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**190905522 CSE D 62**

**DAA Lab 7 (Week 7) – Transform and Conquer – I**

1. **Modify the solved exercise to find the balance factor for every node in the binary search tree.**

**CODE:**

#include<stdio.h>

#include<stdlib.h>

#define MAX(a,b) ((a)>(b) ? a : b)

typedef struct node{

    int val;

    struct node \*left;

    struct node \*right;

}\*NODE;

NODE insert(NODE root,int x){

    if(root==NULL){

        root=(NODE)malloc(sizeof(struct node));

        root->val=x;

        root->left=root->right=NULL;

    }

    else if(x>root->val)

        root->right=insert(root->right,x);

    else if(x<root->val)

        root->left=insert(root->left,x);

    else{

        printf("Duplicate node\n");

        exit(0);

    }

    return(root);

}

void postorder(NODE cur){

    if(cur){

        postorder(cur->left);

        postorder(cur->right);

        printf("%4d",cur->val);

    }

}

void preorder(NODE cur){

    if(cur){

        printf("%4d",cur->val);

        preorder(cur->left);

        preorder(cur->right);

    }

}

void inorder(NODE cur){

    if(cur){

        inorder(cur->left);

        printf("%4d",cur->val);

        inorder(cur->right);

    }

}

int height(NODE cur){

    if (cur == NULL)

        return -1;

    else

        return MAX(height(cur->left),height(cur->right))+1;

}

void balancefactor(NODE cur){

    static int x;

    if(cur){

        balancefactor(cur->left);

        x = height(cur->left)-height(cur->right);

        printf("\nNode with value %d has a balance factor of %d",cur->val,x);

        balancefactor(cur->right);

    }

}

int main(){

    NODE root = NULL;

    int ch,x;

    do{

        printf("\n1.Enter element(no duplicates)  2. Print elements  3. Show balance factor  4.Exit    Enter choice : ");

        scanf("%d",&ch);

        switch (ch){

            case 1 : printf("Enter element : ");

                     scanf("%d",&x);

                     root = insert(root,x);

                     break;

            case 2 : printf("\nInorder traversal is : ");

                     inorder(root);

                     printf("\nPreorder traversal is : ");

                     preorder(root);

                     printf("\nPostorder traversal is : ");

                     postorder(root);

                     break;

            case 3 : balancefactor(root);

                     break;

            case 4 : break;

            default:

                break;

        }

    }while(ch != 4);

    return 0;

}

**OUTPUT:**

**Text

Description automatically generated**

**Time Complexity Analysis:**

The number of additions made is A(n) = n and the number of comparisons made to check whether tree is empty is C(n) = 2n+1 for finding the height of the subtree, which is called upon to get the balance factor, where n is the total number of nodes from that node to the bottom most leaf node. Therefore, the order of growth is belonging to **Θ(n)** for that subtree.

1. **Write a program to create the AVL tree by iterative insertion.**

**CODE:**

#include<stdio.h>

#include<stdlib.h>

#define MAX(a,b) ((a)>(b) ? a : b)

typedef struct node{

    int val;

    struct node \*left;

    struct node \*right;

    int height;

}\*NODE;

int height(NODE cur){

    if(cur == NULL)

        return 0;

    return cur->height;

}

NODE newNode(int key){

    NODE new = (NODE)malloc(sizeof(struct node));

    new->val=key;

    new->height=1;

    new->left=NULL;

    new->right=NULL;

    return(new);

}

NODE rRotate(NODE y){

    NODE x = y->left;

    NODE T2 = x->right;

*//Rotate here*

    x->right = y;

    y->left = T2;

*//Update height here*

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

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

    return x; *//new root*

}

NODE lRotate(NODE y){

    NODE x = y->right;

    NODE T2 = x->left;

    x->left = y;

    y->right = T2;

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

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

    return x;

}

int balFactor(NODE cur){

    if(cur == NULL)

        return 0;

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

}

NODE insert(NODE new, int k){

    if(new == NULL)

        return(newNode(k));

    if(k < new->val)

        new->left = insert(new->left, k);

    else if(k > new->val)

        new->right = insert(new->right, k);

    else

        return new;

    new->height = MAX(height(new->left),height(new->right))+1;

    int bal = balFactor(new);

*//Now to check all four cases of imbalance we have:*

    if(bal>1 && k < new->left->val) *//LeftLeftCase*

        return rRotate(new);

    if(bal<-1 && k > new->right->val)*//RightRightCase*

        return lRotate(new);

    if(bal>1 && k > new->left->val){*//LeftRightCase*

        new->left = lRotate(new->left);

        return rRotate(new);

    }

    if (bal<-1 && k < new->right->val){*//RightLeftCase*

        new->right = rRotate(new->right);

        return lRotate(new);

    }

*//return unchanged node*

    return new;

}

void inorder(NODE cur){

    if(cur != NULL){

        inorder(cur->left);

        printf("%d ",cur->val);

        inorder(cur->right);

    }

}

int main(){

    NODE root = NULL;

    int ch,x;

    do{

        printf("\n1.Enter element(no duplicates)  2. Print inorder of AVL Tree  3.Exit    Enter choice : ");

        scanf("%d",&ch);

        switch (ch){

            case 1 : printf("Enter element : ");

                     scanf("%d",&x);

                     root = insert(root,x);

                     break;

            case 2 : printf("\nInorder traversal is : ");

                     inorder(root);

                     break;

            case 3 : break;

            default: break;

        }

    }while(ch != 3);

    return 0;

}

**OUTPUT:**

**Text

Description automatically generated**

**Time Complexity Analysis**

The number of nodes on some level ‘k’ of the binary tree can have value 2k.

The complexity of the operations on such trees belongs to **Θ(log2n).**

The steps of conversion for the same tree as used in the example:

A piece of paper with writing on it

Description automatically generated with medium confidence

**THE END**