Experiment NO 4

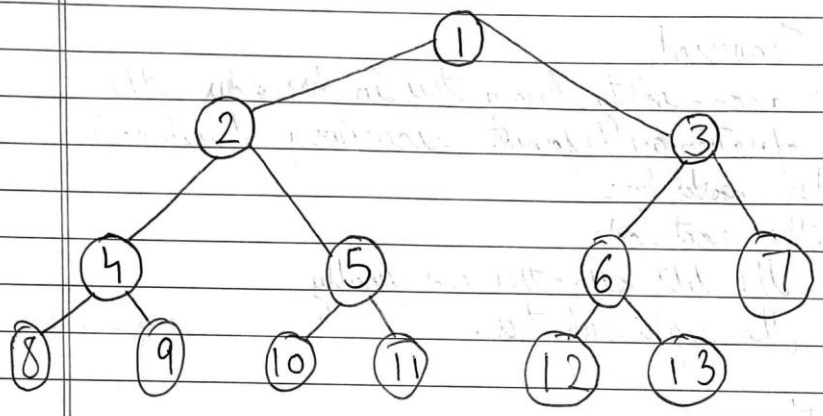
* Aim:- Implementation of Binary Tree and its Traversal for real world Programming.

* Objectives:-
1. To learn fundamental and implementation of Binary tree
2. To develop an ability to design and analyze algorithm using tree data structure.

* 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 node. 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 any node in T that has left successor S_1 and right successor S_2, then N is called parent of S_1 & 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 number of children that node has
- Sibling:- All nodes that are at the same level and share same parent are called siblings.
- Leaf node:- A node that has no children.
- Similar binary Tree:- Two binary trees are said to be similar if both have the same structure
- Edge:- It is a 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 a 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 types

=> Traversing a binary tree is the process of visiting each node in the tree exactly once in a systematic way. Unlike linear data structure in which the element are traversed sequentially, tree is a non-linear data structure in which the element can traversed in many different ways.

* Pre-Order Traversal

=> To traverse a non-empty binary tree in pre-order, the following operation 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.

* In-Order Traversal

=> To traverse a non-empty binary tree 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 subtree.

* Post-order Traversal

=> To traverse a non-empty binary tree in post order, the following operation 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 value

Step 1:- IF TREE -> DATA = VAL OR TREE = NULL
Return TREE
ELSE
IF VA < TREE -> DATA
Return search element (TREE -> LEFT VAL)
ELSE
Return search element (TREE -> RIGHT, NALVE)
[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 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

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

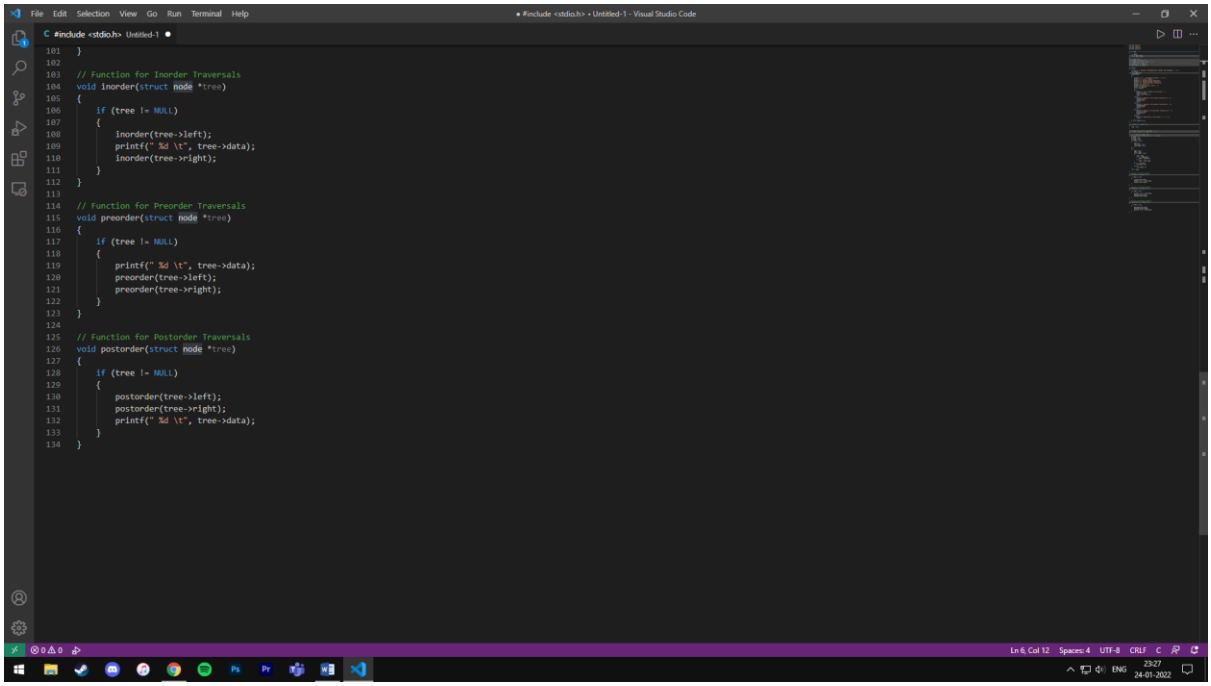
- Routing Tables: A routing table is used to link routers in a network
- Trees are used in file system directories.
- Trees are widely used for information storage and retrieval in symbol tables.

