**PROGRAM 4)** Write a program to perform insertion and deletion operations on AVL trees.

CODE:

// AVL tree implementation in C

#include <stdio.h>

#include <stdlib.h>

// Create Node

struct Node {

int key;

struct Node \*left;

struct Node \*right;

int height;

};

int max(int a, int b);

// Calculate height

int height(struct Node \*N) {

if (N == NULL)

return 0;

return N->height;

}

int max(int a, int b) {

return (a > b) ? a : b;

}

// Create a node

struct Node \*newNode(int key) {

struct Node \*node = (struct Node \*)

malloc(sizeof(struct Node));

node->key = key;

node->left = NULL;

node->right = NULL;

node->height = 1;

return (node);

}

// Right rotate

struct Node \*rightRotate(struct Node \*y) {

struct Node \*x = y->left;

struct Node \*T2 = x->right;

x->right = y;

y->left = T2;

y->height = max(height(y->left), height(y->right)) + 1;

x->height = max(height(x->left), height(x->right)) + 1;

return x;

}

// Left rotate

struct Node \*leftRotate(struct Node \*x) {

struct Node \*y = x->right;

struct Node \*T2 = y->left;

y->left = x;

x->right = T2;

x->height = max(height(x->left), height(x->right)) + 1;

y->height = max(height(y->left), height(y->right)) + 1;

return y;

}

// Get the balance factor

int getBalance(struct Node \*N) {

if (N == NULL)

return 0;

return height(N->left) - height(N->right);

}

// Insert node

struct Node \*insertNode(struct Node \*node, int key) {

// Find the correct position to insertNode the node and insertNode it

if (node == NULL)

return (newNode(key));

if (key < node->key)

node->left = insertNode(node->left, key);

else if (key > node->key)

node->right = insertNode(node->right, key);

else

return node;

// Update the balance factor of each node and

// Balance the tree

node->height = 1 + max(height(node->left),

height(node->right));

int balance = getBalance(node);

if (balance > 1 && key < node->left->key)

return rightRotate(node);

if (balance < -1 && key > node->right->key)

return leftRotate(node);

if (balance > 1 && key > node->left->key) {

node->left = leftRotate(node->left);

return rightRotate(node);

}

if (balance < -1 && key < node->right->key) {

node->right = rightRotate(node->right);

return leftRotate(node);

}

return node;

}

struct Node \*minValueNode(struct Node \*node) {

struct Node \*current = node;

while (current->left != NULL)

current = current->left;

return current;

}

// Delete a nodes

struct Node \*deleteNode(struct Node \*root, int key) {

// Find the node and delete it

if (root == NULL)

return root;

if (key < root->key)

root->left = deleteNode(root->left, key);

else if (key > root->key)

root->right = deleteNode(root->right, key);

else {

if ((root->left == NULL) || (root->right == NULL)) {

struct Node \*temp = root->left ? root->left : root->right;

if (temp == NULL) {

temp = root;

root = NULL;

} else

\*root = \*temp;

free(temp);

} else {

struct Node \*temp = minValueNode(root->right);

root->key = temp->key;

root->right = deleteNode(root->right, temp->key);

}

}

if (root == NULL)

return root;

// Update the balance factor of each node and

// balance the tree

root->height = 1 + max(height(root->left),

height(root->right));

int balance = getBalance(root);

if (balance > 1 && getBalance(root->left) >= 0)

return rightRotate(root);

if (balance > 1 && getBalance(root->left) < 0) {

root->left = leftRotate(root->left);

return rightRotate(root);

}

if (balance < -1 && getBalance(root->right) <= 0)

return leftRotate(root);

if (balance < -1 && getBalance(root->right) > 0) {

root->right = rightRotate(root->right);

return leftRotate(root);

}

return root;

}

void PreOrder(struct Node \*root) {

if (root != NULL) {

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

PreOrder(root->left);

PreOrder(root->right);

}

}

int main() {

struct Node \*root = NULL;

int n,x,num,y;

printf("Enter the size:\n");

scanf("%d",&n);

printf("\n INSERTION IN AVL TREES\n");

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

printf("\nEnter the value to be inserted:\n");

scanf("%d",&x);

root = insertNode(root,x);

printf("\nAfter insertion of node:\n");

PreOrder(root);

}

printf("\n DELETION IN AVL TREES\n");

printf("\nEnter the number of values to be deleted:\n");

scanf("%d",&num);

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

printf("\nEnter the value to be deleted:\n");

scanf("%d",&y);

root = deleteNode(root,y);

printf("\nAfter deletion of node:\n");

PreOrder(root);

}

return 0;

}

OUTPUT:



