



ACTIVIDAD 13: EL ÁRBOL AVL, IMPLEMENTACIÓN DINÁMICA

ESTUDIANTE: EFRAIN ROBLES PULIDO

CODIGO: 221350095

NOMBRE DE LA MATERIA: ESTRUCTURAS DE DATOS I

SECCIÓN: D12

CLAVE: I5886

FECHA: DOMINGO 1 DE MAYO DE 2022

Tabla de autoevaluación:

Autoevaluación			
Concepto	Sí	No	Acumulación
Bajé el trabajo de internet o alguien me lo pasó (aunque sea de forma parcial)	-100 pts	0 pts	0 pts
Incluí el código fuente en formato de texto (sólo si funciona cumpliendo todos los requerimientos)	+25 pts	0 pts	25 pts
Incluí las impresiones de pantalla (sólo si funciona cumpliendo todos los requerimientos)	+25 pts	0 pts	25 pts
Incluí una portada que identifica mi trabajo (nombre, código, materia, fecha, título)	+25 pts	0 pts	25 pts
Incluí una descripción y conclusiones de mi trabajo	+25 pts	0 pts	25 pts
Suma:			100 pts

Introducción:

Una vez leído las instrucciones de la plataforma, se volvió a reutilizar el código de la actividad anterior, el árbol binario de búsqueda, pero para esta actividad fue modificada para que nuestro árbol binario este balanceada conforme se vaya agregando o eliminando elementos del árbol. En donde se le agrego métodos extras para el funcionamiento del árbol AVL, así como un encabezado en cada nodo del árbol que nos servirá para guardar la altura de cada nodo y evitamos la recursividad para calcular la altura como en la anterior actividad, se agregó los métodos: doBalancing; para que haga las rotaciones necesarias según el factor de equilibrio calculado del nodo recibido, una rotación simple o doble hacia la izquierda o hacia la derecha, y si es necesario una doble rotación podemos usar dos veces la simple rotación otra vez pero su contraria; getBalanceFactor; en donde obtenemos el factor de equilibrio de la altura de la derecha menos la altura de la izquierda, desde su encabezado que tendrá esa información; doSimpleLeftRot y doSimpleRightRot; para que haga la rotación simple hacia la izquierda o derecha del subárbol correspondiente y en donde al final recalculamos el encabezado de la altura de cada hijo principal del subárbol debido a las rotaciones; y el recalculHeight; será el método que calculará la altura del nodo recibido y modificara el encabezado del nodo para tener la altura actualizada en el momento en que se llame. Finalmente se reutilizo el código principal (Menu) para la aplicación del árbol AVL en donde se hicieron algunas modificaciones en la manera de obtener los datos del nodo y la forma de obtener las alturas de los hijos de la raíz del árbol mediante otros métodos en la clase del Árbol para que nos de los nodos hijos de la raíz, obteniendo el mismo resultado como la anterior actividad.

Código fuente:

```
/*Efrain Robles Pulido*/
#include "Menu.h"
#include "Integer.h"
#include <iostream>

using namespace std;

int main() {
    AVL_BTree<Integer> myTree;
    Menu interfaz(myTree);
    interfaz.mainMenu();
    return 0;
}

#ifndef MENU_H_INCLUDED
#define MENU_H_INCLUDED

#include "AVL_BTree.h"
#include "Integer.h"

#include <iostream>
#include <random>
#include <chrono>
#include <functional>

class Menu {
private:
    ///Atributos
    AVL_BTree<Integer>* myTree;

public:
    ///Constructor
    Menu(AVL_BTree<Integer>&);

    ///Metodo publico
    void mainMenu();
};

#endif // MENU_H_INCLUDED

#include "Menu.h"

using namespace std;
using namespace std::chrono;

///Constructor
Menu::Menu(AVL_BTree<Integer>& _Tree): myTree(&_Tree) {}

///Metodo publico
void Menu::mainMenu() {
    int i(0), N(0);
    Integer myInt;
```

```

        cout<<"\t\t\tARBOLES BINARIO DE BUSQUEDA
BALANCEADO"<<endl<<endl<<"Ingrese N valores a utilizar: ";
        cin>>N;
        cout<<endl<<"->Valores generados: "<<endl;

        std::default_random_engine
generator(chrono::system_clock::now().time_since_epoch().count());
        std::uniform_int_distribution<long long int> distribution(0,100000);
        auto randomInt = bind(distribution, generator);

        while(i < N) {
            myInt.setInteger(randomInt());
            cout<<myInt.toString() + ", ";
            myTree->insertData(myInt);
            i++;
        }

        cout<<endl<<endl<<"->PreOrder: "<<endl;
        myTree->parsePreOrder();

        cout<<endl<<endl<<"->InOrder: "<<endl;
        myTree->parseInOrder();

        cout<<endl<<endl<<"->PostOrder: "<<endl;
        myTree->parsePostOrder();

        cout<<endl<<endl<<"->Elemento menor: "<< myTree->retrieve(myTree-
>getLowest()).toString();

        cout<<endl<<endl<<"->Elemento mayor: "<<myTree->retrieve(myTree-
>getHighest()).toString()<<endl;

        cout<<endl<<"->Altura de Subarbol Izquierdo, respecto a la Raiz del
Arbol: "<<myTree->getHeight(myTree->getLeftSonOfRoot())<<endl;

        cout<<endl<<"->Altura de Subarbol Derecho, respecto a la Raiz del
Arbol: "<<myTree->getHeight(myTree->getRightSonOfRoot())<<endl;

    }

#ifdef AVL_BTree_H_INCLUDED
#define AVL_BTree_H_INCLUDED

#include <iostream>
#include <string>
#include <exception>

///Definicion del Arbol AVL
template <class T>
class AVL_BTree {
private:
    ///Definicion del Nodo
    class Node {
        private:

```

```

        T* dataPtr;
        Node* left;
        Node* right;
        int height;

public:
    ///Definicion de Excepcion para el Nodo
    class Exception : public std::exception {
    private:
        std::string msg;
    public:
        explicit Exception(const char* message):
msg(message) {}

        explicit Exception(const std::string& message):
msg(message) {}

        virtual ~Exception() throw() {}
        virtual const char* what() const throw () {
            return msg.c_str();
        }
    };

    Node();
    Node(const T&);

    ~Node();

    T* getDataPtr() const;
    T getData() const;
    Node*& getLeft();
    Node*& getRight();
    int getHeight() const;

    void setDataPtr(T*);
    void setData(const T&);
    void setLeft(Node*&);
    void setRight(Node*&);
    void setHeight(const int&);
};

public:
    typedef Node* Position;

    ///Definicion de Excepcion para el arbol
    class Exception : public std::exception {
    private:
        std::string msg;
    public:
        explicit Exception(const char* message): msg(message) {}
        explicit Exception(const std::string& message):
msg(message) {}

        virtual ~Exception() throw() {}
        virtual const char* what() const throw () {
            return msg.c_str();
        }
    };

private:

```

```

Position root;

void copyAll (AVL_BTree<T>&);

void insertData (Position&, const T&);
void deleteData (Position&, const T&);
Position& findData (Position&, const T&);

Position& getLowest (Position&);
Position& getHighest (Position&);

void recalculatedHeight (Position&);

void parsePreOrder (Position&);
void parseInOrder (Position&);
void parsePostOrder (Position&);

void parsePostOrderDeleteAll (Position&);
void parsePreOrderCopy (Position&, Position&);

///Metodos del arbol AVL
void doBalancing (Position&);

int getBalanceFactor (const Position&) const;

void doSimpleLeftRot (Position&);
void doSimpleRightRot (Position&);

public:
    ///Constructores
    AVL_BTree ();
    AVL_BTree (AVL_BTree<T>&);
    ~AVL_BTree (); ///Destructor

    ///Sobrecarga de operador
    AVL_BTree<T>& operator = (const AVL_BTree<T>&);

    ///Metodos para un Arbol
    bool isEmpty () const;

    void insertData (const T&);
    void deleteData (const T&);
    void deleteAll ();

    T retrieve (Position&) const;

    Position& getLeftSonOfRoot ();
    Position& getRightSonOfRoot ();

    Position& findData (const T&);
    Position& getLowest ();
    Position& getHighest ();

    bool isLeaf (const Position&) const;

    int getHeight (const Position&) const;

