UCS 2312 Data Structures Lab

Assignment 7: Implementation of AVL Tree

Date of Assignment: 30.10.2023

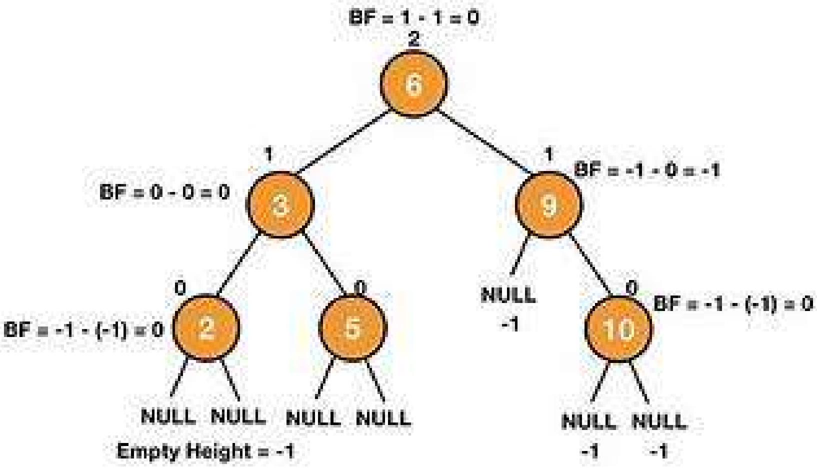
Design an ADT for the AVL Tree data structure with the following functions. Each node consists of a character data, address of left, right and parent nodes

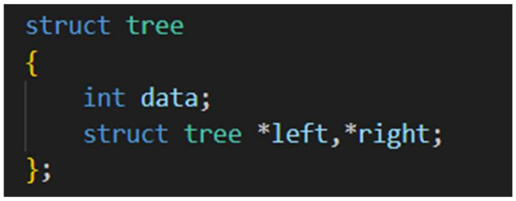
a. insertAVL(t, data) – insert data into BST
b. hierarchical(t) – display the tree in hierarchical fashion
c. findParent(t, key) – will return the parent of the given data

Demonstrate the AVL ADT with the insertion of the following character data one at a time.

H, I, J, B, A, E, C, F, D, G, K, L

Data Structure – AVL Tree:





```
struct tree
{
    int data;
    struct tree *left,*right;
};
```

Algorithm –

Algorithm: Insert data into BST

Input – Pointer to tree, data to be added to tree

Output – struct tree *

```
1.  if (t==NULL)
        t=(struct tree *)malloc(sizeof(struct tree));
        t->data=data;
        t->right=NULL;
        t->left=NULL;
2.  else if(data<t->data)
        t->left=insert(t->left,data)
        if(height(t->left)-height(t->right)==2)
            if(data<t->left->data)
                t=singlerotateleft(t)
            else
                t=doublerotateleft(t)
3.  else if(data>t->data)
        t->right=insert(t->right,data)
        if(height(t->right)-height(t->left)==2)
            if(data<t->left->data)
                t=singlerotateright(t)
            else
                t=doublerotateright(t)

4.  t->height=max(heigth(t->left),height(t->right))+1
5.  return t;
```

Algorithm: display the tree in hierarchical fashion

Input – Pointer to tree, space

Output – void

```
1.  if (t==NULL)
        return
2.  space+=1
3.  hierarchical(t->right,space)
4.  print \n
5.  for i from 0 till space-1
        print \t
6.  print data and \n
7.  hierarchical(t->left,space)
```

Algorithm: will return the parent of the given data

Input – Pointer to tree, key

Output – struct tree *

```
1.  if (t->left==NULL && t->right==NULL)
        return NULL
2.  else if(t->left->data==key || t->right->data==key)
        return t
3.  else if(t->data>key)
        findParent(t->left,key)
```

4. else if(t->data<key)
   findParent(t->right,key)

