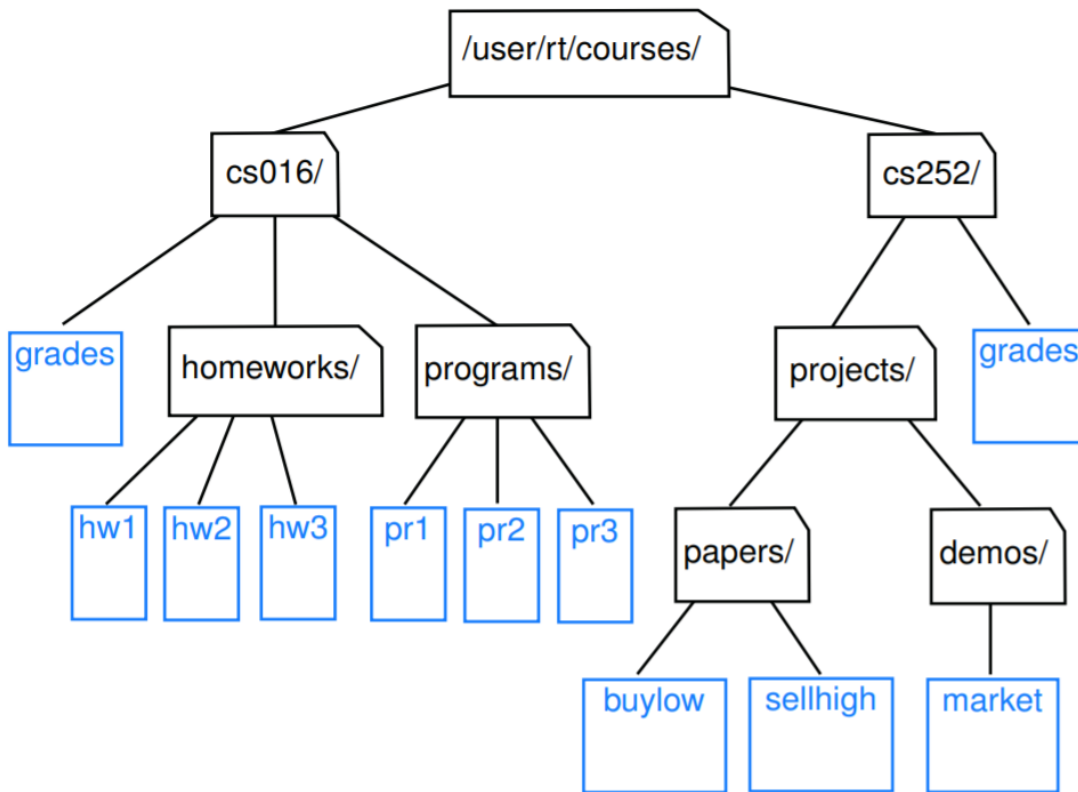**Tree**

Figure : Tree

Figure : Tree representing a portion of a file system

Binary Tree

A binary tree is a tree with the following properties:

1. Every node has at most two children.

2. Each child node is labeled as being either a left child or a right child.

Note that in Binary Tree, one or both of the child nodes can be empty.

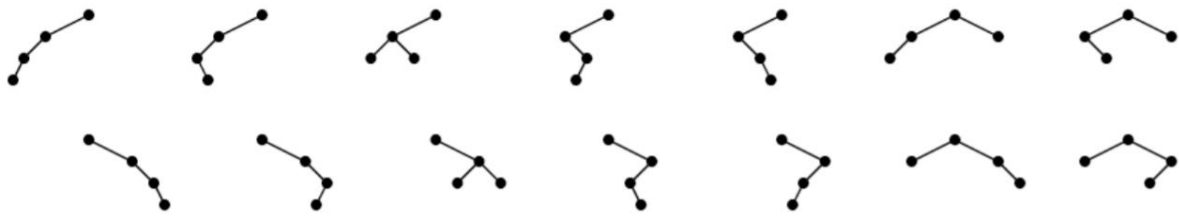Figure : Different Binary Trees of 3 nodes

