

Threaded Binary Tree

- When a binary tree is represented using linked list representation, the reference part (left and right) of the node which doesn't have a child is filled with a NULL pointer.
- There are a number of NULL pointers than actual pointers pointing to left or right child.
- If there are $2N$ number of reference fields, then $N+1$ number of reference fields are filled with NULL.
- This NULL pointer does not play any role except indicating that there is no link (no child).
- Threaded Binary Tree is a binary tree which makes use of NULL pointers *to improve its traversal process*. The NULL pointers are replaced by references of other nodes in the tree. These extra references are called as threads.

What is a Threaded Binary Tree ? :

Threaded Binary Tree is also a binary tree in which all left child pointers that are NULL (in Linked list representation) points to its *in-order predecessor*, and all right child pointers that are NULL (in Linked list representation) points to its *in-order successor*.

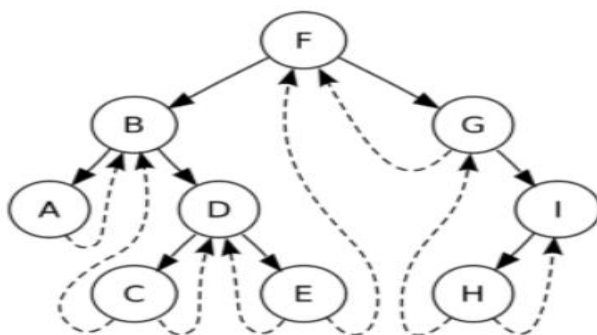
In-order predecessor:

- The node coming before the current node in the in-order traversal of a binary tree.

In-order successor:

- The node coming next to the current node in the in-order traversal of a binary tree.

Example:



In-order traversal: A B C D E F G H I

Leaf nodes: A C E H

Node with one child (left child): I

Node with one child (right child): G

Nodes with both child nodes empty (leaf nodes):

Node A:

left: no predecessor available (NULL),
right: will point to B

Node C:

Left: will point to B,
Right: will point to D

And so on for E , H

Nodes with one child empty:

Node I:

right: no successor available (NULL)

Node G:

Left: will point to F

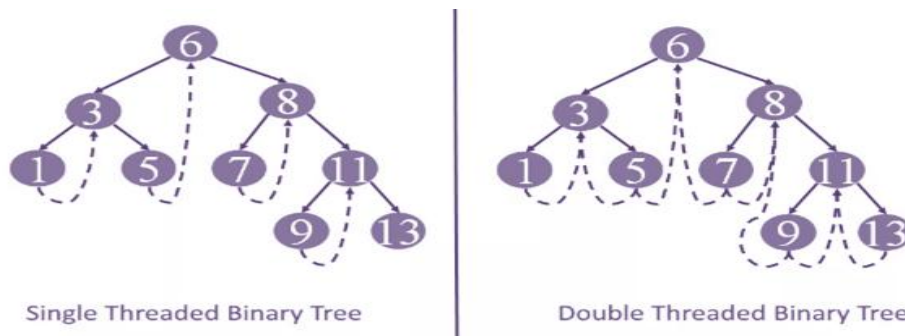
Based on the pointers threaded in a node there are two types of threaded binary trees:

(1) Single Threaded Trees:

For every node only one of the pointers is threaded i.e. either the left node is made to point the in-order predecessor **OR** the right node is made to point to the in-order successor of the tree.

(2) Double Threaded Trees:

For every node both of the pointers are threaded i.e. the left node is made to point the in-order predecessor **AND** the right node is made to point to the in-order successor of the tree.

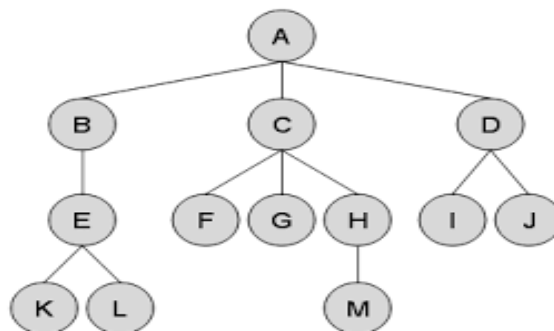


General Tree:

- General tree is a tree in which each node can have either zero or many child nodes. There is no limitation on the degree of a node. The topmost node of a general tree is called the root node.

General trees are used to model applications such as file systems.

Example:



Note: - A binary tree is a specialized case of a general tree where a node can have 0, 1, or 2 child nodes.