AVLtree.h code:

```
struct tree
{
      int data;
      struct tree *left,*right;
      int height;
};
#define c 1
int height(struct tree *t)
{
      if(t==NULL)
            return -1;
      else
            return t->height;
}

int max(int a,int b)
{
      if(a>b)
            return a;
      return b;
}

struct tree* singlerotateleft(struct tree *k2)
{
      struct tree *k1 = k2->left;
      k2->left = k1->right;
      k1->right = k2;
      k2->height = max(height(k2->left),height(k2->right)) + 1;
      k1->height = max(height(k1->left),height(k1->right)) + 1;
      return k1;
}

struct tree* singlerotateright(struct tree *k1)
{
      struct tree *k2 = k1->right;
      k1->right = k2->left;
      k2->left = k1;
      k1->height = max(height(k1->left),height(k1->right)) + 1;
      k2->height = max(height(k2->left),height(k2->right)) + 1;
      return k2;
}

struct tree* findParent(struct tree* t,int key)
{
    if (t->left==NULL && t->right==NULL)
        return NULL;
    else if (t->left->data==key || t->right->data==key)
      {
        return t;
    }
    else if (t->data>key)
      {
        findParent(t->left, key);
    }
      else if (t->data<key)
      {
           findParent(t->right, key);
      }
}

void hierarchical(struct tree *t, int space)
{
      if(t == NULL)
           return;
      space+=c;
      hierarchical(t->right, space);
      printf("\n");
      for(int i = 0 ; i < space; i++)
      {
           printf("\t");
      }
      printf("%d\n", t->data);
      hierarchical(t->left, space);
}

struct tree *doublerotateleft(struct tree * k1)
{
      k1->left = singlerotateright(k1->left);
      return singlerotateleft(k1);
}

struct tree *doublerotateright(struct tree * k1)
{
      k1->right  = singlerotateleft(k1->right);
      return singlerotateright(k1);
}

struct tree* insert(struct tree *t,int x)
{
      if(t==NULL)
      {
           t=(struct tree *)malloc(sizeof(struct tree));
           t->data=x;
           t->height=0;
           t->left=t->right=NULL;
      }
      else if(x<t->data)
      {
           t->left=insert(t->left,x);
           if(height(t->left)-height(t->right)==2)
           {
                 if(x<t->left->data)
                       t=singlerotateleft(t);
                 else
```

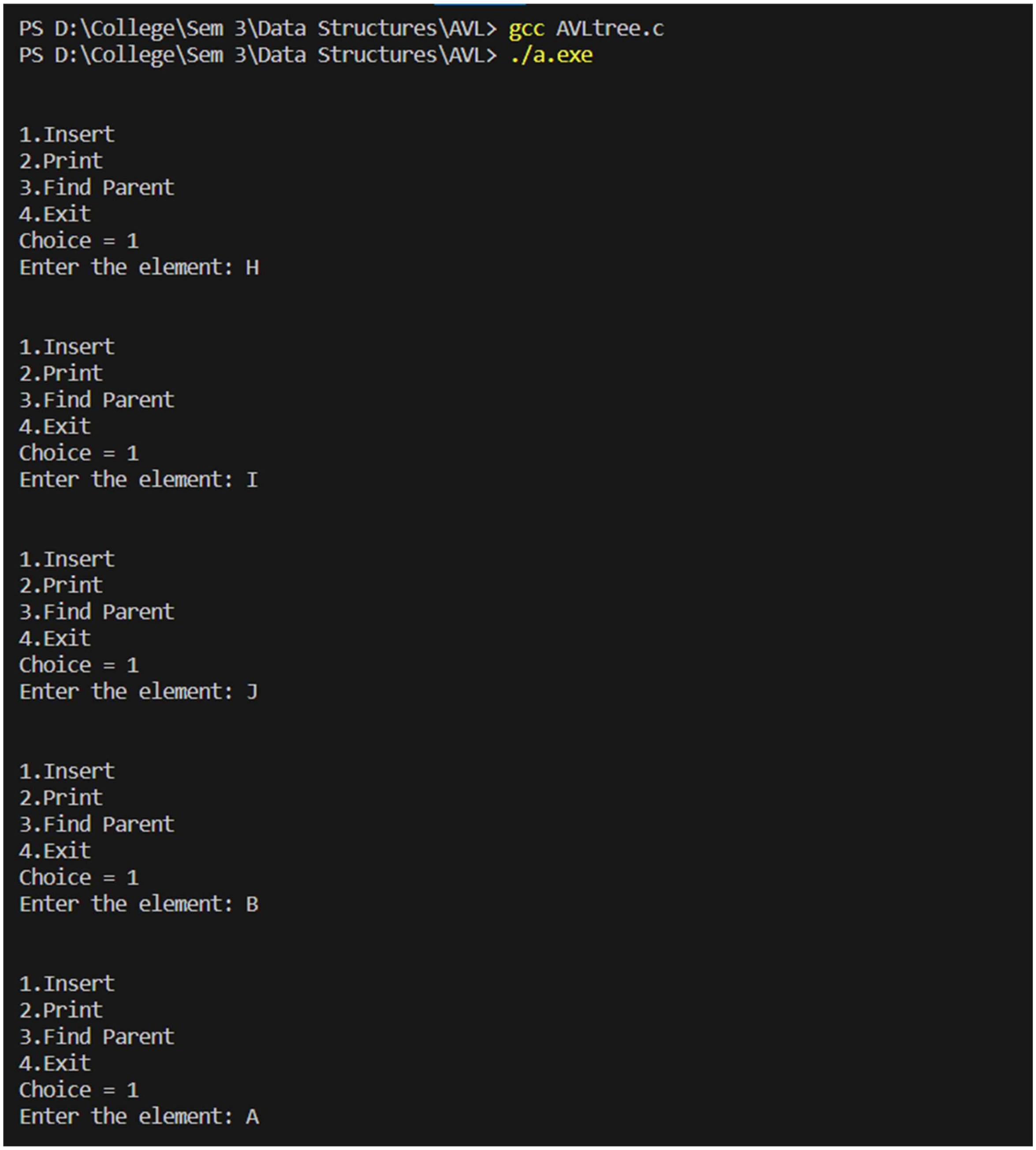
```
                    t=doublerotateleft(t);
            }
      }
      else if(x>t->data)
      {
            t->right=insert(t->right,x);
            if(height(t->right)-height(t->left)==2)
            {
                  if(x>t->right->data)
                        t=singlerotateright(t);
                  else
                        t=doublerotateright(t);
            }
      }
      t->height=max(height(t->left),height(t->right))+1;
      return t;
}
```

