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Experiment No. 4

Aim: Implementation of Binary Tree and 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 right child. The root element is pointed by a 'root' pointer.

Terminology:

- **Parent:** If N is one node in T that has left successor S_1 and right successor, S_2 then N is called the parent of S_1 and S_2.

- **Level number:** Every node in the binary tree is assigned to a level number.

- **Degree of a node**:- It is equal to the no 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

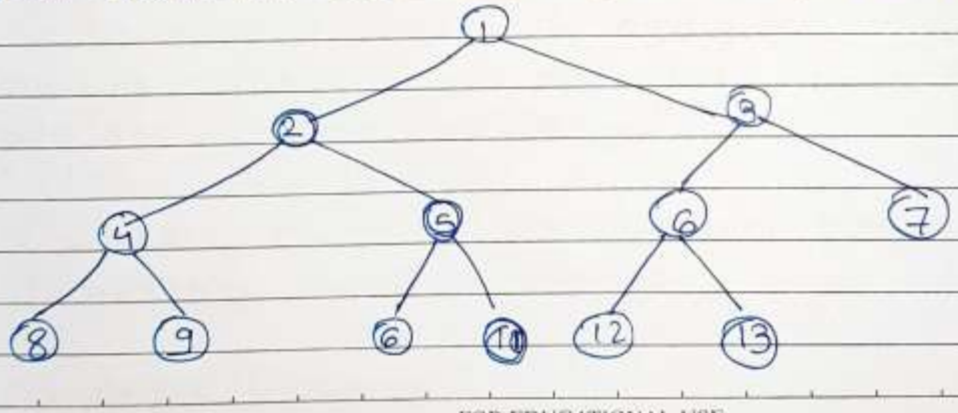
- **Similar binary trees**: Two binary trees are said to be similar. If both these trees have the same structure.

- **Edge**: It is the line connecting a node N to any of its successor.

- **Path**: A sequence of consecutive 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.



Operations :

① Searching : Find the location of some specific element in a binary tree.

② Insertion : Adding a new element to the tree at the appropriate location.

③ Deletion : Deleting some specific node from a binary tree

④ Traversing : Process of visiting each node exactly once.

Tree traversal and its Type :-

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 can traversed in many 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 operations 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 subtree

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 sub-tree
2) Traversing the right sub-tree, and 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 -> ~~RIGHT~~ LEFT)
SET TREE -> DATA = TEMP -> DATA
Delete (TREE -> LEFT, TEMP -> DATA)

ELSE
SET TEMP = TREE
IF TREE → LEFT = NULL and 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

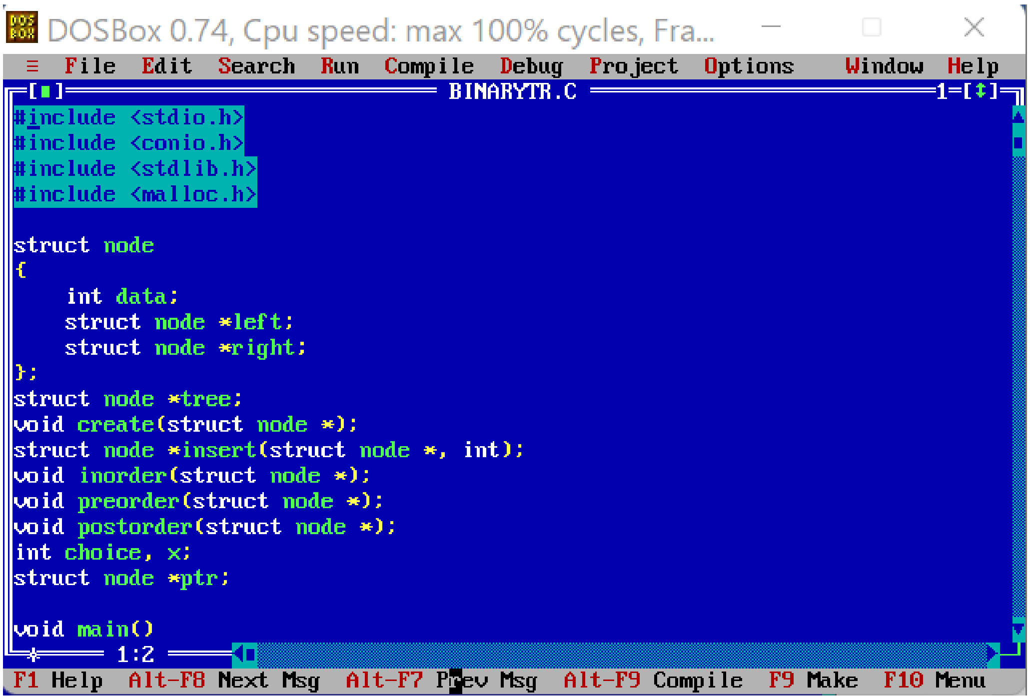
Example :- * Routing Tables : A routing table is used to link routers in a network.