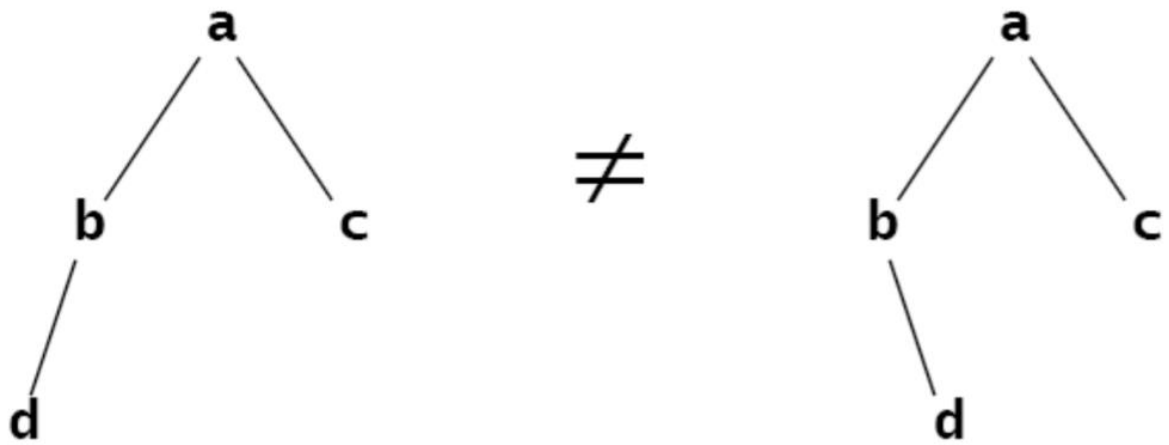Figure : Different Binary Trees of 4 nodes
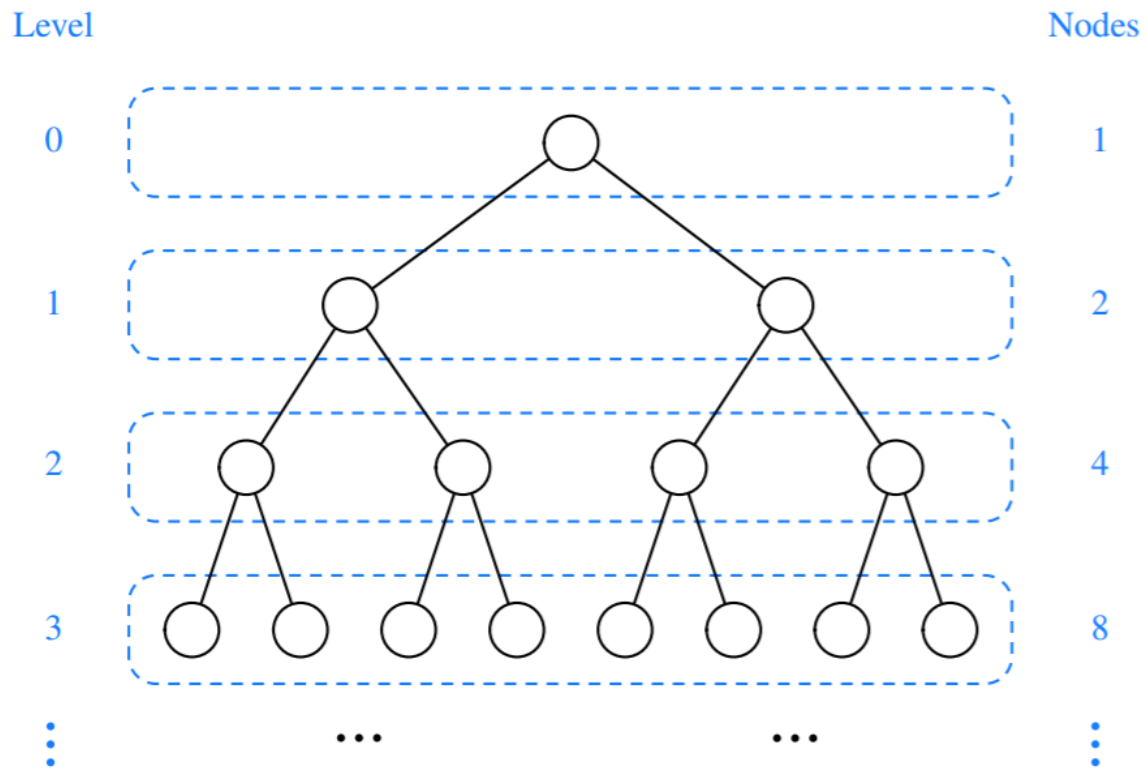

