Practical 9: Implementation of Tree and Searching

Q-1. Write a program to do the following operations.

- Create a Binary Tree by collecting information from users.
- Create a Binary Search Tree by collecting information from users.
- Traverse the created trees using
  - preorder
  - postorder
  - inorder
  - level order
- Search Element in Binary Search Tree
- Find Internal Nodes, External Nodes, Total Nodes and Height of Tree

Source Code:

```
#include <stdio.h>

#include <stdlib.h>

struct Node {

int data;struct Node* left;

struct Node* right;

}

struct Node* create(int data) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct
   Node)); newNode->data = data;
   newNode->left = NULL;
   newNode->right = NULL;
   return newNode;
}

struct Node* insertNode(struct Node* root, int data) {
   if (root == NULL) {
      return create(data);
   }
   if (data < root->data) {
      root->left = insertNode(root->left, data);
   } else if (data> root->data) {
      root->right = insertNode(root->right, data);
   }
   return root;
}
```

```
struct Node* createBinaryTree() {
int data;
struct Node* root = NULL;
printf("Enter root node data: ");
scanf("%d", &data);
root = create(data);
printf("Enter left child of %d : ", data);
scanf("%d", &data);
if (data != -1) {

root->left = create(data);
printf("Enter left child of %d : ", root->left->data);
scanf("%d", &data);
if (data != -1) {
root->left->left = create(data);
}
printf("Enter right child of %d : ", root->left->data);
scanf("%d", &data);
if (data != -1) {
root->left->right = create(data);
}
}
printf("Enter right child of %d : ", data);
scanf("%d", &data);
if (data != -1) {
root->right = create(data);
printf("Enter left child of %d : ", root->right->data);
scanf("%d", &data);
if (data != -1) {
root->right->left = create(data);
}
printf("Enter right child of %d : ", root->right->data);
scanf("%d", &data);
if (data != -1) {
root->right->right = create(data);
}
}
return root;
}
```

```
void preorderTraversal(struct Node*
root) {

if (root == NULL)

return;

printf("%d ", root->data);

preorderTraversal(root->left);

preorderTraversal(root->right);

}

void inorderTraversal(struct Node*
root) {

if (root == NULL)

return;

inorderTraversal(root->left);

printf("%d ", root->data);

inorderTraversal(root->right);

}

void postorderTraversal(struct Node*
root) {

if (root == NULL)

return;

postorderTraversal(root->left);

postorderTraversal(root->right);

printf("%d ", root->data);

}
```

```
void levelorderTraversal(struct Node* root) {
if (root == NULL)
return;
struct Node** queue = (struct Node**)malloc(sizeof(struct Node*) * 100);
int front = -1;
int rear = -1;
queue[++rear] = root;
while (front < rear) {
struct Node* node = queue[++front];
printf("%d ", node->data);
if (node->left != NULL)
queue[++rear] = node->left;
if (node->right != NULL)
queue[++rear] = node->right;
}
}
void countNodesAndHeight(struct Node* root, int* internalNodes, int* externalNodes, int* totalNodes, int*
height) {
    if (root == NULL)
        return;

    (*totalNodes)++;
    if (root->left == NULL && root->right == NULL)
        (*externalNodes)++;
```

```
else
        (*internalNodes)++;
    int leftHeight = 0, rightHeight = 0;
    countNodesAndHeight(root->left, internalNodes, externalNodes, totalNodes, &leftHeight);
    countNodesAndHeight(root->right, internalNodes, externalNodes, totalNodes, &rightHeight);
    (*height) = 1 + (leftHeight > rightHeight ? leftHeight : rightHeight);
}
struct Node* searchNode(struct Node* root, int key) {
if (root == NULL || root->data == key)
return root;
if (root->data < key)
return searchNode(root->right, key);
else
return searchNode(root->left, key);
}


int main() {
        struct Node* root = NULL;
        int choice, data, key, internalNodes = 0, externalNodes = 0, totalNodes = 0, height = 0;
        do {
                printf("\n--- Binary Tree and Binary Search Tree Operations ---\n");
                printf("1. Create Binary Tree\n");
                printf("2. Create Binary Search Tree\n");
                printf("3. Preorder Traversal\n");
                printf("4. Inorder Traversal\n");
                printf("5. Postorder Traversal\n");
                printf("6. Levelorder Traversal\n");
                printf("7. Search Element in Binary Search Tree\n");
```

