ENSF 614 – Fall 2021

Lab 6 – Tuesday, November 16

Student Name: Bhavyai Gupta

Submission date: November 16, 2021

# Exercise A – AR Diagram for Point Two

Diagram

Description automatically generated

# Exercise B – Source file exAmain.cpp

/\*

 \* File Name:               exAmain.cpp

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise A and B

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

#include <assert.h>

#include <iostream>

#include "dictionaryList.h"

using namespace std;

DictionaryList dictionary\_tests();

void test\_copying();

void print(DictionaryList &dl);

void test\_finding(DictionaryList &dl);

void test\_operator\_overloading(DictionaryList &dl);

int main()

{

    DictionaryList dl = dictionary\_tests();

    test\_operator\_overloading(dl);

    return 0;

}

DictionaryList dictionary\_tests()

{

    DictionaryList dl;

    assert(dl.size() == 0);

    cout << "\nPrinting list just after its creation ...\n";

    print(dl);

    // Insert using new keys.

    dl.insert(8001, "Dilbert");

    dl.insert(8002, "Alice");

    dl.insert(8003, "Wally");

    assert(dl.size() == 3);

    cout << "\nPrinting list after inserting 3 new keys ...\n";

    print(dl);

    dl.remove(8002);

    dl.remove(8001);

    dl.insert(8004, "PointyHair");

    assert(dl.size() == 2);

    cout << "\nPrinting list after removing two keys and inserting PointyHair ...\n";

    print(dl);

    // Insert using existing key.

    dl.insert(8003, "Sam");

    assert(dl.size() == 2);

    cout << "\nPrinting list after changing data for one of the keys ...\n";

    print(dl);

    dl.insert(8001, "Allen");

    dl.insert(8002, "Peter");

    assert(dl.size() == 4);

    cout << "\nPrinting list after inserting 2 more keys ...\n";

    print(dl);

    cout << "\*\*\*----Finished dictionary tests---------------------------\*\*\*\n\n";

    return dl;

}

void test\_operator\_overloading(DictionaryList &dl)

{

    DictionaryList dl2 = dl;

    dl.go\_to\_first();

    dl.step\_fwd();

    dl2.go\_to\_first();

    cout << "\nTestig a few comparison and insertion operators." << endl;

    // Needs to overload >= and << (insertion operator) in class Mystring

    if (dl.cursor\_datum() >= (dl2.cursor\_datum()))

        cout << endl

             << dl.cursor\_datum() << " is greater than or equal " << dl2.cursor\_datum();

    else

        cout << endl

             << dl2.cursor\_datum() << " is greater than " << dl.cursor\_datum();

    // Needs to overload <= for Mystring

    if (dl.cursor\_datum() <= (dl2.cursor\_datum()))

        cout << dl.cursor\_datum() << " is less than or equal" << dl2.cursor\_datum();

    else

        cout << endl

             << dl2.cursor\_datum() << " is less than " << dl.cursor\_datum();

    if (dl.cursor\_datum() != (dl2.cursor\_datum()))

        cout << endl

             << dl.cursor\_datum() << " is not equal to " << dl2.cursor\_datum();

    else

        cout << endl

             << dl2.cursor\_datum() << " is equal to " << dl.cursor\_datum();

    if (dl.cursor\_datum() > (dl2.cursor\_datum()))

        cout << endl

             << dl.cursor\_datum() << " is greater than " << dl2.cursor\_datum();

    else

        cout << endl

             << dl.cursor\_datum() << " is not greater than " << dl2.cursor\_datum();

    if (dl.cursor\_datum() < (dl2.cursor\_datum()))

        cout << endl

             << dl.cursor\_datum() << " is less than " << dl2.cursor\_datum();

    else

        cout << endl

             << dl.cursor\_datum() << " is not less than " << dl2.cursor\_datum();

    if (dl.cursor\_datum() == (dl2.cursor\_datum()))

        cout << endl

             << dl.cursor\_datum() << " is equal to " << dl2.cursor\_datum();

    else

        cout << endl

             << dl.cursor\_datum() << " is not equal to " << dl2.cursor\_datum();

    cout << endl

         << "\nUsing square bracket [] to access elements of Mystring objects. ";

    char c = dl.cursor\_datum()[1];

    cout << endl

         << "The second element of " << dl.cursor\_datum() << " is: " << c;

    dl.cursor\_datum()[1] = 'o';

    c = dl.cursor\_datum()[1];

    cout << endl

         << "The second element of " << dl.cursor\_datum() << " is: " << c;

    cout << endl

         << "\nUsing << to display key/datum pairs in a Dictionary list: \n";

    /\* The following line is expected to display the content of the linked list

     \* dl2 -- key/datum pairs. It should display:

     \*   8001  Allen

     \*   8002  Peter

     \*   8003  Sam

     \*   8004  PointyHair

     \*/

    cout << dl2;

    cout << endl

         << "\nUsing [] to display the datum only: \n";

    /\* The following line is expected to display the content of the linked list

     \* dl2 -- datum. It should display:

     \*   Allen

     \*   Peter

     \*   Sam

     \*   PointyHair

     \*/

    for (int i = 0; i < dl2.size(); i++)

        cout << dl2[i] << endl;

    cout << endl

         << "\nUsing [] to display sequence of charaters in a datum: \n";