Figure : Unequal Binary Trees

Figure : Maximum number of nodes in every level of a binary tree

Complete Binary Tree

A Binary Tree T is said to be complete if all the levels of the tree, except possibly the last, have the maximum number of possible nodes and **if all the nodes at the last level appear as far left as possible.**
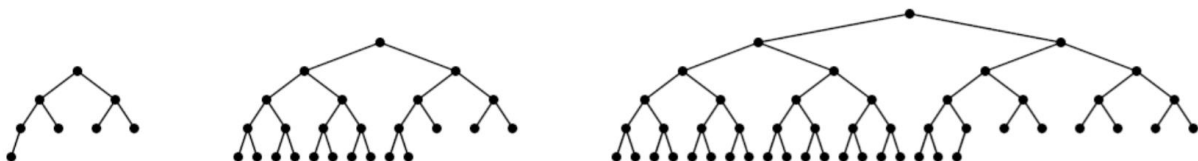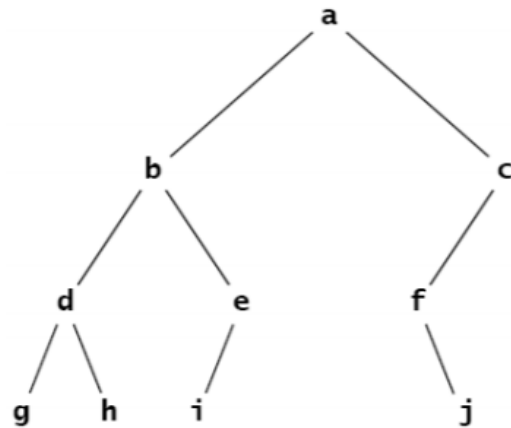

Figure : Complete Binary Trees

Figure : Not a Complete Binary Tree

Full Binary Tree

A binary tree is said to be full if **all its leaves are at the same level and every interior node has two children.**
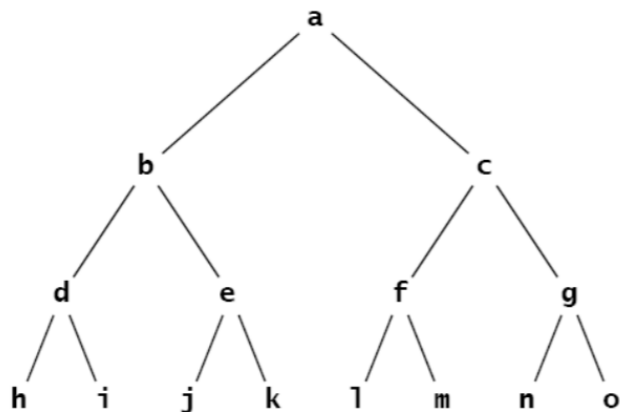

Figure : Full Binary Tree of height 3

So a full binary tree will always be a complete binary tree, but a complete binary tree does not necessarily have to be a full binary tree.

Note : Some textbooks use the term "almost complete binary tree" for a complete binary tree and the term "complete binary tree" for a full binary tree.

Array Representation of Binary Trees

Assign the number 1 to the root; for any node, if i is its number, then assign 2i to its left child and 2i+1 to its right child. This assigns a unique positive integer to each node.

To navigate a binary tree stored in an array:

1. The parent of the node stored at location i, is stored at location i/2.

2. The left child of the node stored at location i, is stored at location 2i.

3. The right child of the node stored at location i, is stored at location 2i + 1.

Example 1 : Storing an incomplete binary tree in an array

0	1	2	3	4	5	6	7	8	9	10	11	12	13
	a	b	c	d	e	f		g	h	i			j
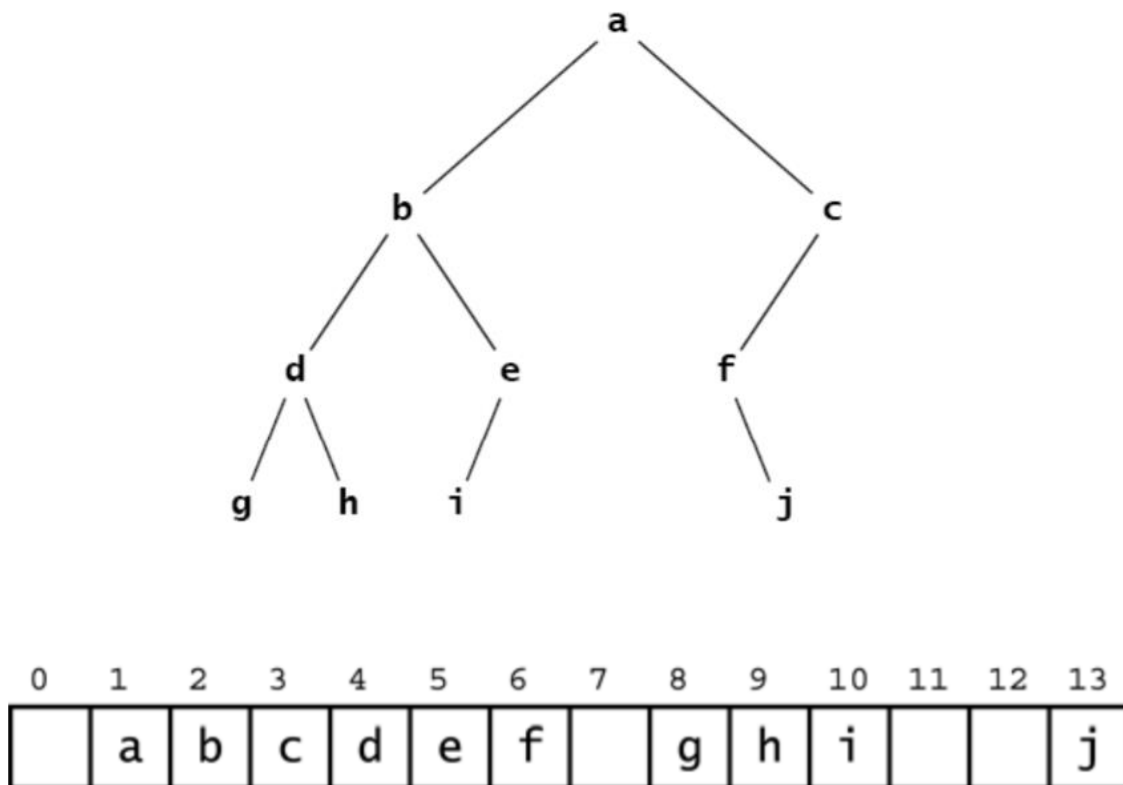
Example 2 : Storing a complete binary tree in an array
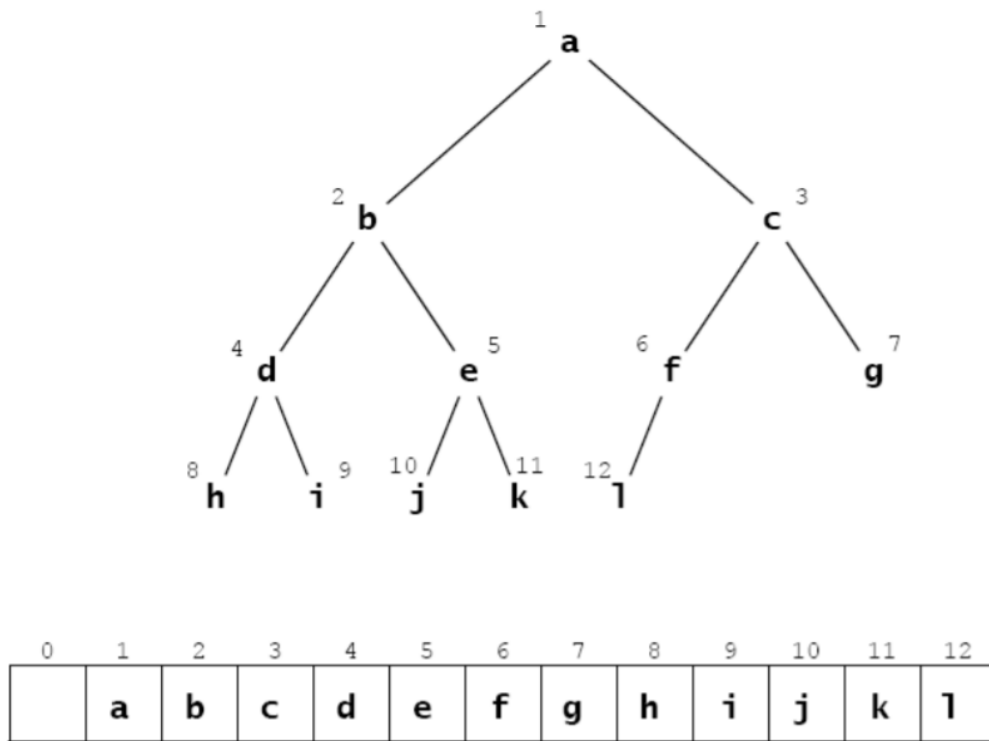
For example, node e is stored at index i = 5 in the array; its parent node b is stored at index i/2 = 5/2 = 2, its left child node j is stored at location 2i = 2·5 = 10, and its right child node k is stored at index 2i + 1 = 2·5 + 1 = 11.

Note : The most important property of a complete binary tree is that, it guarantees that when storing the complete binary tree in an array there will be no gaps.