* Trees are used in file System directories
* Trees are widely used for information storage and retrieval in a symbol tables.

Conclusion :- Thus we understand the concept of binary trees, their operations including traversal and its various types and also learn its implementation

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

***PROGRAM ON BINARY TREE AND ITS TRAVERSAL:-**



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BINARYTR.C

```
#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 *);
int choice, x;
struct node *ptr;

void main()
```

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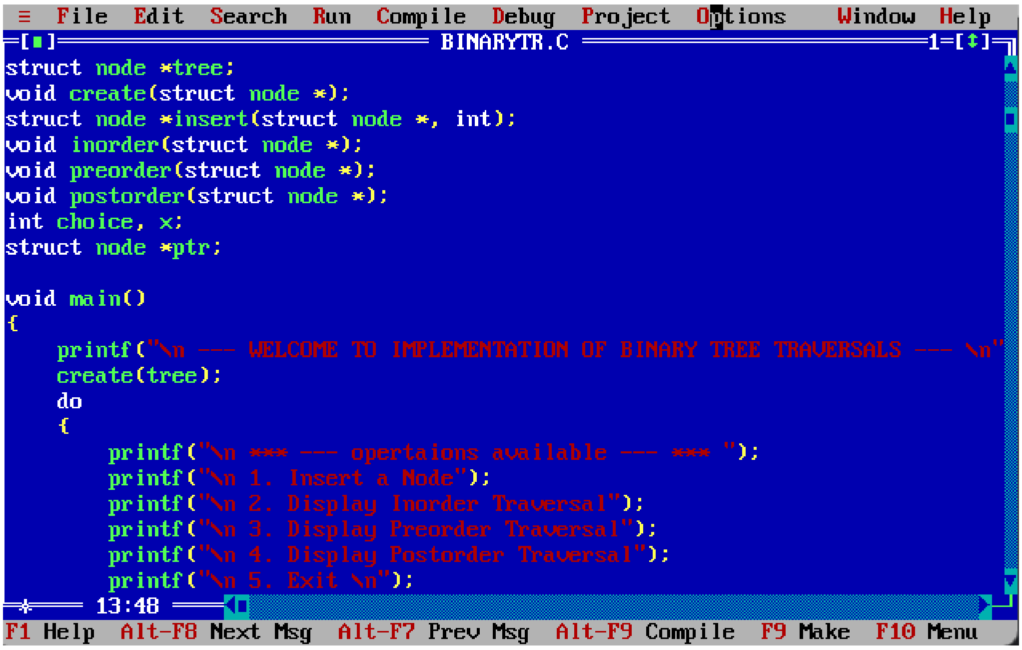

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BINARYTR.C

```
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 *);
int choice, x;
struct node *ptr;

void main()
{
    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");
```

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F1 Help Alt-F8 Next Msg Alt-F7 Prev Msg Alt-F9 Compile F9 Make F10 Menu

```
        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("\n Enter the data to be inserted : ");
            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);
```

```
        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;
}
```

```
{
    tree = NULL;
}

// 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;
```

```
    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
```

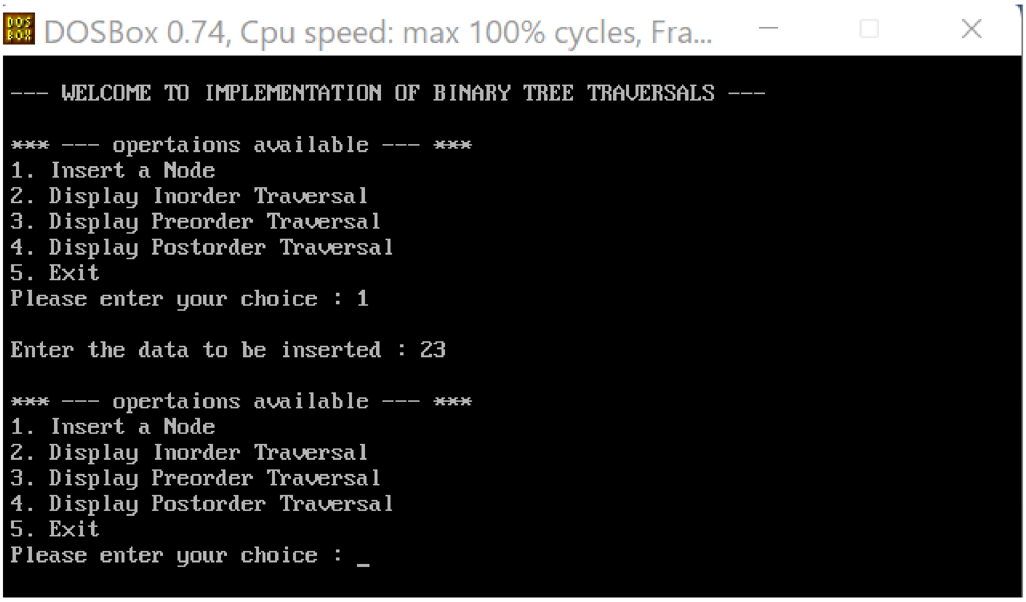
```
// Function for Inorder Traversals
void inorder(struct node *tree)
{
    if (tree != NULL)
    {
        inorder(tree->left);
        printf(" %d \t", tree->data);
        inorder(tree->right);
    }
}

// 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 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);
    }
}
```