```

```

        int getHeight();

        void parsePreOrder ();
        void parseInOrder ();
        void parsePostOrder ();
    };

    ///Implementacion
    using namespace std;

    ///del Nodo
    template <class T>
    AVL_BTree<T>::Node::Node():dataPtr(nullptr), left(nullptr),
    right(nullptr), height(1) {}

    template <class T>
    AVL_BTree<T>::Node::Node(const T& e): dataPtr(new T(e)), left(nullptr),
    right(nullptr), height(1) {
        if(dataPtr == nullptr) {
            throw Exception ("Memoria insuficiente, creando nodo");
        }
    }

    template <class T>
    AVL_BTree<T>::Node::~~Node() {
        delete dataPtr;
    }

    template <class T>
    T* AVL_BTree<T>::Node::getDataPtr() const {
        return dataPtr;
    }

    template <class T>
    T AVL_BTree<T>::Node::getData() const {
        if(dataPtr == nullptr) {
            throw Exception("Dato inexistente, getData");
        }

        return *dataPtr;
    }

    template <class T>
    typename AVL_BTree<T>::Position& AVL_BTree<T>::Node::getLeft() {
        return left;
    }

    template <class T>
    typename AVL_BTree<T>::Position& AVL_BTree<T>::Node::getRight() {
        return right;
    }

    template <class T>
    int AVL_BTree<T>::Node::getHeight() const {
        return height;
    }

```

```

template <class T>
void AVL_BTree<T>::Node::setDataPtr(T* e) {
    dataPtr = e;
}

template <class T>
void AVL_BTree<T>::Node::setData(const T& e) {
    if(dataPtr == nullptr) {
        if((dataPtr = new T(e)) == nullptr) {
            throw Exception("Memoria no disponible, setData");
        }
    }
    else {
        *dataPtr = e;
    }
}

template <class T>
void AVL_BTree<T>::Node::setLeft(Node*& p) {
    left = p;
}

template <class T>
void AVL_BTree<T>::Node::setRight(Node*& p) {
    right = p;
}

template <class T>
void AVL_BTree<T>::Node::setHeight(const int& h) {
    height = h;
}

///del Arbol
///Metodos privados
template <class T>
void AVL_BTree<T>::copyAll(AVL_BTree<T>& t) {
    parsePreOrderCopy(root, t.root);
}

template <class T>
void AVL_BTree<T>::insertData(Position& r, const T& e) {
    if(r == nullptr) { //Inserta como hoja(esta balanceado)
        try {
            if((r = new Node(e)) == nullptr) {
                throw Exception("Memoria no disponible, insertData");
            }
        }
        catch (typename Node::Exception ex) {
            throw Exception(ex.what());
        }
    }
    else { //Inserta recursivamente a la izq o der (ruta de insercion)
        if(e < r->getData()) {
            insertData(r->getLeft(), e);
        }
        else {
            insertData(r->getRight(), e);
        }
    }
}

```



```

        }
        //Sale de recursividad - paso atras en la ruta
        recalculHeight(r);
        doBalancing(r);
    }
}

template <class T>
void AVL_BTree<T>::deleteData(Position& r, const T& e) {
    if(isEmpty()) {
        return;
    }
    if(e == r->getData()) { //Encontro el valor
        if(isLeaf(r)) { //Es hoja
            delete r;
            r = nullptr;
            return;
        }
        else if(r->getRight() == nullptr or r->getLeft() == nullptr)
        { //Tiene un hijo
            Position aux(r);
            r = r->getLeft() == nullptr? r->getRight():r->getLeft();
            delete aux;
            return;
        }
        //Tiene dos hijos
        T substitution(getHighest(r->getLeft())->getData());
        r->setData(substitution);
        deleteData(r->getLeft(), substitution);
    }
    else { //Elimina recursivamente a la izq o der (ruta de eliminacion)
        if(e < r->getData()) {
            deleteData(r->getLeft(), e);
        }
        else {
            deleteData(r->getRight(), e);
        }
        //Sale de recursividad - paso atras en la ruta
        recalculHeight(r);
        doBalancing(r);
    }
}

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::findData (Position& r,
const T& e) {
    if(r == nullptr or r->getData() == e) {
        return r;
    }
    if(e < r->getData()) {
        return findData(r->getLeft(), e);
    }
    return findData(r->getRight(), e);
}

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::getLowest (Position& r) {