    /\* The following line is expected to display the characters in the first node

     \* of the dictionary. It should display:

     \*   A

     \*   l

     \*   l

     \*   e

     \*   n

     \*/

    cout << dl2[0][0] << endl;

    cout << dl2[0][1] << endl;

    cout << dl2[0][2] << endl;

    cout << dl2[0][3] << endl;

    cout << dl2[0][4] << endl;

    cout << "\n\n\*\*\*----Finished tests for overloading operators ----------\*\*\*\n\n";

}

void print(DictionaryList &dl)

{

    if (dl.size() == 0)

        cout << "  List is EMPTY.\n";

    for (dl.go\_to\_first(); dl.cursor\_ok(); dl.step\_fwd())

    {

        cout << "  " << dl.cursor\_key();

        cout << "  " << dl.cursor\_datum().c\_str() << '\n';

    }

}

# Exercise B – Source file mystring\_B.h

/\*

 \* File Name:               mystring\_B.h

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise B

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

#include <iostream>

#include <string>

using namespace std;

#ifndef MYSTRING\_H

#define MYSTRING\_H

class Mystring

{

public:

    Mystring();

    // PROMISES: Empty string object is created.

    Mystring(int n);

    // PROMISES: Creates an empty string with a total capacity of n.

    //           In other words, dynamically allocates n elements for

    //           charsM,sets the lengthM to zero, and fills the first

    //           element of charsM with '\0'.

    Mystring(const char \*s);

    // REQUIRES: s points to first char of a built-in string.

    // REQUIRES: Mystring object is created by copying chars from s.

    ~Mystring(); // destructor

    Mystring(const Mystring &source); // copy constructor

    Mystring &operator=(const Mystring &rhs); // assignment operator

    // REQUIRES: rhs is reference to a Mystring as a source

    // PROMISES: to make this-object (object that this is pointing to, as a copy

    //           of rhs.

    bool operator==(const Mystring &rhs) const; // is equal to operator

    //  REQUIRES: rhs is reference to a Mystring as a source

    //  PROMISES: returns true if this object is lexicographically equal to rhs, otherwise false

    bool operator!=(const Mystring &rhs) const; // not equal to operator

    //  REQUIRES: rhs is reference to a Mystring as a source

    //  PROMISES: returns true if this object is lexicographically not equal to rhs, otherwise false

    bool operator>(const Mystring &rhs) const; // greater than operator

    //  REQUIRES: rhs is reference to a Mystring as a source

    //  PROMISES: returns true if this object is lexicographically greater than rhs, otherwise false

    bool operator>=(const Mystring &rhs) const; // greater than or equal to operator

    //  REQUIRES: rhs is reference to a Mystring as a source

    //  PROMISES: returns true if this object is lexicographically greater than or equal to rhs, otherwise false

    bool operator<(const Mystring &rhs) const; // less than operator

    //  REQUIRES: rhs is reference to a Mystring as a source

    //  PROMISES: returns true if this object is lexicographically less than rhs, otherwise false

    bool operator<=(const Mystring &rhs) const; // less than or equal to operator

    //  REQUIRES: rhs is reference to a Mystring as a source

    //  PROMISES: returns true if this object is lexicographically less than or equal to rhs, otherwise false

    char &operator[](int i) const;

    //  REQUIRES: 0 <= i <= lengthM

    //  PROMISES: returns the character at index i of string charsM

    friend ostream &operator<<(ostream &os, const Mystring &rhs); // insertion operator

    //  REQUIRES: rhs is reference to a Mystring as a source

    //  PROMISES: prints the charsM to the stdout

    int length() const;

    // PROMISES: Return value is number of chars in charsM.

    char get\_char(int pos) const;

    // REQUIRES: pos >= 0 && pos < length()

    // PROMISES:

    // Return value is char at position pos.

    // (The first char in the charsM is at position 0.)

    const char \*c\_str() const;

    // PROMISES:

    //   Return value points to first char in built-in string

    //   containing the chars of the string object.

    void set\_char(int pos, char c);

    // REQUIRES: pos >= 0 && pos < length(), c != '\0'

    // PROMISES: Character at position pos is set equal to c.

    Mystring &append(const Mystring &other);

    // PROMISES: extends the size of charsM to allow concatenate other.charsM to

    //           to the end of charsM. For example if charsM points to "ABC", and

    //          other.charsM points to XYZ, extends charsM to "ABCXYZ".

    //

    void set\_str(char \*s);

    // REQUIRES: s is a valid C++ string of characters (a built-in string)

    // PROMISES:copys s into charsM, if the length of s is less than or equal lengthM.

    //          Othrewise, extends the size of the charsM to s.lengthM+1, and copies

    //          s into the charsM.

private:

    int lengthM;  // the string length - number of characters excluding \0

    char \*charsM; // a pointer to the beginning of an array of characters, allocated dynamically.

    void memory\_check(char \*s);

    // PROMISES: if s points to NULL terminates the program.