Conclusion: Thus we understand the concept of binary tree operations including Traversal and its various types and also learn its implementation.

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

```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 *);

void main()
{
    printf("\n --- WELCOME TO IMPLEMENTATION OF BINARY TREE TRAVERSALS --- \n");
    int choice, x;
    struct node *ptr;
    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("\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);
            printf("\n");
```

```c
            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;
}

// 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;
```


File Edit Selection View Go Run Terminal Help
• #include <stdio.h> • Untitled-1 - Visual Studio Code
#include <stdio.h> Untitled-1 •
}
// 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);
}
}
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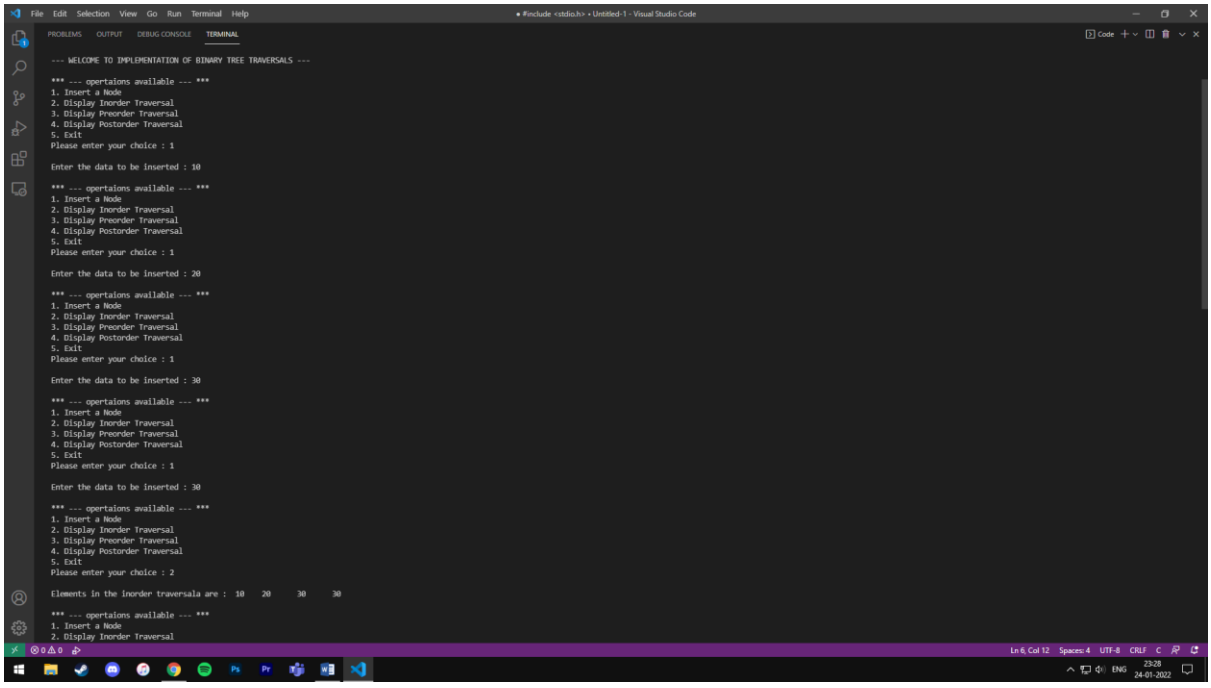
File Edit Selection View Go Run Terminal Help
• #include <stdio.h> • Untitled-1 - Visual Studio Code
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
Code
--- WELCOME TO IMPLEMENTATION OF BINARY TREE TRAVERSALS ---
*** --- opertaions available --- ***
1. Insert a Node
2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Please enter your choice : 1