```

```

        if(r == nullptr or r->getLeft() == nullptr) {
            return r;
        }
        return getLowest(r->getLeft());
    }

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::getHighest (Position& r) {
    if(r == nullptr or r->getRight() == nullptr) {
        return r;
    }
    return getHighest(r->getRight());
}

template <class T>
void AVL_BTree<T>::parsePreOrder (Position& r) {
    if(r == nullptr) {
        return;
    }
    std::cout << r->getData().toString() << ", ";
    parsePreOrder(r->getLeft());
    parsePreOrder(r->getRight());
}

template <class T>
void AVL_BTree<T>::parseInOrder (Position& r) {
    if(r == nullptr) {
        return;
    }
    parseInOrder(r->getLeft());
    cout << r->getData().toString() << ", ";
    parseInOrder(r->getRight());
}

template <class T>
void AVL_BTree<T>::parsePostOrder (Position& r) {
    if(r == nullptr) {
        return;
    }
    parsePostOrder(r->getLeft());
    parsePostOrder(r->getRight());
    cout << r->getData().toString() << ", ";
}

template <class T>
void AVL_BTree<T>::parsePostOrderDeleteAll(Position& r) {
    if(r == nullptr) {
        return;
    }

    parsePostOrderDeleteAll(r->getLeft());
    parsePostOrderDeleteAll(r->getRight());
    delete r;
}

template <class T>
void AVL_BTree<T>::parsePreOrderCopy(Position& r, Position& rCopy) {

```

```

        if(rCopy == nullptr) {
            r = nullptr;
        }
        else {
            try {
                if((r = new Node(rCopy->getData())) == nullptr) {
                    throw Exception("Memoria no disponible, copyAll");
                }
            }
            catch (typename Node::Exception ex) {
                throw Exception(ex.what());
            }

            parsePreOrderCopy(r->getLeft(), rCopy->getLeft());
            parsePreOrderCopy(r->getRight(), rCopy->getRight());
        }
    }

    ///Metodos del arbol AVL
    template <class T>
    void AVL_BTree<T>::doBalancing(Position& r) {
        switch(getBalanceFactor(r)) {
            case -2://Desbalanceado a la izq.
                ///Se factorizo la funcion simpleRightRot
                if(getBalanceFactor(r->getLeft()) == 1) { //Rotacion Doble
                    doSimpleLeftRot(r->getLeft());
                }
                doSimpleRightRot(r);
                break;

            case 2://Desbalanceado a la der.
                ///Se factorizo la funcion simpleLeftRot
                if(getBalanceFactor(r->getRight()) == -1) { //Rotacion Doble
                    doSimpleRightRot(r->getRight());
                }
                doSimpleLeftRot(r);
                break;
        }
    }

    template <class T>
    int AVL_BTree<T>::getBalanceFactor(const Position& r) const {
        return getHeight(r->getRight()) - getHeight(r->getLeft());
    }

    template <class T>
    void AVL_BTree<T>::doSimpleLeftRot(Position& r) {
        Position aux1(r->getRight());
        Position aux2(aux1->getLeft());

        r->setRight(aux2);
        aux1->setLeft(r);
        r = aux1;

        recalculHeight(r->getLeft());
        recalculHeight(r);
    }

```

```

template <class T>
void AVL_BTree<T>::doSimpleRightRot(Position& r) {
    Position aux1(r->getLeft());
    Position aux2(aux1->getRight());

    r->setLeft(aux2);
    aux1->setRight(r);
    r = aux1;

    recalculHeight(r->getRight());
    recalculHeight(r);
}

///Constructores
template <class T>
AVL_BTree<T>::AVL_BTree(): root(nullptr) {}

template <class T>
AVL_BTree<T>::AVL_BTree(AVL_BTree<T>& t): AVL_BTree() {
    copyAll(t);
}

template <class T>
AVL_BTree<T>::~~AVL_BTree() {///Destructor
    deleteAll();
}

///Sobre carga de operador
template <class T>
AVL_BTree<T>& AVL_BTree<T>::operator =(const AVL_BTree<T>&t) {
    deleteAll();
    copyAll(t);
    return *this;
}

///Metodos publicos de la AVL_BTree
template <class T>
bool AVL_BTree<T>::isEmpty() const {
    return root == nullptr;
}

template <class T>
void AVL_BTree<T>::insertData(const T& e) {
    insertData(root, e);
}

template <class T>
void AVL_BTree<T>::deleteData(const T& e) {
    deleteData(root, e);
}

template <class T>
void AVL_BTree<T>::deleteAll() {
    parsePostOrderDeleteAll(root);
    root = nullptr;
}

