University of Calgary
Department of Electrical and Computer Engineering
Principles of Software Design (ENSF 480)

Lab 1– September 17, 2021

Written by: M. Moussavi

Instructors:

- M. Moussavi (B01)
- M. Moshirpour and M. Lasby (B02)

Important Notes:

- In this lab you can work with a partner (groups of three or more **are NOT allowed**). Working with a partner usually should give you the opportunity to discuss some of details of the topics and learn from each other. Also, it will give you the opportunity to practice one of the popular methods of program development called, **pair-programming.** This method which is normally associated with "Agile Software Development" technique, two programmers work together normally on the same workstation (you may consider a zoom session for this purpose). While one partner, the driver, writes the code, the other partner, acts as observer, looks over his/her shoulder making sure the syntax and solution logic is correct. Partners should switch roles frequently in a way that both of them have equivalent opportunity to practice both roles.

  If you decided to work with a partner, please submit only one lab report with both names. Submitting two lab reports with the same content will be considered as copies and plagiarism.

- When submitting your source code (.cpp, or .h), make sure the following information appears at the top of your file:
  a. File Name
  b. Assignment and exercise number
  c. Lab section
  d. Your name
  e. Submission Date:

  Here is an example:

```
/*
 *  File Name: lab1exe_F.cpp
 *  Assignment: Lab 1 Exercise F
 *  Completed by: Your Name (or your team name for group exercises)
 *  Submission Date: Sept 18, 2020
 */
```

Plagiarism Warning:

We trust that our students take integrity and honesty seriously, and during their course of studies at the U of C have built relationships with their instructor and peers throughout the semester and do not want to disappoint those relationships. However, I would like to remind your duty and responsibility as ethical future engineers:

University of Calgary has a strict plagiarism policy. Therefore, in this course, and other similar software-engineering courses, you MUST submit a lab report that is solely your work (or your team's work). Giving your work to the other students or submitting works that are copied from other students or Internet resources, will be considered as plagiarism.

Due Dates:

Friday Sept 24, before 2:00 PM. If your assignment in this lab or future labs is submitted after the due date it will not be marked and your lab assignment score will be zero.

Objectives:

As mentioned during the lectures, the focus of the first part of the course is on code-level design concepts that haven't been taught in previous courses (ENSF 409, and ENSF 337). These topics includes concepts such as overloading operators, friend concept, inheritance, multiple inheritance, realization, aggregation, and delegation in C++. However, the pupose of this lab is:

1. First to give you a quick review of basic C++ concepts that you have learned in the previous course, ENSF 337 or its older version of the course ENCM 339.
2. Understand and apply the basic low-level object-oriented design and programming concept such as "Abstraction", "Encapsulation", "Modularity", and "Hierarchy".

Note:

Your lab reports must have a cover page with the following information. This is just for helping your TAs to easily record your marks on the D2L system.

Name (s): If working with a partner both students' name must be written
Course Name: Principles of Software Design
Lab Section: B01 (with Dr. Moussavi), or B02 (with Dr. Moshirpour)
Course Code: ENSF 480
Assignment Number: For example, Lab-1
Submission Date and Time: DD/MM/YYYY

Marking scheme:

The total mark for the exercises in this lab is: **51 marks**

- Exercise A (12 marks)
- Exercise B (14 marks)
- Exercise C (10 marks)
- Exercise D (15 marks)

Exercise A (12 marks) – Review of C++ Fundamentals Learned in ENSF 337

The purpose of this exercise is to refresh your memory about some of the basic constructs of C++ classes that you have learned in ENSF 337.

What to do:

Step1. Download files `mystring.h`, `mystring.cpp` and `exAmain.cpp` from D2L.

Step 2. If you are using Cygwin, Geany, or Mac Terminal, compile the files `mystring.cpp` and `exAmain.cpp`, using the following command:

```
g++ -Wall  -o myprog  mystring.cpp exAmain.cpp
```

Note: `myprog` is the program's executable file name.

Step 3. Run the program from your working directory (exA), using the following command:

```
./myprog
```

Step 4. Use your text editor to open files: `mystring.h`, `mystring.cpp`, `exAmain.cpp`, and try to understand how class `Mystring` and its functions work.

Step 5. Now to better understand this class, draw AR diagrams for points `one,` and `two`, when the program reaches these points for the first time. If you have never taken the previous course, ENSF 337/ENCM 339, or if you have taken this course long time ago and do not remember about details of AR notations for C/C++ please ask for help immediately. You don't need to submit this diagrams.

Step 6. If you compile and run this program you will see several lines of output as shown in the left side of the following table. On the right side of this table, explain why and at which point in the file `exAmain.cpp`, these outputs will be produced. Your explanation must be clear and backed with some reasoning.

