Tutorial Letter 101/3/2018

Introduction to Programming II
COS1512

Semesters 1 and 2

School of Computing

IMPORTANT INFORMATION:
Please activate your *myUnisa* and *my*Life email addresses and ensure you have regular access to the *my*Unisa module site COS1512-2018-S1 or COS1512-2018-S2 as well as your e-tutor group site.

Note: This is a blended online module, and therefore your module is available on myUnisa. However, in order to support you in your learning process, you will also receive Tutorial Letter 101 in printed format. Please visit the COS1512 course website on myUnisa at least twice a week.

BARCODE

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CONTENTS

2

Please note / important note: COS1512 is a semester module. You need AT LEAST eight hours per week for this module.

If you do not receive your study material immediately after registration, you have to download it from myUnisa so that you are able to start IMMEDIATELY with your studies. See section 5.3 in this tutorial letter for details about the downloading of study material.
To gain admission to the examination you have to submit one assignment before a specific date. The due date is 6 April if you are registered for the first semester and 31 August if you are registered for the second semester.

The COSALLF/301/0/2018 tutorial letter contains important general information that you will need during the year such as the names and contact details of lecturers assigned to the different modules.

1 INTRODUCTION AND WELCOME

Dear Student

Welcome to COS1512. We hope that you will find this module interesting and stimulating and that you will increase your knowledge about and your skills in programming in C++. We shall do our best to make your study of this module successful. In order to succeed with your studies, you need to start studying immediately and do the assignments properly.

This Tutorial Letter 101 contains important information about the scheme of work, resources and assignments for this module. We urge you to read it carefully and to keep it at hand when working through the study material, preparing the assignments, preparing for the examination and addressing questions to your lecturers.

Please read Tutorial Letter 301 and the *Study @ Unisa* brochure in combination with Tutorial Letter 101 as it gives you an idea of generally important information when studying at a distance university and within a particular College.

In Tutorial Letter 101, you will find the assignments and assessment criteria as well as instructions on the preparation and submission of the assignments. This tutorial letter also provides all the information you need with regard to the prescribed study material and other resources and how to obtain it. Please study this information carefully and make sure that you obtain the prescribed material as soon as possible.

We have also included certain general and administrative information about this module. Please study this section of the tutorial letter carefully.

Because this is a blended online module, you need to use myUnisa to study and complete the learning activities for this course. You need to visit the website on myUnisa for COS1512 frequently. The website for COS1512 for the **first semester** is **COS1512-18-S1** and for the **second semester** it is **COS1512-18-S2**.

We hope that you will enjoy this module and wish you all the best!

1.1 To get started…

Because this is a blended online module, you need to go online to see your study materials and read what to do for the module. Go to the myUnisa website here: https://my.unisa.ac.za and login with your student number and password. You will see **COS1512-18-S1** (for the first semester) or **COS1512-18-S2** (for the second semester) in the row of modules in the orange blocks across the top of the webpage. Remember to also check in the -**more**- tab if you cannot find it in the orange blocks. Click on the module you want to open.

In addition, you will receive a printed copy of this tutorial letter from your module. While the printed material may appear to be different from the online study materials, they are exactly the same and have been copied from the online myUnisa website.

1.1.1 About myUnisa

myUnisa is the student website that allows you to connect with your lecturers, e-tutors and fellow students, download your study material, submit assignments, gain access to the Library and various learning resources and participate in online discussion forums.

We also use myUnisa for announcements, and to deliver additional study material. Please join myUnisa and visit the COS1512 course website regularly, at least twice a week.

1.2   Tutorial Matter

The tutorial matter for this module consists of the following:

- this tutorial letter, COS1512/101/3/2018;

- tutorial letter COSALLF/301/4/2018;

- a CD containing the prescribed C++ software (Disk2018);

- additional tutorial letters published on the COS1512 course website under Additional Resources, containing additional information or solutions to assignments.

When you register, you will receive an **inventory letter** containing information about your tutorial matter. See also the brochure entitled *Study @ Unisa*, (which you received with your tutorial matter). Check the study material that you have received against the inventory letter. You should have received all the items listed in the inventory, unless there is a statement like "out of stock" or "not available". If any item is missing, follow the instructions on the back of the inventory letter without delay.