```

```

template <class T>
T AVL_BTree<T>::retrieve(Position& r) const {
    return r->getData();
}

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::getLeftSonOfRoot () {
    return root->getLeft();
}

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::getRightSonOfRoot () {
    return root->getRight();
}

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::findData(const T& e) {
    return findData(root, e);
}

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::getLowest () {
    return getLowest(root);
}

template <class T>
typename AVL_BTree<T>::Position& AVL_BTree<T>::getHighest () {
    return getHighest(root);
}

template <class T>
bool AVL_BTree<T>::isLeaf(const Position& r) const {
    return r != nullptr and r->getLeft() == r->getRight();
}

template <class T>
int AVL_BTree<T>::getHeight () {
    return getHeight(root);
}

template <class T>
int AVL_BTree<T>::getHeight(const Position& r) const {
    if(r == nullptr) {
        return 0;
    }
    return r->getHeight();
}

template <class T>
void AVL_BTree<T>::recalculatedHeight(Position& r) {
    int lH(r->getLeft() == nullptr? 0 : r->getLeft()->getHeight());
    int rH(r->getRight() == nullptr? 0 : r->getRight()->getHeight());

    r->setHeight((lH > rH ? lH : rH) + 1);
}

```

```

template <class T>
void AVL_BTree<T>::parsePreOrder () {
    parsePreOrder(root);
}

template <class T>
void AVL_BTree<T>::parseInOrder () {
    parseInOrder(root);
}

template <class T>
void AVL_BTree<T>::parsePostOrder () {
    parsePostOrder(root);
}

#endif // AVL_BTree_H_INCLUDED

#ifndef INTEGER_H_INCLUDED
#define INTEGER_H_INCLUDED

#include <string>

class Integer {
private:
    long long int data;

public:
    Integer();

    Integer(const Integer&);

    Integer(const long long int&);

    std::string toString() const;

    void setInteger(const long long int&);

    long long int getInteger() const;

    Integer& operator ++ ();

    Integer operator ++ (int);

    Integer& operator -- ();

    Integer operator -- (int);

    Integer operator + (const Integer&) const;

    Integer operator - (const Integer&) const;

    Integer operator * (const Integer&) const;

    Integer operator / (const Integer&) const;

```

```

Integer operator % (const Integer&) const;

Integer operator - () const;

Integer& operator = (const Integer&);

Integer& operator += (const Integer&);

Integer& operator -= (const Integer&);

Integer& operator *= (const Integer&);

Integer& operator /= (const Integer&);

Integer& operator %= (const Integer&);

bool operator == (const Integer&) const;

bool operator != (const Integer&) const;

bool operator < (const Integer&) const;

bool operator <= (const Integer&) const;

bool operator > (const Integer&) const;

bool operator >= (const Integer&) const;
};

#endif // INTEGER_H_INCLUDED

#include "Integer.h"

///Costructor
Integer::Integer() {}

Integer::Integer(const Integer& _integer): data(_integer.data) {}

Integer::Integer(const long long int& _data) : data(0) {}

std::string Integer::toString() const {
    return std::to_string(data);
}

void Integer::setInteger(const long long int& i) {
    data = i;
}

long long int Integer::getInteger() const {
    return data;
}

Integer& Integer::operator++() { //Version prefija
    return *this;
}

```

```

Integer Integer::operator++(int) { //Version postfija
    Integer old = *this;
    operator++();
    return old;
}

Integer& Integer::operator--() { //Version prefija
    return *this;
}

Integer Integer::operator--(int) { //Version postfija
    Integer old = *this;
    operator--();
    return old;
}

Integer Integer::operator+(const Integer& i) const {
    return data + i.data;
}

Integer Integer::operator-(const Integer& i) const {
    return data - i.data;
}

Integer Integer::operator*(const Integer& i) const {
    return data * i.data;
}

Integer Integer::operator/(const Integer& i) const {
    return data / i.data;
}

Integer Integer::operator%(const Integer& i) const {
    return data % i.data;
}

Integer Integer::operator-() const {
    return data;
}

Integer& Integer::operator=(const Integer& i) {
    data = i.data;
    return *this;
}

Integer& Integer::operator+=(const Integer& i) {
    data = data + i.data;
    return *this;
}

Integer& Integer::operator-=(const Integer& i) {
    return *this = *this - i.data;
}

Integer& Integer::operator*=(const Integer& i) {
    return *this = *this * i.data;
}

```



```

Integer& Integer::operator/=(const Integer& i) {
    return *this = *this / i.data;
}

Integer& Integer::operator%=(const Integer& i) {
    return *this = *this % i.data;
}

bool Integer::operator==(const Integer& i) const {
    return data == i.data;
}

bool Integer::operator!=(const Integer& i) const {
    return !(*this == i);
}

bool Integer::operator<(const Integer& i) const {
    return data < i.data;
}

bool Integer::operator<=(const Integer& i) const {
    return (*this < i) or (*this == i);
}

bool Integer::operator>(const Integer& i) const {
    return !(*this <= i);
}

bool Integer::operator>=(const Integer& i) const {
    return !(*this < i);
}