AVLtree.c code:

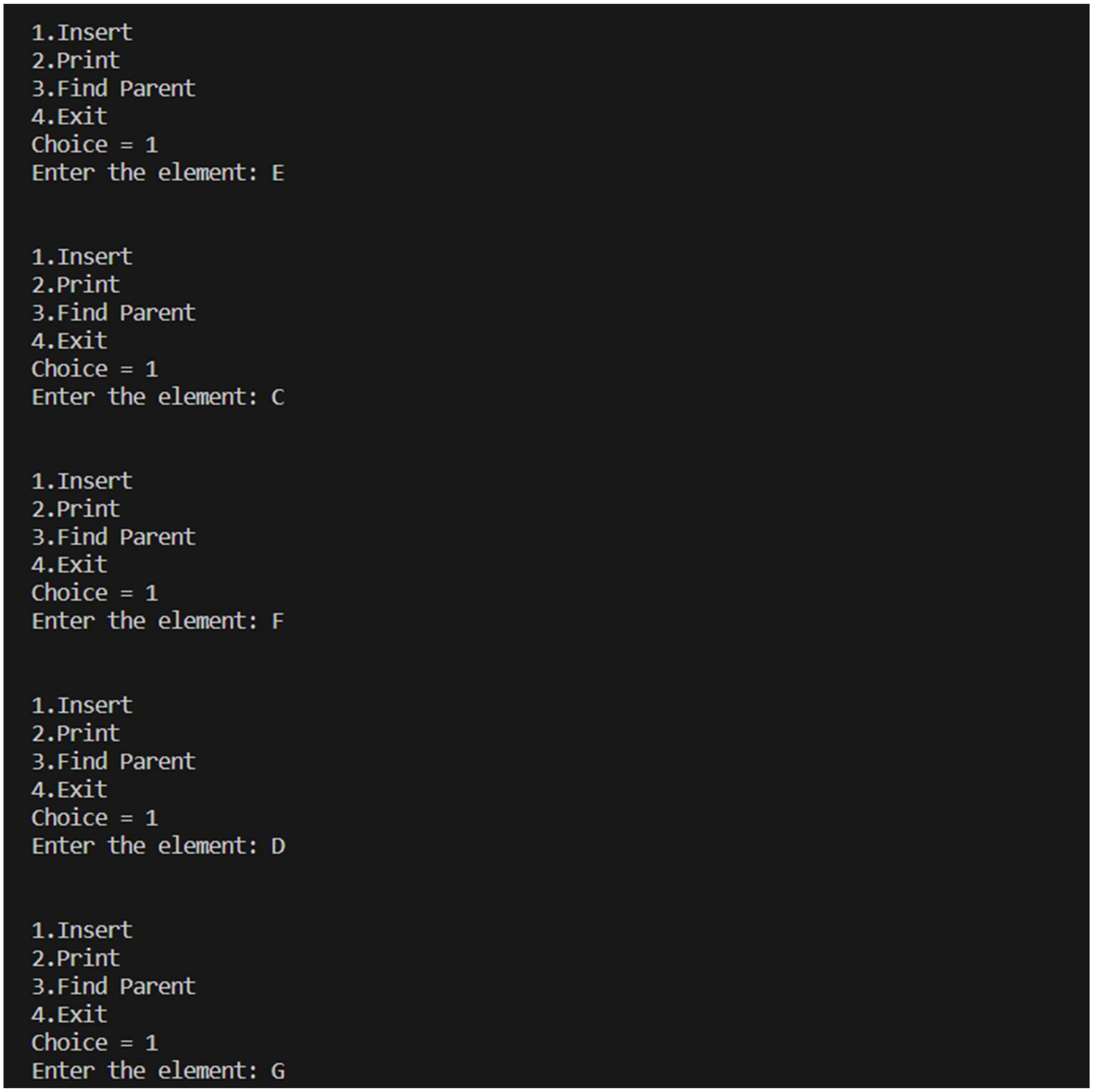
```
#include<stdio.h>
#include<stdlib.h>
#include"AVLtree.h"

void main()
{

      struct tree* t=NULL;
      int choice=100;
      int el;
      while(choice!=4)
      {
            printf("\n\n1.Insert\n2.Print\n3.Find Parent\n4.Exit\nChoice =
");
            scanf("%d",&choice);
            switch(choice)
            {
                  case 1:
                  printf("Enter the element: ");
                  scanf("%d",&el);
                  t=insert(t,el);
                  break;
                  case 2:
                  hierarchical(t,0);
                  printf("\n\n");
                  break;
                  case 3:
                  printf("Enter the element: ");
                  scanf("%d",&el);
                  struct tree *parent=findParent(t,el);
                  if(parent!=NULL)
                        printf("Parent = %d",parent->data);
                  else
                        printf("Element Not Found");
                  break;
```

```
                        case 4:
                        exit(0);
                        break;
                }
        }
}
```

