Experiment No. 4

Aim: Implementation of Binary Tree & its Traversal for real-world application.

Objectives: 1) To learn fundamentals and implementation of Binary tree.
2) To develop an ability to design and analyze algorithms using tree data structures.

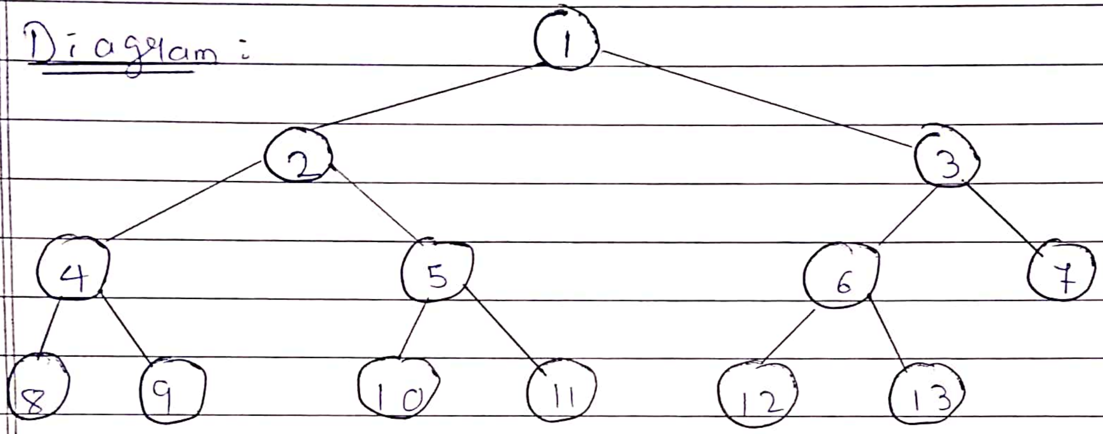
Theory: A binary tree is a data structure that is defined as a collection of elements called nodes. In a binary tree, the topmost element is called the root node, and each node has 0, 1 or at the most 2 children. A node that has zero children is called a leaf node or a terminal node. Every node contains a data element, a left pointer which points to the left child, and a right pointer which points to the right child. The root element is pointed by a 'root' pointer.

Terminology:

- **Parent:** If N is only node in T that has left successor S_1 & right successor S_2, then N is called the parent of S_1 & S_2.
- **Level number:** Eevery node in the binary tree is assigned to a level number.
- **Degree of a node:** It is equal to the number of children that a node has.
- **Sibling:** All nodes that are at the same level and share the same parent are called siblings.
- **Leaf node:** A node that has no children.

- Similar binary trees : Two binary trees are solid to be similar if both these trees have the same structure.
- Edge : It is the line connecting a node N to any of its successors.
- Path : A sequence of concecutive edges.
- Depth : The depth of a node is given as the length of the path from the root to the node.
- Height of a tree : It is the total number of nodes on the path from the root node to the deepest node in the tree.

Diagram :



Operations :

1) Serching : Find the locction of some specific element in a binary tree.
2) Insertion : Adding a new element to the tree at the appro-priate location.
3) Deletion : Deleting some specific node from a binary tree
4) Traversing : Process of visiting each node exactly ance.

Tree traversal & its types : Traversing a binary tree is the process of visiting each node in the tree exactly once in a systematic way. Unlike linear data structures in which the elements are traversed sequentially, tree is a non-linear data structure in which the elements are traversed sqentially, tree is a non-linear data structure in which the elements can traversed in many different ways.

1) Pre-order Traversal : To traverse a non-empty binary tree in pre-order, the following operations are performed recursively at each node.

