University of Calgary
Department of Electrical and Computer Engineering

Advanced Systems Analysis and Software Design (ENSF 614)
Lab 1 – Fall 2024

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Important Notes:

- This is a group assignment, and 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.

- 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 both team members name for group exercises)
 *  Submission Date: Sept 18, 2024
 */
```

Start Date: Wed. Sept 11, 2024
Due Dates: Wed Sept 18, before 3:00 PM

Objectives:

As mentioned during the lectures, the focus of the first part of the course is code-level design concepts. These topics includes concepts such as overloading operators, friend concept, inheritance, multiple inheritance, realization, aggregation, and delegation in C++. However, the purpose of this lab is:

1. First to review basic C++ concepts.
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

Marking scheme:

- Only some of the lab exercises in this lab will be marked. Since each TA should mark approximately 46 lab assignments and for each lab on average we will have 3 or 4 exercises, it is almost impossible for them to mark all the lab exercises. Therefore, we only mark some of the exercises. As we have 4 exercises, we only mark one of the following combinations of exercises: [A and B], [A and C], [A and D], [B and C], [B and D], or [C and D]. I should mention that doing the lab exercises is obviously one of the best ways to better understand and learn the concepts that we discuss during the lectures, and I strongly urge you to complete all the exercises in each lab assignment. The solutions for the lab exercises that are not marked will be posted on the D2L, to allow you check your solutions. The total mark for the marked exercises in this lab will be 50 points.

Exercise A – Review of C++ Fundamentals

The purpose of this exercise is to refresh your memory about some of the basic constructs of C++.

What to do:

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

Step 2. If you are using Cygwin, 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 694 or one of our undergraduate courses: ENSF 337/ENCM 339; please study the slides and documents posted on the D2L

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 :

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. Also notice that the definition of class `Node` contains three private data members: `keyM`, `datumM`, and `nextM`, a pointer of type `Node`. Additionally, class `Node` declares class `DictionaryList` as a `friend`.

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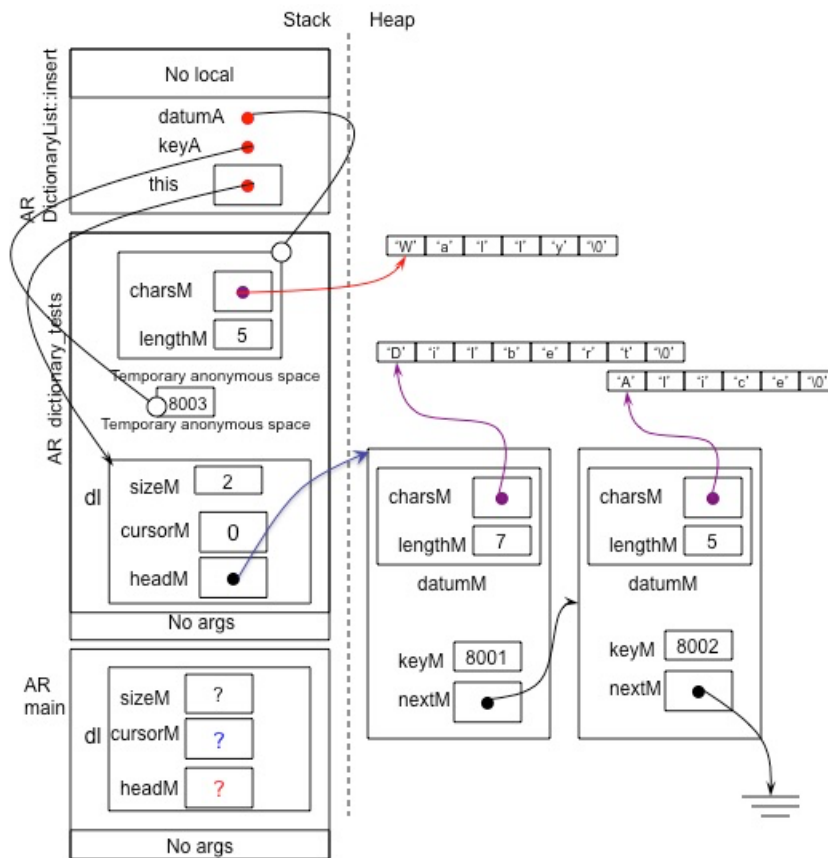
Now that you know how class `DictionaryList` and its member function insert work, draw an AR diagram for **point two** in function remove, when the program reaches this point for the first time.

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

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

What to Submit:

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

Exercise C:

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 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 existing code:
```cpp
// company.cpp
#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 simplicity in this exercise, you don't need to worry about member functions and their implementation, at all. Put your focus only on the data members of the class.

What to Submit:
Submit the copy of your modified code as part of your lab report in PDF format

Exercise D:

In this exercise you should download the file `human_program.cpp` from 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. Another issue with this program is that the definition of the classes is kept in single .cpp file. In general, in a properly designed program we should keep the outside view of the program (class definitions) separate from its implementation. Please make sure this concept is properly considered.
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`. Refactoring 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:
Submit the copy of your refactored .cpp and .h files, as part of your lab report in PDF format.