There is a copy of the following table in MS Word format available on the D2L. You should download the given file (called `AnswerSheet.doc`) and type your answers into the given table.
The answer for the first output is given, as an example for the expected details of your answer.

Program output and its order	Your explanation (why and where this output was created)
constructor with int argument is called.	it is called at line 12 in exAmain. The statement, Mystring c = 3 is interpreted by the compiler as a call to the constructor `Mystring::Mystring(int n).`
default constructor is called. **default constructor is called.**	
constructor with char* argument is called.	
copy constructor is called. **copy constructor is called.**	
destructor is called. **destructor is called.**	
copy constructor is called.	
assignment operator called.	
constructor with char* argument is called. **constructor with char* argument is called.**	
destructor is called. **destructor is called.** **destructor is called.** **destructor is called.** **destructor is called.**	
constructor with char* argument is called.	
Program terminated successfully.	
destructor is called. **destructor is called**	

What to Submit:

Submit the copy of the above table as part of your lab report. You don't need to submit your AR diagram is this exercise.

Exercise B (14 marks):

Part I – Drawing an AR Diagram for a Dictionary Data Structure (5 marks):

Dictionary is a data structure, which is generally an association of unique keys with some values. (Other common names for this type of data structures are Map and Lookup Table). *Dictionaries* are very useful abstract data types (ADT) that

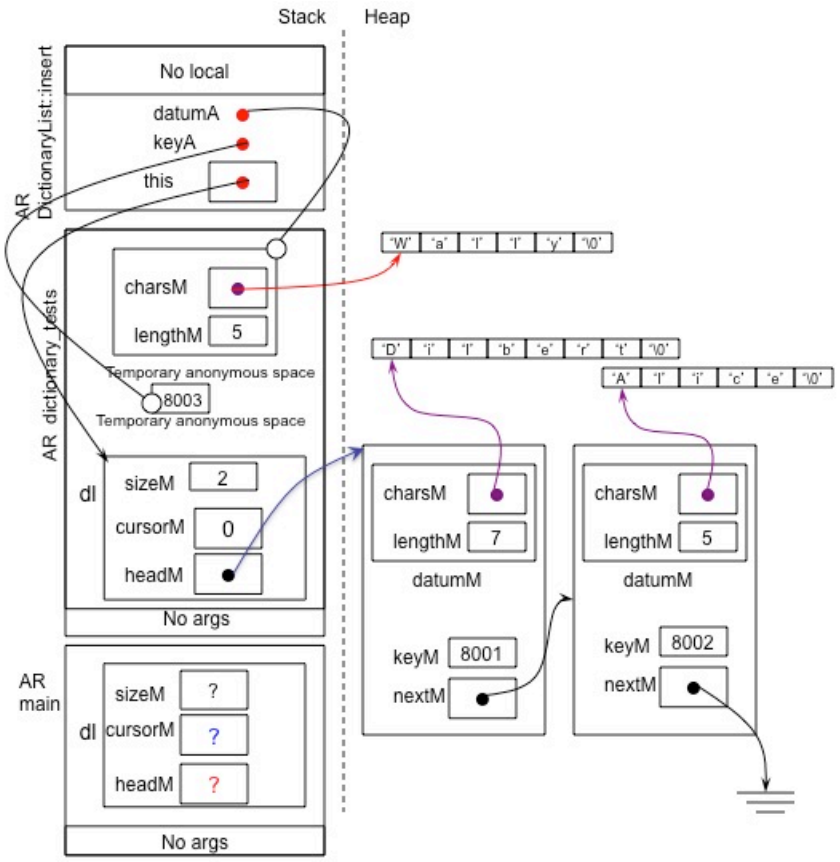
contain a collection of items called *keys*, which are typically strings or numbers. Associated with each key is another item that will be called a *datum* in this exercise. (``Datum" is singular form of the plural noun “data”.)

Typical operations for a Dictionary include: inserting a key with an associated datum, removing a key/datum pair by specifying a key, and searching for a pair by specifying a key. Dictionaries can be implemented using different data structure such as arrays, vectors, or linked lists. In this exercise a linked list implementation, called `DictionaryList` class is introduced. Class `DictionaryList`, in addition to a node-pointer that usually points to the first node in the linked list has another node-pointer called `cursor` that is used for accesses to the individual key/datum pairs.