};

#endif

# Exercise B – Source file mystring\_B.cpp

/\*

 \* File Name:               mystring\_B.cpp

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise B

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

#include "mystring\_B.h"

#include <string.h>

#include <iostream>

using namespace std;

Mystring::Mystring()

{

    charsM = new char[1];

    // make sure memory is allocated.

    memory\_check(charsM);

    charsM[0] = '\0';

    lengthM = 0;

}

Mystring::Mystring(const char \*s) : lengthM(strlen(s))

{

    charsM = new char[lengthM + 1];

    // make sure memory is allocated.

    memory\_check(charsM);

    strcpy(charsM, s);

}

Mystring::Mystring(int n) : lengthM(0), charsM(new char[n])

{

    // make sure memory is allocated.

    memory\_check(charsM);

    charsM[0] = '\0';

}

Mystring::Mystring(const Mystring &source) : lengthM(source.lengthM), charsM(new char[source.lengthM + 1])

{

    memory\_check(charsM);

    strcpy(charsM, source.charsM);

}

Mystring::~Mystring()

{

    delete[] charsM;

}

int Mystring::length() const

{

    return lengthM;

}

char Mystring::get\_char(int pos) const

{

    if (pos < 0 && pos >= length())

    {

        cerr << "\nERROR: get\_char: the position is out of boundary.";

    }

    return charsM[pos];

}

const char \*Mystring::c\_str() const

{

    return charsM;

}

void Mystring::set\_char(int pos, char c)

{

    if (pos < 0 && pos >= length())

    {

        cerr << "\nset\_char: the position is out of boundary."

             << " Nothing was changed.";

        return;

    }

    if (c != '\0')

    {

        cerr << "\nset\_char: char c is empty."

             << " Nothing was changed.";

        return;

    }

    charsM[pos] = c;

}

Mystring &Mystring::operator=(const Mystring &S) {

    if (this == &S)

        return \*this;

    delete[] charsM;

    lengthM = (int)strlen(S.charsM);

    charsM = new char[lengthM + 1];

    memory\_check(charsM);

    strcpy(charsM, S.charsM);

    return \*this;

}

bool Mystring::operator==(const Mystring &S) const {

    return (strcmp(this->charsM, S.charsM) == 0);

}

bool Mystring::operator!=(const Mystring &S) const {

    return (strcmp(this->charsM, S.charsM) != 0);

}

bool Mystring::operator>(const Mystring &S) const {

    return (strcmp(this->charsM, S.charsM) > 0);

}

bool Mystring::operator>=(const Mystring &S) const {

    return (strcmp(this->charsM, S.charsM) >= 0);

}

bool Mystring::operator<(const Mystring &S) const {

    return (strcmp(this->charsM, S.charsM) < 0);

}

bool Mystring::operator<=(const Mystring &S) const {

    return (strcmp(this->charsM, S.charsM) <= 0);

}

char &Mystring::operator[](int i) const {

    return this->charsM[i];

}

ostream &operator<<(ostream &os, const Mystring &S) {

    return os << S.charsM;

}

Mystring &Mystring::append(const Mystring &other)

{

    char \*tmp = new char[lengthM + other.lengthM + 1];

    memory\_check(tmp);

    lengthM += other.lengthM;

    strcpy(tmp, charsM);

    strcat(tmp, other.charsM);

    delete[] charsM;

    charsM = tmp;

    return \*this;

}

void Mystring::set\_str(char \*s)

{

    delete[] charsM;

    lengthM = (int)strlen(s);

    charsM = new char[lengthM + 1];

    memory\_check(charsM);

    strcpy(charsM, s);

}

void Mystring::memory\_check(char \*s)

{

    if (s == 0)

    {

        cerr << "Memory not available.";

        exit(1);

    }

}

# Exercise B – Source file dictionaryList.h

/\*

 \* File Name:               dictionaryList.h

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise A and B

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

#ifndef DICTIONARY\_H

#define DICTIONARY\_H

#include <iostream>

using namespace std;

// class DictionaryList: GENERAL CONCEPTS

//

//    key/datum pairs are ordered.  The first pair is the pair with

//    the lowest key, the second pair is the pair with the second

//    lowest key, and so on.  This implies that you must be able to

//    compare two keys with the < operator.

//

//    Each DictionaryList object has a "cursor" that is either attached

//    to a particular key/datum pair or is in an "off-list" state, not

//    attached to any key/datum pair.  If a DictionaryList is empty, the

//    cursor is automatically in the "off-list" state.

#include "mystring\_B.h"

// Edit these typedefs to change the key or datum types, if necessary.

typedef int Key;

typedef Mystring Datum;

// THE NODE TYPE

//    In this exercise the node type is a class, that has a ctor.

//    Data members of Node are private, and class DictionaryList

//    is declared as a friend. For details on the friend keyword refer to your

//    lecture notes.

class Node {

    friend class DictionaryList;

private:

    Key keyM;

    Datum datumM;

    Node \*nextM;

    // This ctor should be convenient in insert and copy operations.

    Node(const Key &keyA, const Datum &datumA, Node \*nextA);

};

class DictionaryList {

public:

    DictionaryList();

    DictionaryList(const DictionaryList &source);

    DictionaryList &operator=(const DictionaryList &rhs);

    ~DictionaryList();

    int size() const;

    // PROMISES: Returns number of keys in the table.

    int cursor\_ok() const;

    // PROMISES:

    //   Returns 1 if the cursor is attached to a key/datum pair,

    //   and 0 if the cursor is in the off-list state.

    const Key &cursor\_key() const;

    // REQUIRES: cursor\_ok()

    // PROMISES: Returns key of key/datum pair to which cursor is attached.

    const Datum &cursor\_datum() const;

    // REQUIRES: cursor\_ok()

    // PROMISES: Returns datum of key/datum pair to which cursor is attached.

    void insert(const Key &keyA, const Datum &datumA);

    // PROMISES:

    //   If keyA matches a key in the table, the datum for that

    //   key is set equal to datumA.