The algorithm works by :

1. Visiting the root node
2. Traversing the left sub-tree and finally
3. Traversing the right sub tree.

2) In-order traversal : To traverse a non-empty binary tree in in-order, the following operation are performed recursively at each node. The algorithm works by:

1. Traversing the left sub-tree
2. Visiting the root node, and finally
3. Traversing the right sub tree

3) Post-order traversal : To traverse a non-empty binary tree in post-order, the following operations are performed recursively at each node. The algorithm works by

1. Traversing the left subtree
2. Traversing the right subtree & finally.
3. Visiting the root node.

Algorithms:

Searching for a given value:

step 1: IF TREE -> DATA = VAL OR TREE = NULL
            Return TREE
        ELSE
        IF VAL < TREE -> DATA
        Return search Element (TREE -> LEFT VAL)
        Else
        Return search Element (TREE -> RIGHT, VALUE)
        [END OF IF]
        [END OF IF]
step 2: END

Insertion: Insert (TREE, VAL)

step 1: IF TREE = NULL
        Allocate memory for TREE.
        SET TREE -> DATA = VAL
        SET TREE -> LEFT = TREE -> RIGHT = NULL
        ELSE
            IF VAL < TREE -> DATA
                Insert (TREE -> LEFT, VAL)
            ELSE
                Insert (TREE -> RIGHT, VAL)
            [END OF IF]
        [END OF IF]
Step 2: END

Deletion

Delete (TREE, VAL)

Step 1 : IF TREE = NULL

Write " VAL not found in the tree "

ELSE IF VAL < TREE -> DATA

Delete (TREE -> LEFT, VAL)

ELSE IF VAL > TREE -> DATA

Delete (TREE -> RIGHT, VAL)

ELSE IF TREE -> LEFT AND TREE -> RIGHT

SET TEMP = Find Largest Node (TREE -> LEFT)

SET TREE -> DATA = TEMP -> DATA

Delete (TREE -> LEFT, TEMP -> DATA)

ELSE

SET TEMP = TREE

IF TREE -> LEFT = NULL & TREE -> RIGHT = NULL

SET TREE = NULL

ELSE IF TREE -> LEFT != NULL

SET TREE = TREE -> LEFT

ELSE

SET TREE = TREE -> RIGHT

[END OF IF]

FREE TEMP

[END OF IF]

Step 2 : END

Pre-order Traversal :

Step 1 : Repeat steps 2 to 4 while TREE != NULL

Step 2 : Write TREE -> DATA

Step 3 : PREORDER (TREE -> LEFT)

Step 4 : PREORDER (TREE → RIGHT)
[END OF LOOP]
Step 5 : END

Inorder Traversal:
Step 1 : Repeat steps 2 to 4 while TREE != NULL
Step 2 : INORDER (TREE → LEFT)
Step 3 : Write TREE → DATA
Step 4 : INORDER (TREE → RIGHT)
[END OF LOOP]
Step 5 : END

Post-order Traversal
Step 1 : Repeat steps 2 to 4 while TREE != NULL
Step 2 : POSTORDER (TREE → LEFT)
Step 3 : POSTORDER (TREE → RIGHT)
Step 4 : Write TREE → DATA
[END OF LOOP]
Step 5 : END

Example : i) Routing tables : A routing table is used to link routers in a network.
ii) Trees are used in file system directories

Conclusion : Thus, we understand the concept of binary trees, their operations including traversal & its various typs & also learn it's implementation.

Outcome : Implement tree data structure for real-world application.

