Experiment No. 8: Binary Search Tree Operations

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Aim : Implementation of Binary Search Tree ADT using Linked List.

Objective:

1) Understand how to implement a BST using a predefined BST ADT.

2) Understand the method of counting the number of nodes of a binary tree.

Theory:

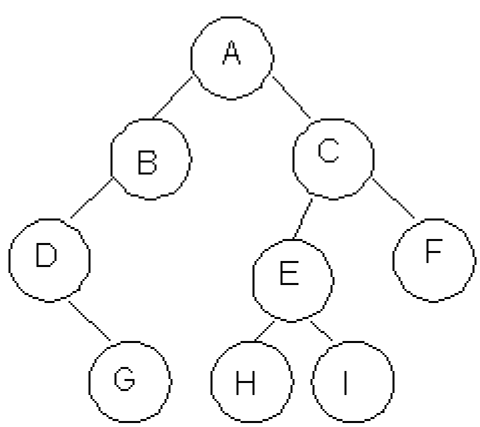
A binary tree is a finite set of elements that is either empty or partitioned into disjoint subsets. In other words node in a binary tree has at most two children and each child node is referred as left or right child.

Traversals in tree can be in one of the three ways : preorder, postorder, inorder.

Preorder Traversal

Here the following strategy is followed in sequence

1. Visit the root node R
2. Traverse the left subtree of R
3. Traverse the right sub tree of R



Description	Output
Visit Root	A
Traverse left sub tree – step to B then D	ABD
Traverse right sub tree – step to G	ABDG
As left subtree is over. Visit root , which is already visited so go for right subtree	ABDGC
Traverse the left subtree	ABDGCEH
Traverse the right sub tree	ABDGCEHI F

Inorder Traversal

Here the following strategy is followed in sequence

1. Traverse the left subtree of R
2. Visit the root node R
3. Traverse the right sub tree of R

Description	Output
Start with root and traverse left sub tree from A-B-D	D
As D doesn't have left child visit D and go for right subtree of D which is G so visit this.	DG
Backtrack to D and then to B and visit it.	DGB
Backtract to A and visit it	DGBA
Start with right sub tree from C-E-H and visit H	DGBAH
Now traverse through parent of H which is E and then I	DGBAHEI
Backtrack to C and visit it and then right subtree of E which is F	DGBAHEICF

Postorder Traversal

Here the following strategy is followed in sequence

1. Traverse the left subtree of R
2. Traverse the right sub tree of R
3. Visit the root node R

Description	**Output**
Start with left sub tree from A-B-D and then traverse right sub tree to get G	G
Now Backtrack to D and visit it then to B and visit it.	GD
Now as the left sub tree is over go for right sub tree	GDB
In right sub tree start with leftmost child to visit H followed by I	GDBHI
Visit its root as E and then go for right sibling of C as F	GDBHIEF
Traverse its root as C	GDBHIEFC
Finally a root of tree as A	GDBHIEFCA

Algorithm

Algorithm: PREORDER(ROOT)

Input : Root is a pointer to root node of binary tree

Output : Visiting all the nodes in preorder fashion.

Description : Linked structure of binary tree

1. ptr=ROOT
2. if ptr!=NULL then

   visit(ptr)

   PREORDER(LSON(ptr))\

   PREORDER(RSON(ptr))

   End if

3. Stop

Algorithm: INORDER(ROOT)

Input : Root is a pointer to root node of binary tree

Output : Visiting all the nodes in inorder fashion.

Description : Linked structure of binary tree

1. ptr=ROOT
2. if ptr!=NULL then
   INORDER (LSON(ptr))
   visit(ptr)
   INORDER (RSON(ptr))
   End if
3. Stop

Algorithm: POSTORDER(ROOT)

Input : Root is a pointer to root node of binary tree

Output : Visiting all the nodes in postorder fashion.

Description : Linked structure of binary tree

1. ptr=ROOT
2. if ptr!=NULL then
   PREORDER(LSON(ptr))
   PREORDER(RSON(ptr))
   visit(ptr)
   End if
3. Stop

Code:

```
#include <stdio.h>
```

```
#include <stdlib.h>
struct node {
   int data;
   struct node *leftChild, *rightChild;
};
struct node *root = NULL;
struct node *newNode(int item){
   struct node *temp = (struct node *)malloc(sizeof(struct node));
   temp->data = item;
   temp->leftChild = temp->rightChild = NULL;
   return temp;
}
void insert(int data){
   struct node *tempNode = (struct node*) malloc(sizeof(struct node));
   struct node *current;
   struct node *parent;
   tempNode->data = data;
   tempNode->leftChild = NULL;
   tempNode->rightChild = NULL;

   //if tree is empty
   if(root == NULL) {
      root = tempNode;
```

```
} else {
  current = root;
  parent = NULL;
  while(1) {
    parent = current;

    //go to left of the tree
    if(data < parent->data) {
      current = current->leftChild;

      //insert to the left
      if(current == NULL) {
        parent->leftChild = tempNode;
        return;
      }
    }//go to right of the tree
    else {
      current = current->rightChild;

      //insert to the right
      if(current == NULL) {
        parent->rightChild = tempNode;
        return;
```

```
         }
       }
     }
   }
}
struct node* search(int data){
   struct node *current = root;
   printf("\n\nVisiting elements: ");
   while(current->data != data) {
      if(current != NULL) {
         printf("%d ",current->data);

         //go to left tree
         if(current->data > data) {
            current = current->leftChild;
         }//else go to right tree
         else {
            current = current->rightChild;
         }

         //not found
         if(current == NULL) {
            return NULL;
```

```
      }
    }
  }
  return current;
}

// Inorder Traversal
void inorder(struct node *root){
  if (root != NULL) {
    inorder(root->leftChild);
    printf("%d -> ", root->data);
    inorder(root->rightChild);
  }
}

// Preorder Traversal
void preorder(struct node *root){
  if (root != NULL) {
    printf("%d -> ", root->data);
    preorder(root->leftChild);
    preorder(root->rightChild);
  }
}
```

```
// Postorder Traversal
void postorder(struct node *root){
  if (root != NULL) {
    printf("%d -> ", root->data);
    postorder(root->leftChild);
    postorder(root->rightChild);
  }
}
int main(){
  insert(10);
  insert(14);
  insert(19);
  insert(26);
  insert(27);
  insert(31);
  insert(33);
  insert(35);
  insert(42);
  insert(44);
  printf("Insertion done\n");
  printf("\nPreorder Traversal: ");
  preorder(root);
```

```
  printf("\nInorder Traversal: ");
  inorder(root);
  printf("\nPostorder Traversal: ");
  postorder(root);
  struct node* k;
  k = search(35);
  if(k != NULL)
    printf("\nElement %d found", k->data);
  else
    printf("\nElement not found");
  return 0;
}
```

Output:

```
Insertion done

Preorder Traversal: 10 -> 14 -> 19 -> 26 -> 27 -> 31 -> 33 -> 35 -> 42 -> 44 ->
Inorder Traversal: 10 -> 14 -> 19 -> 26 -> 27 -> 31 -> 33 -> 35 -> 42 -> 44 ->
Postorder Traversal: 10 -> 14 -> 19 -> 26 -> 27 -> 31 -> 33 -> 35 -> 42 -> 44 ->

Visiting elements: 10 14 19 26 27 31 33
Element 35 found
--------------------------------
```

Conclusion: Binary trees have many applications in computer science, including data storage and retrieval, expression evaluation, network routing, and game AI.