    //   If keyA does not match an existing key, keyA and datumM are

    //   used to create a new key/datum pair in the table.

    //   In either case, the cursor goes to the off-list state.

    void remove(const Key &keyA);

    // PROMISES:

    //   If keyA matches a key in the table, the corresponding

    //   key/datum pair is removed from the table.

    //   If keyA does not match an existing key, the table is unchanged.

    //   In either case, the cursor goes to the off-list state.

    void find(const Key &keyA);

    // PROMISES:

    //   If keyA matches a key in the table, the cursor is attached

    //   to the corresponding key/datum pair.

    //   If keyA does not match an existing key, the cursor is put in

    //   the off-list state.

    void go\_to\_first();

    // PROMISES: If size() > 0, cursor is moved to the first key/datum pair

    //   in the table.

    void step\_fwd();

    // REQUIRES: cursor\_ok()

    // PROMISES:

    //   If cursor is at the last key/datum pair in the list, cursor

    //   goes to the off-list state.

    //   Otherwise the cursor moves forward from one pair to the next.

    void make\_empty();

    // PROMISES: size() == 0.

    friend ostream &operator<<(ostream &os, DictionaryList dl); // insertion operator

    //  REQUIRES: dl is reference to a DictionaryList as a source

    //  PROMISES: prints all the key/datum pairs in the DictionaryList to the stdout

    const Mystring &operator[](int i);

    //  REQUIRES: 0 <= i <= sizeM

    //  PROMISES: returns a reference to the datum at index i of the DictionaryList

private:

    int sizeM;

    Node \*headM;

    Node \*cursorM;

    void destroy();

    // Deallocate all nodes, set headM to zero.

    void copy(const DictionaryList &source);

    // Establishes \*this as a copy of source.  Cursor of \*this will

    // point to the twin of whatever the source's cursor points to.

};

#endif

# Exercise B – Source file dictionaryList.cpp

/\*

 \* File Name:               dictionaryList.cpp

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise A and B

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

#include <assert.h>

#include <iostream>

#include <stdlib.h>

#include "dictionaryList.h"

#include "mystring.h"

using namespace std;

Node::Node(const Key &keyA, const Datum &datumA, Node \*nextA) : keyM(keyA), datumM(datumA), nextM(nextA)

{

}

DictionaryList::DictionaryList() : sizeM(0), headM(0), cursorM(0)

{

}

DictionaryList::DictionaryList(const DictionaryList &source)

{

    copy(source);

}

DictionaryList &DictionaryList::operator=(const DictionaryList &rhs)

{

    if (this != &rhs)

    {

        destroy();

        copy(rhs);

    }

    return \*this;

}

DictionaryList::~DictionaryList()

{

    destroy();

}

int DictionaryList::size() const

{

    return sizeM;

}

int DictionaryList::cursor\_ok() const

{

    return cursorM != 0;

}

const Key &DictionaryList::cursor\_key() const

{

    assert(cursor\_ok());

    return cursorM->keyM;

}

const Datum &DictionaryList::cursor\_datum() const

{

    assert(cursor\_ok());

    return cursorM->datumM;

}

void DictionaryList::insert(const int &keyA, const Mystring &datumA)

{

    // Add new node at head?

    if (headM == 0 || keyA < headM->keyM)

    {

        headM = new Node(keyA, datumA, headM);

        cout << "Insertion of " << datumA.c\_str() << " at head" << endl;

        sizeM++;

    }

    // Overwrite datum at head?

    else if (keyA == headM->keyM)

        headM->datumM = datumA;

    // Have to search ...

    else

    {

        // Point ONE

        cout << "Point one encountered \n";

        // if key is found in list, just overwrite data;

        for (Node \*p = headM; p != 0; p = p->nextM)

        {

            if (keyA == p->keyM)

            {

                p->datumM = datumA;

                return;

            }

        }

        //OK, find place to insert new node ...

        Node \*p = headM->nextM;

        Node \*prev = headM;

        while (p != 0 && keyA > p->keyM)

        {

            prev = p;

            p = p->nextM;

        }

        prev->nextM = new Node(keyA, datumA, p);

        sizeM++;

    }

    cursorM = NULL;

}

void DictionaryList::remove(const int &keyA)

{

    if (headM == 0 || keyA < headM->keyM)

        return;

    Node \*doomed\_node = 0;

    if (keyA == headM->keyM)

    {

        doomed\_node = headM;

        headM = headM->nextM;

        // POINT TWO

    }

    else

    {

        Node \*before = headM;

        Node \*maybe\_doomed = headM->nextM;

        while (maybe\_doomed != 0 && keyA > maybe\_doomed->keyM)

        {

            before = maybe\_doomed;

            maybe\_doomed = maybe\_doomed->nextM;

        }

        if (maybe\_doomed != 0 && maybe\_doomed->keyM == keyA)