Enter the data to be inserted : 10
*** --- 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 : 20
*** --- 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 : 30
*** --- 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 : 30
*** --- 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 : 10 20 30 30
*** --- opertaions available --- ***
1. Insert a Node
2. Display Inorder Traversal
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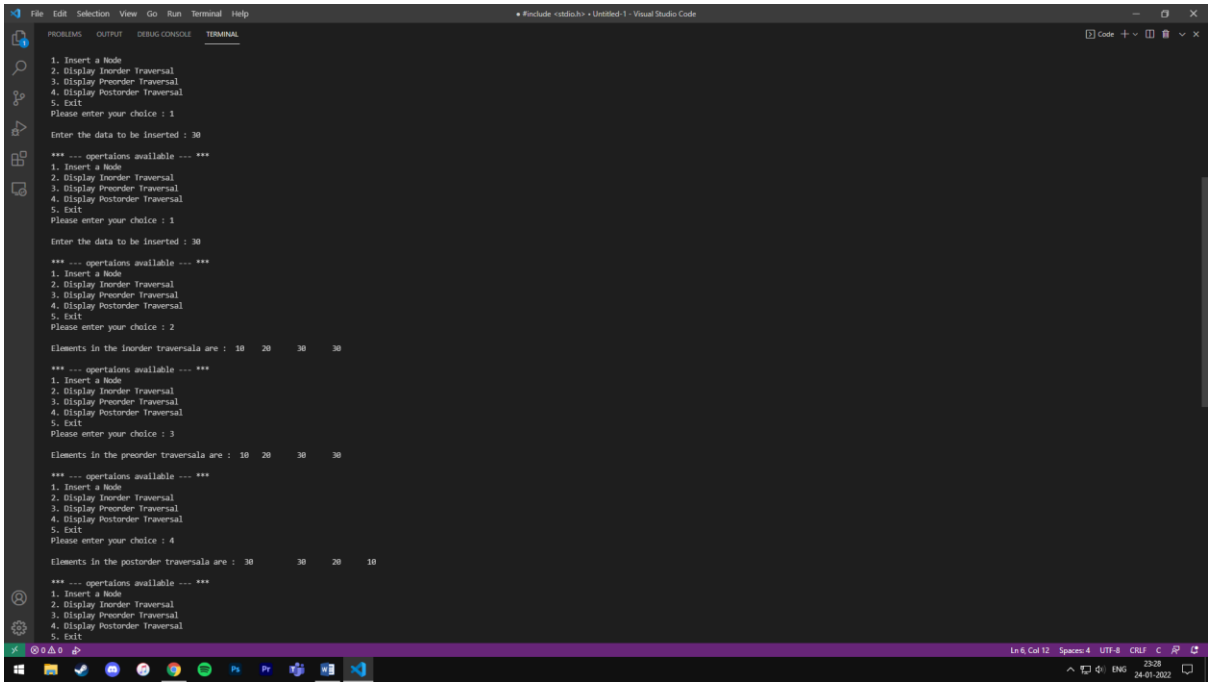
File Edit Selection View Go Run Terminal Help
• #include <stdio.h> • Untitled-1 - Visual Studio Code
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
Code
1. Insert a Node
2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Please enter your choice : 1
Enter the data to be inserted : 30
*** --- 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 : 30
*** --- 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 : 10 20 30 30
*** --- 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 : 10 20 30 30
*** --- 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 : 30 30 20 10
*** --- opertaions available --- ***
1. Insert a Node
2. Display Inorder Traversal
3. Display Preorder Traversal
4. Display Postorder Traversal
5. Exit
Ln 6, Col 12 Spaces: 4 UTF-8 CRLF C
ENG
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