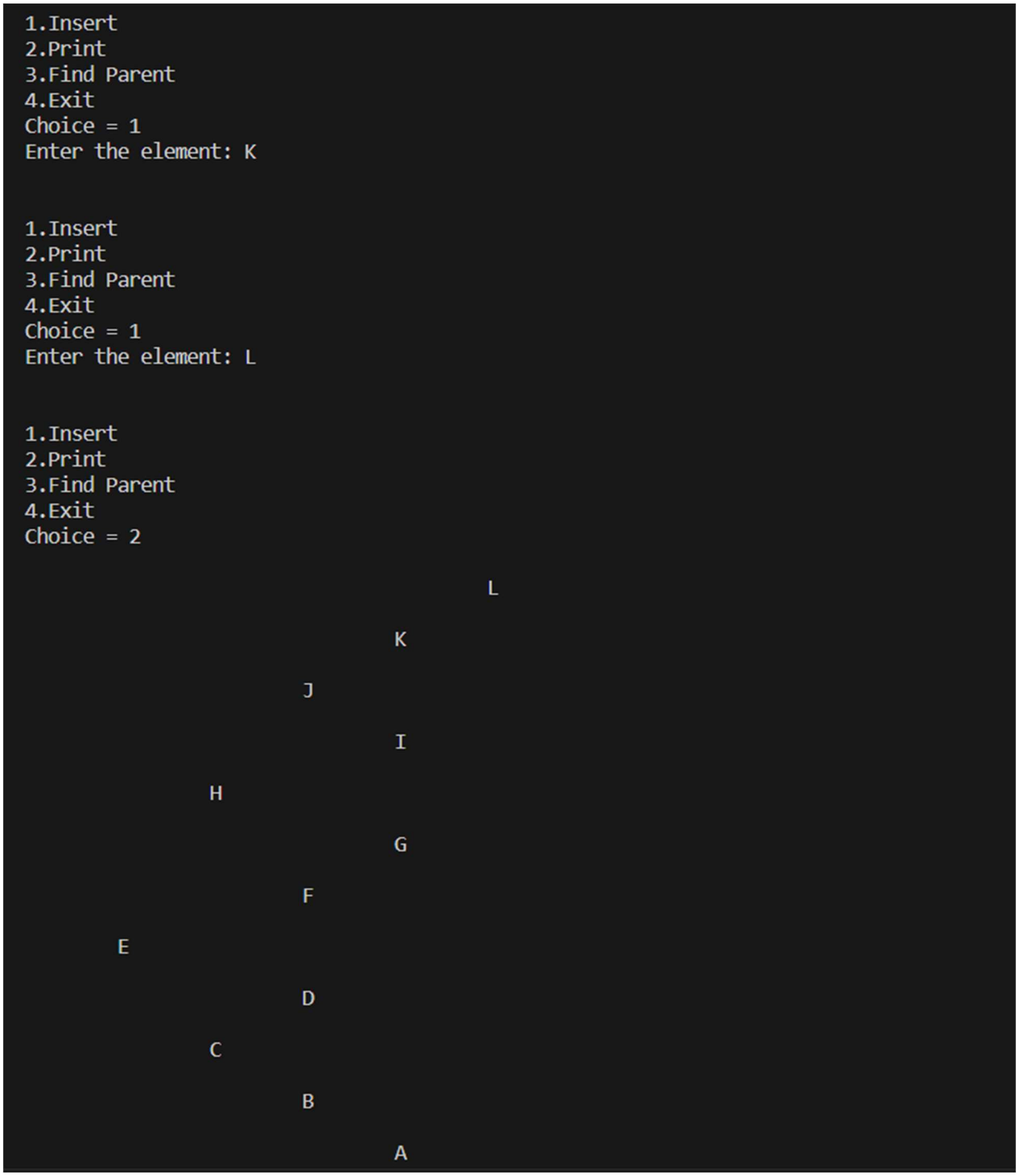
Output Screen:



```
PS D:\College\Sem 3\Data Structures\AVL> gcc AVLtree.c
PS D:\College\Sem 3\Data Structures\AVL> ./a.exe


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: H


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: I


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: J


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: B


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: A
```