        {

            doomed\_node = maybe\_doomed;

            before->nextM = maybe\_doomed->nextM;

        }

    }

    if (doomed\_node == cursorM)

        cursorM = 0;

    delete doomed\_node; // Does nothing if doomed\_node == 0.

    sizeM--;

}

void DictionaryList::go\_to\_first()

{

    cursorM = headM;

}

void DictionaryList::step\_fwd()

{

    assert(cursor\_ok());

    cursorM = cursorM->nextM;

}

void DictionaryList::make\_empty()

{

    destroy();

    sizeM = 0;

    cursorM = 0;

}

void DictionaryList::copy(const DictionaryList &source)

{

    if (source.headM == 0)

    {

        headM = 0;

        return;

    }

    headM = new Node(source.headM->keyM, source.headM->datumM, NULL);

    Node \*newest\_node = headM;

    const Node \*source\_node = source.headM;

    while (true)

    {

        source\_node = source\_node->nextM;

        if (source\_node == 0)

            break;

        newest\_node->nextM = new Node(source\_node->keyM, source\_node->datumM, NULL);

        newest\_node = newest\_node->nextM;

    }

    cursorM = source.cursorM;

    sizeM = source.sizeM;

}

void DictionaryList::find(const int &keyA)

{

    for (Node \*p = headM; p != 0; p = p->nextM)

        if (keyA == p->keyM)

        {

            cout << "'" << keyA << "' was found with datum value " << p->datumM.c\_str() << ".\n";

            cursorM = p;

            return;

        }

    cout << "'" << keyA << "' was not found.\n";

    cursorM = 0;

}

void DictionaryList::destroy()

{

    Node \*p = headM;

    Node \*prev;

    while (p != 0)

    {

        prev = p;

        p = p->nextM;

        delete prev;

    }

    headM = 0;

    sizeM = 0;

}

ostream &operator<<(ostream &os, DictionaryList dl)

{

    dl.go\_to\_first();

    while (dl.cursor\_ok())

    {

        os << dl.cursor\_key() << "  " << dl.cursor\_datum() << endl;

        dl.step\_fwd();

    }

    return os;

}

const Mystring &DictionaryList::operator[](int i)

{

    int x = 0;

    this->go\_to\_first();

    while (x != i)

    {

        step\_fwd();

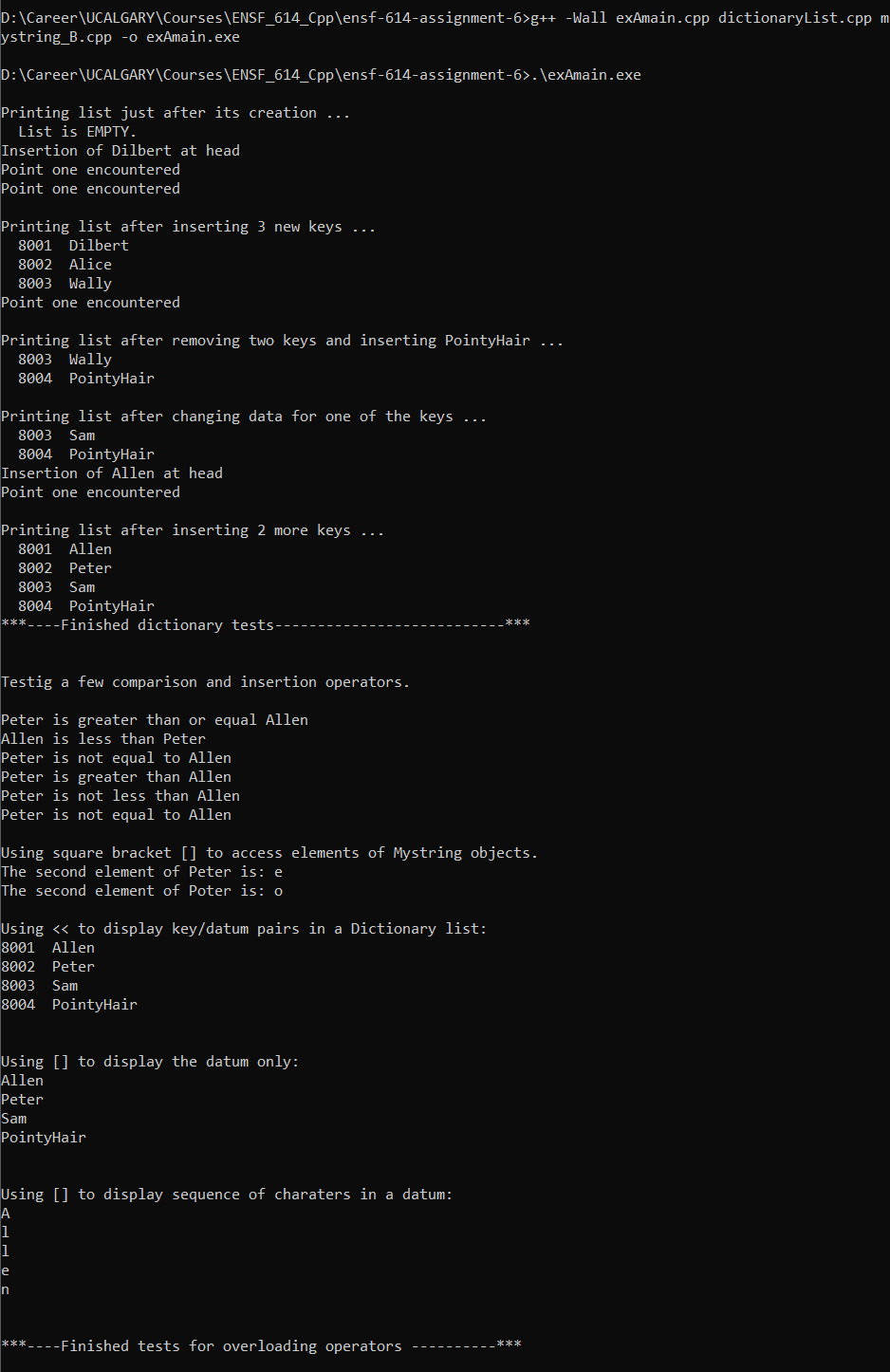
        x++;