What to do:

Download files `dictionaryList.h`, `dictionaryList.cpp`, `mystring_B.h`, `mystring_B.cpp`, and `exBmain` from D2L. Read them carefully and try to understand what the functionalities of these classes are doing. Note also the definition of class `Node` that contains three private data members: `keyM`, `datumM`, and `nextM`, a pointer of type `Node`. Also, class `Node` declares class `DictionaryList` as a `friend`. For details about `friend` keyword in C++, please refer to your lecture notes.

The idea of implementing a dictionary as a linked list is simple: each node contains a key, a datum, a pointer to the next node, and another node pointer called cursor that can either point to any node or can be set to NULL. For better understanding of the details of `DictionaryList`, try to understand how the function `insert` works. Further details about the operation of inserting a node into the list, can be learned from following AR diagram, which represents **point one** in this function, when reaches this **point for the second time**:



Now that you know how class `DictionaryList` and its member function insert work, draw an AR diagram for **point two** in function remove, when the program reaches this point for the first time.

What to Submit:

Submit you AR diagram as part of Lab1-report.
Since lab assignments will be submitted electronically on the D2L, please make sure to provide clear images of your diagrams. Poor and unclear images of the diagrams may be returned unmarked.

Part II – Writing Missing Functions (9 marks)

If you compile and run the files that you downloaded from D2L in part one of this exercise, you will notice that the program will work properly, as some functions are missing. Here is all you will see as a screen output of the list just after its creation:

```
Printing table just after its creation ...
  Table is EMPTY.

Printing table after inserting 3 new keys ...
  8001  Dilbert
  8002  Alice
  8003  Wally

Printing table after removing two keys and inserting PointyHair ...
  8003  Wally
  8004  PointyHair

Printing table after changing data for one of the keys ...
  8003  Sam
  8004  PointyHair

Printing table after inserting 2 more keys ...
  8001  Allen
  8002  Peter
  8003  Sam
  8004  PointyHair
***----Finished dictionary tests----------------------------***

DictionaryList::copy is not implemented properly, so the program is calling exit.
```

The function definitions that are not properly implemented are: `find`, `copy`, and `destroy`. Your job in this part of the exercise B is to properly implement them.

Test your function definitions and note that you should develop incrementally--implement and test `find` before you start working on `copy`, and finish `copy` before starting `destroy`. To test your function `find`, you have to first uncomment the call to the function `test_finding` in `exBmain.cpp`.

What to Submit:

Please see the instructions at the end of this document.

Exercise C - (10 marks)

The purpose of this exercise is to help you understanding and practicing the application of four pillars of object-oriented programming, which includes:

- Abstraction
- Encapsulation and Information hiding
- Modularity

- Hierarchy

What to Do:

Assume the following definition of class, `Company`, belongs to only a portion of legacy software application. Now, as a group of software developers, you have decided to refactor this code to make better and to comply with four principle and pillar of a good OOP.

Here is the legacy code:

```
#include <string>
#include <vector>
using namespace std;

struct Company{
    string companyName;

    string companyAdderss;

    vector<string> employees;       // vector of information about employees' information
                                    // (name, address, date of birth)

    string dateEstablished;         // the date that company was established

    vector <string> employeeState;  // information about employees' current states
                                    //(active, suspended, retired, fired)

    vector <string> customers;       // vector of information about customers
                                    // (name, address, phone)
};
```

As, you will notice, this C++ program compiles with no syntax error, but even in the first glance, you can find several design issues that needs to be fixed.

Notes:

- In your refactored code you should not use any C++ library classes other than `vector` and `string`.
- For the purpose of simplicity in this exercise, you don't need to worry about functions at all. Put your focus only on the data members of the class.

What to Submit:

Please see the instructions at the end of this document

Exercise D - (15 marks)

In this exercise you should download the file `human_program.cpp` for D2L. In this file there is a program with two classes: class `Point,` and class `Human`. The program compiles and runs with no compilation or runtime error. However:

1. There are serious design flaws in the definition of class `Human`.
2. There are several bad style C++ programming issues in this code that doesn't protect the data members in classes `Point,` and `Human`.

3. The concept of separation of inside-view of the program from its outside-view has not been properly followed.
4. There might be serious logical issue with this code such as: bad memory management.

Your task in this exercise is to refactor the entire definition of the classes `Point,` and `Human`. It means you need to rewrite the program and apply every possible modification to make this program better in terms of design, style, and documentation.

Note:

You are NOT allowed to make any changes to the data member of any of the given classes or their types. Please only focus on the above-mentioned design issues or flaw.

What to Submit:

Please see the instructions at the end of this document

Instructions to Submit Exercises B and C:

For exercises B and C submit the following files electronically on the D2L:

- As part of your lab report (PDF file), submit the copy of all .cpp and .h files, and the output of your program.
- Submit a zipped file that contains your actual source code (all .cpp and .h files)