PROGRAM:

```
/**********************************************************
 Implementation of Binary Tree Traversal
**********************************************************/

#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include <malloc.h>

struct node
{
	int data;
	struct node *left;
	struct node *right;
};
struct node *tree;
void create(struct node *);
struct node *insert(struct node *, int);
void inorder(struct node *);
void preorder(struct node *);
void postorder(struct node *);

void main()
{
	int choice, x, i, n;
	struct node *ptr;
	printf("\n --- WELCOME TO IMPLEMENTATION OF BINARY TREE TRAVERSALS --- \n
	create(tree);
	do
	{
		printf("\n *** --- opertaions available --- *** ");
		printf("\n 1. Insert a Node");
		printf("\n 2. Display Inorder Traversal");
		printf("\n 3. Display Preorder Traversal");
		printf("\n 4. Display Postorder Traversal");
		printf("\n 5. Exit \n");
		printf(" Please enter your choice : ");
		scanf("%d", &choice);
		switch (choice)
		{
			case 1:
			printf("\nEnter N value: " );
			scanf("%d", &n);
			printf("\nEnter the values to create BST like(6,9,5,2,8)\n");
			for(i=0; i<n; i++)
			{
				scanf("%d", &x);
				tree = insert(tree, x);
			}
			break;
			case 2:
				printf("\n Elements in the inorder traversala are : ");
				inorder(tree);
				printf("\n");
				break;
			case 3:
				printf("\n Elements in the preorder traversala are : ");
				preorder(tree);
				printf("\n");
				break;
			case 4:
				printf("\n Elements in the postorder traversala are : ");
				postorder(tree);
				printf("\n");
				break;
			default:
				printf("\n Please enter a valid option 1, 2, 3, 4.");
				break;
		}
	} while (choice != 5);
}

void create(struct node *tree)
{
	tree = NULL;
}
```

```c
// Function for inserting a new node
struct node *insert(struct node *tree, int x)
{
	struct node *p, *temp, *root;
	p = (struct node *)malloc(sizeof(struct node));
	p->data = x;
	p->left = NULL;
	p->right = NULL;
	if (tree == NULL)
	{
		tree = p;
		tree->left = NULL;
		tree->right = NULL;
	}
	else
	{
		root = NULL;
		temp = tree;
		while (temp != NULL)
		{
			root = temp;
			if (x < temp->data)
				temp = temp->left;
			else
				temp = temp->right;
		}
		if (x < root->data)
			root->left = p;
		else
			root->right = p;
	}
	return tree;
}

// Function for Inorder Traversals
void inorder(struct node *tree)
{
	if (tree != NULL)
	{
		inorder(tree->left);
		printf(" %d \t", tree->data);
		inorder(tree->right);
	}
}

// Function for Preorder Traversals
void preorder(struct node *tree)
{
	if (tree != NULL)
	{
		printf(" %d \t", tree->data);
		preorder(tree->left);
		preorder(tree->right);
	}
}

// Function for Postorder Traversals
void postorder(struct node *tree)
{
	if (tree != NULL)
	{
		postorder(tree->left);
		postorder(tree->right);
		printf(" %d \t", tree->data);
	}
```

OUTPUT:

```
 *** --- opertaions available --- ***
 1. Insert a Node
 2. Display Inorder Traversal
 3. Display Preorder Traversal
 4. Display Postorder Traversal
 5. Exit
 Please enter your choice : 1

Enter N value: 15

Enter the values to create BST like(6,9,5,2,8)
25 15 50 10 22 35 70 4 12 18 24 31 44 66 90

 *** --- opertaions available --- ***
 1. Insert a Node
 2. Display Inorder Traversal
 3. Display Preorder Traversal
 4. Display Postorder Traversal
 5. Exit
 Please enter your choice : 2_

 Elements in the inorder traversala are :  4      10      12      15      18
 22      24      25      31      35      44      50      66      70      90


 *** --- opertaions available --- ***
 1. Insert a Node
 2. Display Inorder Traversal
 3. Display Preorder Traversal
 4. Display Postorder Traversal
 5. Exit
 Please enter your choice : 3

 Elements in the preorder traversala are :  25   15      10      4       12
 22      18      24      50      35      31      44      70      66      90


 *** --- opertaions available --- ***
 1. Insert a Node
 2. Display Inorder Traversal
 3. Display Preorder Traversal
 4. Display Postorder Traversal
 5. Exit
 Please enter your choice : 4

 Elements in the postorder traversala are :  4   12      10      18      24
 22      15      31      44      35      66      90      70      50      25


 *** --- opertaions available --- ***
 1. Insert a Node
 2. Display Inorder Traversal
 3. Display Preorder Traversal
 4. Display Postorder Traversal
 5. Exit
 Please enter your choice : 5_
```