    }

    return this->cursor\_datum();

}

# Exercise B – Program Output



# Exercise C and D – Source file Item.java

/\*

 \* File Name:               Item.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

class Item<E extends Number & Comparable<E>> {

    private E item;

    public Item(E value) {

        item = value;

    }

    public void setItem(E value) {

        item = value;

    }

    public E getItem() {

        return item;

    }

}

# Exercise C and D – Source file MyVector.java

/\*

 \* File Name:               MyVector.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class MyVector<E extends Number & Comparable<E>> {

    private ArrayList<Item<E>> storageM;

    private Sorter<E> sorter;

    MyVector(int n) {

        this.storageM = new ArrayList<>(n);

    }

    MyVector(ArrayList<Item<E>> arr) {

        this.storageM = new ArrayList<>(arr.size());

        for (Item<E> i : arr) {

            this.storageM.add(i);

        }

    }

    public void add(Item<E> value) {

        this.storageM.add(value);

    }

    public void setSortStrategy(Sorter<E> s) {

        this.sorter = s;

    }

    public void performSort() {

        this.sorter.sort((this.storageM));

    }

    public void display() {

        for(Item<E> i : this.storageM) {

            if(i.getItem() instanceof Integer) {

                System.out.printf("%d ", i.getItem());

            }

            else {

                System.out.printf("%.2f ", i.getItem());

            }

        }

    }

}

# Exercise C and D – Source file Sorter.java

/\*

 \* File Name:               Sorter.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public interface Sorter<E extends Number & Comparable<E>> {

    public void sort(ArrayList<Item<E>> list);

}

# Exercise C and D – Source file BubbleSorter.java

/\*

 \* File Name:               BubbleSorter.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class BubbleSorter<E extends Number & Comparable<E>> implements Sorter<E> {

    @Override

    public void sort(ArrayList<Item<E>> list) {

        for (int i = 0; i < list.size() - 1; i++) {

            for (int j = 0; j < list.size() - i - 1; j++) {

                if (list.get(j).getItem().compareTo(list.get(j + 1).getItem()) > 0) {

                    Item<E> temp = list.get(j);

                    list.set(j, list.get(j + 1));

                    list.set(j + 1, temp);

                }

            }

        }

    }

}

# Exercise C and D – Source file InsertionSorter.java

/\*

 \* File Name:               InsertionSorter.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class InsertionSorter<E extends Number & Comparable<E>> implements Sorter<E> {

    @Override

    public void sort(ArrayList<Item<E>> list) {

        for (int i = 0; i < list.size(); i++) {

            Item<E> key = list.get(i);

            int j = i - 1;

            while (j >= 0 && (list.get(j).getItem().compareTo(key.getItem()) > 0)) {

                list.set(j + 1, list.get(j));

                j = j - 1;

            }

            list.set(j + 1, key);

        }

    }

}

# Exercise C – Source file DemoStrategyPattern.java

/\*

 \* File Name:               DemoStrategyPattern.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.Random;

public class DemoStrategyPattern {

    public static void main(String[] args) {

        // Create an object of MyVector<Double> with capacity of 50 elements

        MyVector<Double> v1 = new MyVector<Double>(50);

        // Create a Random object to generate values between 0

        Random rand = new Random();

        // adding 5 randomly generated numbers into MyVector object v1

        for (int i = 4; i >= 0; i--) {

            Item<Double> item;

            item = new Item<Double>(Double.valueOf(rand.nextDouble() \* 100));

            v1.add(item);

        }

        // displaying original data in MyVector v1

        System.out.println("The original values in v1 object are:");

        v1.display();

        // choose algorithm bubble sort as a strategy to sort object v1

        v1.setSortStrategy(new BubbleSorter<Double>());

        // perform algorithm bubble sort to v1

        v1.performSort();

        System.out.println("\nThe values in MyVector object v1 after performing BoubleSorter is:");

        v1.display();

        // create a MyVector<Integer> object V2

        MyVector<Integer> v2 = new MyVector<Integer>(50);

        // populate v2 with 5 randomly generated numbers

        for (int i = 4; i >= 0; i--) {

            Item<Integer> item;

            item = new Item<Integer>(Integer.valueOf(rand.nextInt(50)));

            v2.add(item);