***<u>OUTPUT:-</u>**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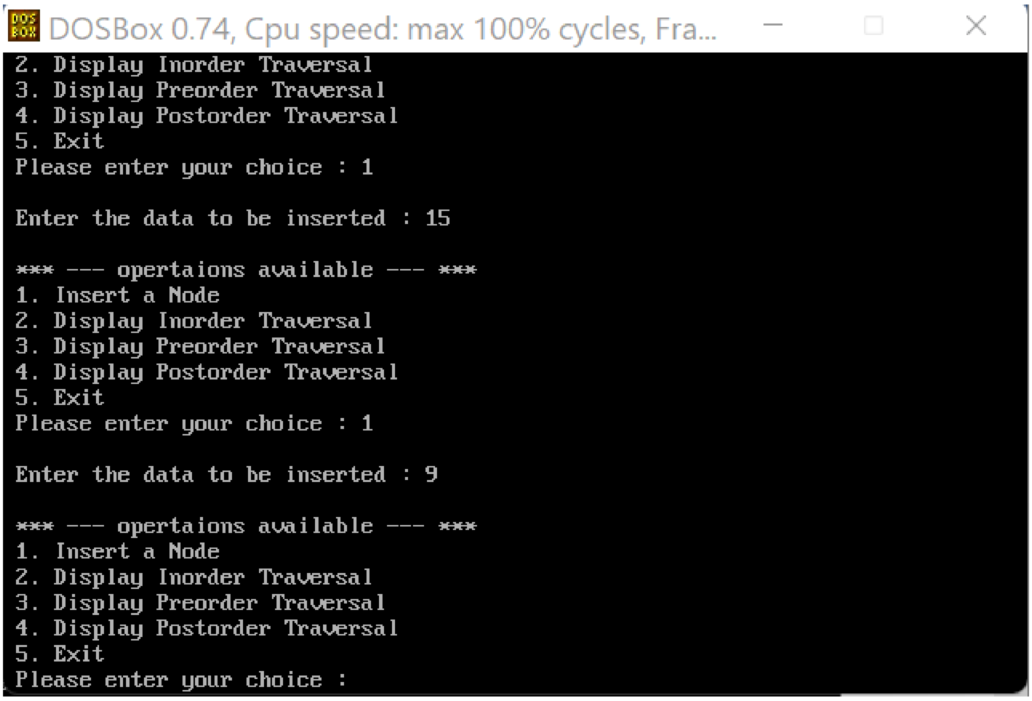
--- WELCOME TO IMPLEMENTATION OF BINARY TREE TRAVERSALS ---
*** --- opertaions available --- ***
1. Insert a Node
2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Please enter your choice : 1
Enter the data to be inserted : 23
*** --- opertaions available --- ***
1. Insert a Node
2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Please enter your choice : _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2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Please enter your choice : 1
Enter the data to be inserted : 15
*** --- 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 the data to be inserted : 9
*** --- opertaions available --- ***
1. Insert a Node
2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Please enter your choice :

DOSBox 0.74, Cpu speed: max 100% cycles, Fra...

```
2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Please enter your choice : 1

Enter the data to be inserted : 14

*** --- 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 the data to be inserted : 27

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

```
*** --- 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 :  9     14      15      23      27


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

DOSBox 0.74, Cpu speed: max 100% cycles, Fra...

```
4. Display Postorder Traversal
5. Exit
Please enter your choice : 2

Elements in the inorder traversala are :  9     14      15      23      27


*** --- 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 :  23   15      9       14      27


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

DOSBox 0.74, Cpu speed: max 100% cycles, Fra...

```
4. Display Postorder Traversal
5. Exit
Please enter your choice : 3

Elements in the preorder traversala are :  23   15      9       14      27


*** --- 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 :  14          9       15      27
23

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