```

ARBOLES BINARIO DE BUSQUEDA BALANCEADO

Ingrese N valores a utilizar: 1100

->Valores generados:

```
16274, 12871, 20447, 42697, 94042, 9342, 17667, 21294, 88191, 84256, 45279, 81000, 24864, 81784, 4216, 68346, 60743, 76106, 80164, 73501, 94329, 2937
5, 480, 75611, 11856, 68974, 14529, 86424, 81136, 2681, 65796, 99613, 37341, 68589, 33530, 33444, 76157, 37467, 88584, 79124, 94154, 90053, 74311, 26
38, 4492, 82475, 13589, 90455, 31787, 25290, 45884, 51575, 92618, 72639, 96613, 18247, 69587, 10966, 5419, 90181, 68903, 18578, 44401, 29607, 92565,
91141, 58765, 30719, 79659, 78038, 38138, 70295, 13884, 41656, 1082, 314, 91630, 68470, 39726, 50534, 93423, 14838, 77570, 75403, 52357, 44879, 5430
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->Elemento mayor: 99992

->Altura de Subarbol Izquierdo, respecto a la Raiz del Arbol: 11
->Altura de Subarbol Derecho, respecto a la Raiz del Arbol: 11

Process returned 0 (0x0)   execution time : 6.670 s
Press any key to continue.
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ARBOLES BINARIO DE BUSQUEDA BALANCEADO

Ingrese N valores a utilizar: 1200

->Valores generados:

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->Altura de Subarbol Derecho, respecto a la Raiz del Arbol: 11
Process returned 0 (0x0)   execution time : 3.343 s
Press any key to continue.
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ARBOLES BINARIO DE BUSQUEDA BALANCEADO

Ingrese N valores a utilizar: 1100

->Valores generados:

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->Elemento menor: 33

->Elemento mayor: 99921

->Altura de Subarbol Izquierdo, respecto a la Raiz del Arbol: 11

->Altura de Subarbol Derecho, respecto a la Raiz del Arbol: 11

Process returned 0 (0x0)   execution time : 3.372 s
Press any key to continue.
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ARBOLES BINARIO DE BUSQUEDA BALANCEADO

Ingrese N valores a utilizar: 1200

->Valores generados:
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->Elemento mayor: 99943

->Altura de Subarbol Izquierdo, respecto a la Raiz del Arbol: 12

->Altura de Subarbol Derecho, respecto a la Raiz del Arbol: 11

Process returned 0 (0x0)   execution time : 2.077 s
Press any key to continue.
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Conclusión:

Para esta actividad fue fácil de realizar debido a que la fui realizando conforme el profesor la explicaba así que solo fue de estudiarla y analizar el funcionamiento del árbol, además de que tuve que hacer unos cambios al código principal en donde tenía que mostrar las alturas de los hijos de la raíz, porque se hizo un cambio en la forma de obtener las alturas de cada nodo en la clase del Árbol AVL, debido que se agregó un encabezado a cada nodo en donde almacenaremos su altura, para que en la clase del Árbol podamos manipular esa altura por cada rotación que se haga al momento de inserción o de eliminación. Además, la clase del Árbol AVL es muy parecida a la de la anterior actividad debido a que se le agrego unos métodos necesarios principalmente en los métodos de inserción y de eliminación, para asegurarnos de que el árbol quede balanceado. En mi opinión, fue muy educativo porque esta practica me ayudo a comprender aun mejor los arboles y su funcionamiento, en donde podemos adecuarlo a nuestras necesidades como para que quede balanceado y que se mantenga los valores estén ordenados. También pude practicar la recursividad en esta práctica también debido a los métodos de balanceo, factor de equilibrio, y sus rotaciones que se usaron, además fue muy práctico hacer los métodos con el modelo de los subárboles para esta práctica, ya que nos ahorramos muchas cosas extras. Y al agregar el encabezado de la altura a los nodos nos permitió ahorrarnos la recursividad cuando necesitábamos obtener su altura, no como la actividad anterior. Finalmente, tenía unos errores en la forma de calcular los hijos de la raíz, así que tuve que resolverlo agregándole métodos a la clase del árbol para que obtuviera los nodos y así pudiera tener acceso al encabezado del nodo para tener su altura.