        }

        System.out.println("\nThe original values in v2 object are:");

        v2.display();

        v2.setSortStrategy(new InsertionSorter<Integer>());

        ;

        v2.performSort();

        System.out.println("\nThe values in MyVector object v2 after performing InsertionSorter is:");

        v2.display();

    }

}

# Exercise C – Program Output

Text

Description automatically generated

# Exercise D – Source file SelectionSorter.java

/\*

 \* File Name:               SelectionSorter.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class SelectionSorter<E extends Number & Comparable<E>> implements Sorter<E> {

    @Override

    public void sort(ArrayList<Item<E>> list) {

        for (int i = 0; i < list.size() - 1; i++) {

            int min\_idx = i;

            for (int j = i + 1; j < list.size(); j++) {

                if (list.get(j).getItem().compareTo(list.get(min\_idx).getItem()) < 0) {

                    min\_idx = j;

                }

            }

            Item<E> temp = list.get(min\_idx);

            list.set(min\_idx, list.get(i));

            list.set(i, temp);

        }

    }

}

# Exercise D – Source file DemoStrategyPattern.java

/\*

 \* File Name:               DemoStrategyPattern.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise C and D

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.Random;

public class DemoStrategyPattern {

    public static void main(String[] args) {

        // Create an object of MyVector<Double> with capacity of 50 elements

        MyVector<Double> v1 = new MyVector<Double>(50);

        // Create a Random object to generate values between 0

        Random rand = new Random();

        // adding 5 randomly generated numbers into MyVector object v1

        for (int i = 4; i >= 0; i--) {

            Item<Double> item;

            item = new Item<Double>(Double.valueOf(rand.nextDouble() \* 100));

            v1.add(item);

        }

        // displaying original data in MyVector v1

        System.out.println("The original values in v1 object are:");

        v1.display();

        // choose algorithm bubble sort as a strategy to sort object v1

        v1.setSortStrategy(new BubbleSorter<Double>());

        // perform algorithm bubble sort to v1

        v1.performSort();

        System.out.println("\nThe values in MyVector object v1 after performing BoubleSorter is:");

        v1.display();

        // create a MyVector<Integer> object V2

        MyVector<Integer> v2 = new MyVector<Integer>(50);

        // populate v2 with 5 randomly generated numbers

        for (int i = 4; i >= 0; i--) {

            Item<Integer> item;

            item = new Item<Integer>(Integer.valueOf(rand.nextInt(50)));

            v2.add(item);

        }

        System.out.println("\nThe original values in v2 object are:");

        v2.display();

        v2.setSortStrategy(new InsertionSorter<Integer>());

        ;

        v2.performSort();

        System.out.println("\nThe values in MyVector object v2 after performing InsertionSorter is:");

        v2.display();

        // create a MyVector<Double> object V3

        MyVector<Double> v3 = new MyVector<Double>(50);

        // populate v3 with 5 randomly generated numbers

        for (int i = 4; i >= 0; i--) {

            Item<Double> item;

            item = new Item<Double>(Double.valueOf(rand.nextDouble() \* 100));

            v3.add(item);

        }

        System.out.println("\nThe original values in v3 object are:");

        v3.display();

        v3.setSortStrategy(new SelectionSorter<Double>());

        v3.performSort();

        System.out.println("\nThe values in MyVector object v3 after performing SelectionSorter is:");

        v3.display();

    }

}

# Exercise D – Program Output

Text

Description automatically generated

# Exercise E – Source file ObserverPatternController.java

/\*

 \* File Name:               ObserverPatternController.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise E

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

public class ObserverPatternController {

    public static void main(String[] s) {

        double[] arr = { 10, 20, 33, 44, 50, 30, 60, 70, 80, 10, 11, 23, 34, 55 };

        System.out.println("Creating object mydata with an empty list -- no data:");

        DoubleArrayListSubject mydata = new DoubleArrayListSubject();

        System.out.println("Expected to print: Empty List ...");

        mydata.display();

        mydata.populate(arr);

        System.out.println("mydata object is populated with: 10, 20, 33, 44, 50, 30, 60, 70, 80, 10, 11, 23, 34, 55 ");

        System.out.print("Now, creating three observer objects: ht, vt, and hl ");

        System.out.println("\nwhich are immediately notified of existing data with different views.");

        ThreeColumnTable\_Observer ht = new ThreeColumnTable\_Observer(mydata);

        FiveRowsTable\_Observer vt = new FiveRowsTable\_Observer(mydata);

        OneRow\_Observer hl = new OneRow\_Observer(mydata);

        System.out.println("\n\nChanging the third value from 33, to 66 -- (All views must show this change):");

        mydata.setData(66.0, 2);

        System.out.println("\n\nAdding a new value to the end of the list -- (All views must show this change)");

        mydata.addData(1000.0);

        System.out.println("\n\nNow removing two observers from the list:");

        mydata.remove(ht);

        mydata.remove(vt);

        System.out.println("Only the remained observer (One Row ), is notified.");

        mydata.addData(2000.0);

        System.out.println("\n\nNow removing the last observer from the list:");

        mydata.remove(hl);

        System.out.println("\nAdding a new value the end of the list:");

        mydata.addData(3000.0);

        System.out.println("Since there is no observer -- nothing is displayed ...");