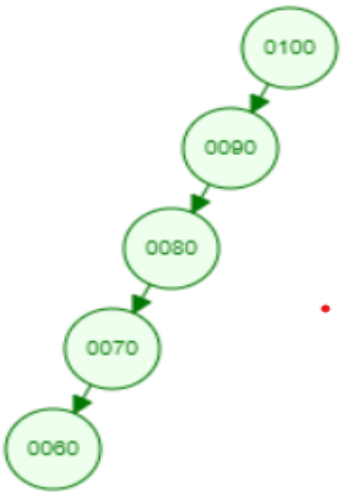
```
printf("8. Count Internal Nodes, External Nodes, Total Nodes, and Height of
Tree\n"); printf("9. Exit\n");

printf("Enter your choice:
"); scanf("%d", &choice);

switch (choice) {
   case 1:
      root = createBinaryTree();
      break;
   case 2:
      printf("Enter root node data: ");
      scanf("%d", &data);
      root = create(data);
      while (1) {
         printf("Enter data to be inserted: in stop then -1 ");
         scanf("%d", &data);
         if (data == -1)
            break;
         insertNode(root, data);
      }
      break;
   case 3:
      printf("Preorder Traversal: ");
      preorderTraversal(root);
      break;
   case 4:
      printf("Inorder Traversal: ");
      inorderTraversal(root);
      break;
   case 5:
      printf("Postorder Traversal: ");
      postorderTraversal(root);
      break;


case 6:
printf("Levelorder Traversal: ");
levelorderTraversal(root);
break;
case 7:
printf("Enter element to search: ");
scanf("%d", &key);
if (searchNode(root, key) != NULL)
printf("Element found in the tree.\n");
else
printf("Element not found in the tree.\n");
```

```
break;
case 8:
countNodesAndHeight(root, &internalNodes, &externalNodes, &totalNodes, &height);
printf("Total number of nodes in the tree: %d\n", totalNodes);
printf("Number of internal nodes in the tree: %d\n", internalNodes);
printf("Number of external nodes in the tree: %d\n", externalNodes);
printf("Height of the tree: %d\n", height);
break;
case 9:
printf("Exiting...\n");
exit(0);
default:
printf("Invalid choice!\n");
break;
}
} while (choice != 9);
return 0;
}
```



OUTPUT:

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```
--- Binary Tree and Binary Search Tree Operations ---
1. Create Binary Tree
2. Create Binary Search Tree
3. Preorder Traversal
4. Inorder Traversal
5. Postorder Traversal
6. Levelorder Traversal
7. Search Element in Binary Search Tree
8. Count Internal Nodes, External Nodes, Total Nodes, and Height of Tree
9. Exit
Enter your choice: 2
Enter root node data: 100
Enter data to be inserted: in stop then -1 100
Enter data to be inserted: in stop then -1 90
Enter data to be inserted: in stop then -1 80
Enter data to be inserted: in stop then -1 70
Enter data to be inserted: in stop then -1 60
Enter data to be inserted: in stop then -1 -1

--- Binary Tree and Binary Search Tree Operations ---
1. Create Binary Tree
2. Create Binary Search Tree
3. Preorder Traversal
4. Inorder Traversal
5. Postorder Traversal
6. Levelorder Traversal
7. Search Element in Binary Search Tree
8. Count Internal Nodes, External Nodes, Total Nodes, and Height of Tree
9. Exit
Enter your choice: 3
Preorder Traversal: 100 90 80 70 60
--- Binary Tree and Binary Search Tree Operations ---
1. Create Binary Tree
2. Create Binary Search Tree
3. Preorder Traversal
4. Inorder Traversal
5. Postorder Traversal
6. Levelorder Traversal
7. Search Element in Binary Search Tree
8. Count Internal Nodes, External Nodes, Total Nodes, and Height of Tree
9. Exit
Enter your choice: 6
Levelorder Traversal: 100 90 80 70 60
--- Binary Tree and Binary Search Tree Operations ---
1. Create Binary Tree
2. Create Binary Search Tree
3. Preorder Traversal
4. Inorder Traversal
5. Postorder Traversal
6. Levelorder Traversal
7. Search Element in Binary Search Tree
8. Count Internal Nodes, External Nodes, Total Nodes, and Height of Tree
9. Exit
Enter your choice:
```

Question 2:

2. Write a program to do the following operations.
- Create an array from user input.
- Search Element in an array using linear search - prints iteration done to find the element
- Search Element in an array using binary search - prints iteration done to find the element

Source Code:

```
#include <stdio.h>

int LinearSearch(int arr[],int size,intkey)

{

for(int i=0; i<size; i++){

if(arr[i]==key)

return i;

}

return -1;

}

int BinarySearch(int arr[],int size,int
        key){ int start=0;
        int end= size-1;

        while(start<= end){
                int mid= start+(end-start)/2;

                if(arr[mid]==key)
                        return mid;
                else if(arr[mid] > key)
                        end=mid-1;
                else
                        start=mid+1;
        }
        return start;
}
int main(){
        int size;
        printf("Enter the Size of Arrays :
        \n"); scanf("%d",&size);
        int arr[size];
                scanf("%d",&arr[i]);
        }
```

```
printf("Enter the Value in to Arrays : \n");
for(int i=0; i<size; i++){
scanf("%d",&arr[i]);
}
int key;
printf("Enter the Key to Want Search : ");
scanf("%d",&key);
int n;
printf("Enter the Number to Perform Perticular Searching Algorithm \n Zero (0) For Linear Search \n One (1) For Binary Search\n");
scanf("%d",&n);
switch(n){
case 0:
printf("Value will be available on This Index : %d\n",LinearSearch(arr,size,key));
break;
case 1:
printf("Value will be available on This Index : %d\n",BinarySearch(arr,size,key));
break;
default:
printf("You select wrong number : ");
break;
}
return 0;
}
```

Output:

```
Enter the Size of Arrays :
5
Enter the Value in to Arrays :
50
60
70
80
90
Enter the Key to Want Search : 80
Enter the Number to Perform Perticular Searching Algorithm
 Zero (0) For Linear Search
 One (1) For Binary Search
0
Value will be available on This Index : 3
```