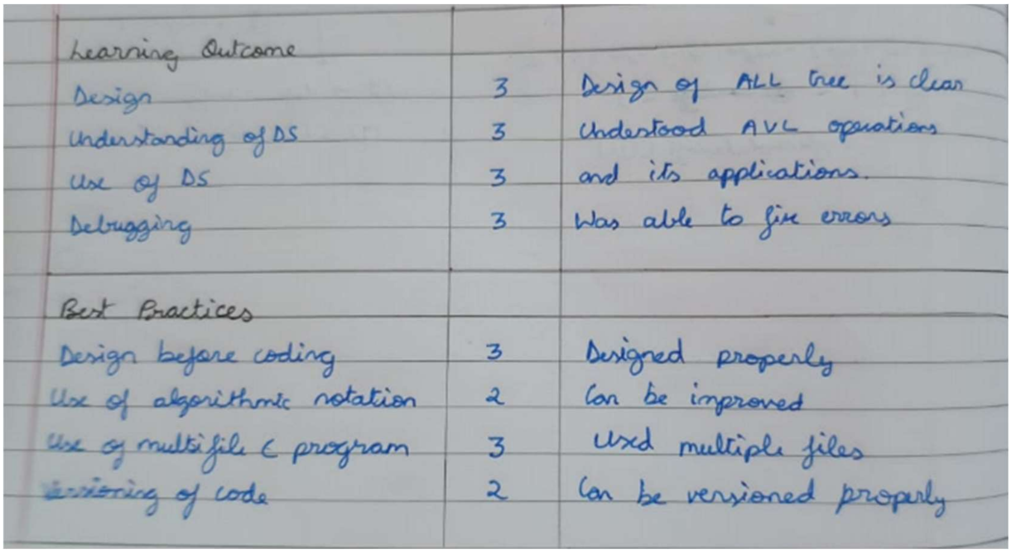


```
1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: E


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: C


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: F


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: D


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: G
```



```
1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: K


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 1
Enter the element: L


1.Insert
2.Print
3.Find Parent
4.Exit
Choice = 2

                                        L

                                K

                        J

                                I

                H

                                G

                        F

        E

                        D

                C

                        B

                                A
```

Learning Outcome:



Learning Outcome		
Design	3	Design of ALL tree is clear
Understanding of DS	3	Understood AVL operations
Use of DS	3	and its applications.
Debugging	3	Was able to fix errors
Best Practices		
Design before coding	3	Designed properly
Use of algorithmic notation	2	Can be improved
Use of multifile C program	3	Used multiple files
Versioning of code	2	Can be versioned properly