        System.out.print("\nNow, creating a new Three-Column observer that will be notified of existing data:");

        ht = new ThreeColumnTable\_Observer(mydata);

    }

}

# Exercise E – Source file Subject.java

/\*

 \* File Name:               Subject.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise E

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

public interface Subject {

    public void registerObserver(Observer o);

    public void remove(Observer o);

    public void notifyAllObservers();

}

# Exercise E – Source file DoubleArrayListSubject.java

/\*

 \* File Name:               DoubleArrayListSubject.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise E

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class DoubleArrayListSubject implements Subject {

    private ArrayList<Observer> observers;

    public ArrayList<Double> data;

    DoubleArrayListSubject() {

        this.data = new ArrayList<>();

        this.observers = new ArrayList<>();

    }

    @Override

    public void registerObserver(Observer o) {

        this.observers.add(o);

        o.update(this.data);

    }

    @Override

    public void remove(Observer o) {

        this.observers.remove(o);

    }

    @Override

    public void notifyAllObservers() {

        for(Observer o : this.observers) {

            o.update(this.data);

        }

    }

    public void addData(Double element) {

        this.data.add(element);

        this.notifyAllObservers();

    }

    public void setData(Double value, int index) {

        this.data.set(index, value);

        this.notifyAllObservers();

    }

    public void populate(double[] arr) {

        for(int i=0; i<arr.length; i++) {

            this.data.add(arr[i]);

        }

        this.notifyAllObservers();

    }

    public void display() {

        if(this.data.size() == 0) {

            System.out.printf("Empty list...");

        }

        for(int i=0; i<this.data.size(); i++) {

            System.out.printf("%.2f ", this.data.get(i));

        }

        System.out.println();

    }

}

# Exercise E – Source file Observer.java

/\*

 \* File Name:               Observer.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise E

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public interface Observer {

    public void update(ArrayList<Double> arr);

}

# Exercise E – Source file OneRow\_Observer.java

/\*

 \* File Name:               OneRow\_Observer.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise E

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class OneRow\_Observer implements Observer {

    private Subject subject;

    private ArrayList<Double> temp;

    OneRow\_Observer(Subject s) {

        this.subject = s;

        this.subject.registerObserver(this);

    }

    @Override

    public void update(ArrayList<Double> arr) {

        System.out.println("\nNotification to One-Row Table Observer: Data Changed:");

        this.temp = arr;

        this.display();

    }

    public void display() {

        for (int i = 0; i < this.temp.size(); i++) {

            System.out.printf("%.1f ", this.temp.get(i));

        }

        System.out.println("\n");

    }

}

# Exercise E – Source file ThreeColumnTable\_Observer.java

/\*

 \* File Name:               ThreeColumnTable\_Observer.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise E

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class ThreeColumnTable\_Observer implements Observer {

    private Subject subject;

    private ArrayList<Double> temp;

    ThreeColumnTable\_Observer(Subject s) {

        this.subject = s;

        this.subject.registerObserver(this);

    }

    @Override

    public void update(ArrayList<Double> arr) {

        System.out.printf("\nNotification to Three-Column Table Observer: Data Changed:");

        this.temp = arr;

        this.display();

    }

    public void display() {

        for (int i = 0; i < this.temp.size(); i++) {

            if (i % 3 == 0) {

                System.out.println();

            }

            System.out.printf("%.1f ", this.temp.get(i));

        }

        System.out.println("\n");

    }

}

# Exercise E – Source file FiveRowsTable\_Observer.java

/\*

 \* File Name:               FiveRowsTable\_Observer.java

 \* Course:                  ENSF 614 - Fall 2021

 \* Lab # and Assignment #:  Lab 6 Exercise E

 \* Lab section:             B01

 \* Completed by:            Bhavyai Gupta

 \* Submission Date:         November 16, 2021

 \*/

import java.util.ArrayList;

public class FiveRowsTable\_Observer implements Observer {

    private Subject subject;

    private ArrayList<Double> temp;

    FiveRowsTable\_Observer(Subject s) {

        this.subject = s;

        this.subject.registerObserver(this);

    }

    @Override

    public void update(ArrayList<Double> arr) {

        System.out.println("\nNotification to Five-Rows Table Observer: Data Changed:");

        this.temp = arr;

        this.display();

    }

    public void display() {

        StringBuffer sb = new StringBuffer();

        for (int i = 0; i < this.temp.size(); i = i+5) {

            sb.append(String.format("%.1f\t", this.temp.get(i)));

        }

        sb.append("\n");

        for (int i = 1; i < this.temp.size(); i = i+5) {

            sb.append(String.format("%.1f\t", this.temp.get(i)));

        }

        sb.append("\n");

        for (int i = 2; i < this.temp.size(); i = i+5) {

            sb.append(String.format("%.1f\t", this.temp.get(i)));

        }

        sb.append("\n");

        for (int i = 3; i < this.temp.size(); i = i+5) {

            sb.append(String.format("%.1f\t", this.temp.get(i)));

        }

        sb.append("\n");

        for (int i = 4; i < this.temp.size(); i = i+5) {

            sb.append(String.format("%.1f\t", this.temp.get(i)));

        }

        sb.append("\n");

        System.out.println(sb.toString());

    }

}

# Exercise E – Program Output

Text

Description automatically generated

Text

Description automatically generated