Binary Search Tree

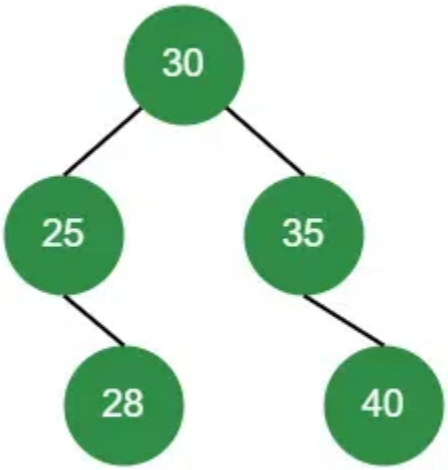
A binary Search Tree is a binary tree where the value of any node is greater than the left subtree and less than the right subtree. In this article, we will discuss Binary Search Trees and various operations on Binary Search trees using C programming language.

Properties of Binary Search Tree

Following are some main properties of the binary search tree in C:

- All nodes of the left subtree are less than the root node and nodes of the right subtree are greater than the root node.
- The In-order traversal of binary search trees gives the values in ascending order.
- All the subtrees of BST hold the same properties.

Example:



Binary Search Tree

Binary Tree Structure in C

```
struct BinaryTreeNode {

  int key;

  struct nodeBinaryTreeNode *left, *right;

};
```

here,

- **key**: It will be the data stored.
- **left**: Pointer to the left child.
- **right:** Pointer to the right child

```c
// C program to implement binary search tree
#include <stdio.h>
#include <stdlib.h>

// Define a structure for a binary tree node
struct BinaryTreeNode {
    int key;
    struct BinaryTreeNode *left, *right;
};

// Function to create a new node with a given value
struct BinaryTreeNode* newNodeCreate(int value)
{
    struct BinaryTreeNode* temp
        = (struct BinaryTreeNode*)malloc(
            sizeof(struct BinaryTreeNode));
    temp->key = value;
    temp->left = temp->right = NULL;
```

```
    return temp;
}

// Function to search for a node with a specific key in the
// tree
struct BinaryTreeNode*
searchNode(struct BinaryTreeNode* root, int target)
{
    if (root == NULL || root->key == target) {
        return root;
    }
    if (root->key < target) {
        return searchNode(root->right, target);
    }
    return searchNode(root->left, target);
}

// Function to insert a node with a specific value in the
// tree
struct BinaryTreeNode*
insertNode(struct BinaryTreeNode* node, int value)
{
    if (node == NULL) {
        return newNodeCreate(value);
    }
    if (value < node->key) {
        node->left = insertNode(node->left, value);
    }
    else if (value > node->key) {
        node->right = insertNode(node->right, value);
    }
    return node;
}

// Function to perform post-order traversal
void postOrder(struct BinaryTreeNode* root)
{
    if (root != NULL) {
```

```
        postOrder(root->left);
        postOrder(root->right);
        printf(" %d ", root->key);
    }
}

// Function to perform in-order traversal
void inOrder(struct BinaryTreeNode* root)
{
    if (root != NULL) {
        inOrder(root->left);
        printf(" %d ", root->key);
        inOrder(root->right);
    }
}

// Function to perform pre-order traversal
void preOrder(struct BinaryTreeNode* root)
{
    if (root != NULL) {
        printf(" %d ", root->key);
        preOrder(root->left);
        preOrder(root->right);
    }
}

// Function to find the minimum value
struct BinaryTreeNode* findMin(struct BinaryTreeNode* root)
{
    if (root == NULL) {
        return NULL;
    }
    else if (root->left != NULL) {
        return findMin(root->left);
    }
    return root;
}

// Function to delete a node from the tree
struct BinaryTreeNode* delete (struct BinaryTreeNode* root,
```

```
                                int x)
{
    if (root == NULL)
        return NULL;

     if (x > root->key) {
        root->right = delete (root->right, x);
    }
    else if (x < root->key) {
        root->left = delete (root->left, x);
    }
    else {
        if (root->left == NULL && root->right == NULL) {
            free(root);
            return NULL;
        }
        else if (root->left == NULL
                 || root->right == NULL) {
            struct BinaryTreeNode* temp;
            if (root->left == NULL) {
                temp = root->right;
            }
            else {
                temp = root->left;
            }
            free(root);
            return temp;
        }
        else {
            struct BinaryTreeNode* temp
                = findMin(root->right);
            root->key = temp->key;
            root->right = delete (root->right, temp->key);
        }
    }
    return root;
}
```

```c
int main()
{
    // Initialize the root node
    struct BinaryTreeNode* root = NULL;

     // Insert nodes into the binary search tree
    root = insertNode(root, 50);
    insertNode(root, 30);
    insertNode(root, 20);
    insertNode(root, 40);
    insertNode(root, 70);
    insertNode(root, 60);
    insertNode(root, 80);

     // Search for a node with key 60
    if (searchNode(root, 60) != NULL) {
        printf("60 found");
    }
    else {
        printf("60 not found");
    }

     printf("\n");

     // Perform post-order traversal
    postOrder(root);
    printf("\n");

     // Perform pre-order traversal
    preOrder(root);
    printf("\n");

     // Perform in-order traversal
    inOrder(root);
    printf("\n");

     // Perform delete the node (70)
    struct BinaryTreeNode* temp = delete (root, 70);
    printf("After Delete: \n");
```

```
    inOrder(root);

     // Free allocated memory (not done in this code, but
    // good practice in real applications)

     return 0;
}
```

Output

```
60 found

 20  40  30  60  80  70  50

 50  30  20  40  70  60  80

 20  30  40  50  60  70  80

After Delete:

 20  30  40  50  60  80
```