Some of this study material may not have been available when you registered. Study material that was not available when you registered will be posted to you as soon as possible, but is also available on myUnisa.

Please do not contact the School about missing tutorial matter, cancellation of a module, payments, enquiries about the registration of assignments, and so on, but rather the relevant department as indicated in the *Study @ Unisa* brochure. The School should only be contacted about academic matters.

If you have not received all of the above mentioned tutorial matter, please contact our DESPATCH DEPARTMENT, using the contact details as given in the *Study @ Unisa* brochure. In the meantime, please download the study material from myUnisa.

2   OVERVIEW OF THE MODULE COS1512

2.1   Purpose

COS1512 is one of a number of first-year Computer Science modules offered by the School of Computing at Unisa.

COS1512 focuses on providing an introduction to objects and the object-oriented programming environment using C++ as programming language. The following topics are covered:
- file I/O streams as an introduction to objects and classes;
- using pre-defined classes such as string and vector;
- C strings, pointers and dynamic arrays;
- ADTs (i.e. user-defined classes including the functions and operators for these classes as well as separate compilation);
- recursion;
- single inheritance, and
- function and class templates.

The paragraphs below show where COS1512 fits into the programming modules offered by the School of Computing:

COS1511 deals with the basic concepts of programming, using the programming language C++. It is aimed at students who have not done any programming before. It is a pre-requisite for COS1512.

COS1512 introduces the learner to objects and the object-oriented programming environment.

COS1521 provides a general background to computer systems.

INF1511 is an introductory course in Python programming.

COS1501 introduces the mathematics relevant to Computer Science.

2.2 Outcomes

Once you have completed this module, you should have reached the following outcomes:

Outcome 1:

You should be able to design a logical solution to a simple programming problem, making appropriate assumptions.

Assessment criteria:

- Through assignments, including multiple choice and written assignments and an examination at the end of the semester, you are assessed on your ability to:

- interpret a problem description which specifies the requirements of a program;

- identify all steps necessary to solve a problem and order the steps in the correct logical sequence;

- write down the logical sequence of operations that a computer should perform to solve a particular problem;

- apply object-oriented principles during problem solving.

Outcome 2:

You should be able to write C++ program code, demonstrating the principles of good programming style.

Assessment criteria:

Through assignments, including multiple choice and written assignments and an examination at the end of the semester, you are assessed on your ability to:

- use the different C++ programming constructs appropriately and correctly, in order to implement a solution to a programming problem;

- write functions and use them in a program;

- define classes and use object-oriented principles to implement programming problems;

- recognise/locate errors in a program and correct them.

Outcome 3:

You should be able to demonstrate an understanding of the theory underlying the basic programming concepts.

Assessment criteria:

Through assignments, including multiple choice and written assignments and an examination at the end of the semester, you are assessed on your ability to:

- explain the purpose of a particular C++ programming construct and identify problem descriptions where they are applicable;

- define relevant programming concepts.

The specific learning *objectives* for each chapter in the prescribed book for COS1512 in order to reach the above learning outcomes are given in more detail in the study guide included in Tutorial Letter 102, available under Additional Resources on the COS1512 course website.

3 LECTURER(S) AND CONTACT DETAILS

3.1   Lecturer(s)

If you experience problems with this subject or have any other enquiry about it, please feel free to contact the lecturers. The names and telephone numbers of your lecturers for this module, as well as the module e-mail address you can use for any queries regarding this module, are supplied in tutorial letter COSALLF/301/0/2018.

Email: Email is a convenient and the most effective way of communicating with a lecturer. **Students registered for the first semester should send e-mail queries either to the module leader for COS1512 (e-mail supplied on the course website) or to** **COS1512-18-S1@unisa.ac.za**

and students registered for the second semester should send e-mail queries either to the module leader for COS1512 (e-mail supplied on the course website) or to **COS1512-18-S2@unisa.ac.za.**

Include the module code and your student number in the subject header of the message. Ask specific questions. It is difficult to respond properly via email to a request such as 'I don't understand problem 5.1. Please explain.' Always state exactly what it is that you do not understand.

Phone us: You are welcome to phone us directly, but please consult your tutorial letters and the myUnisa discussion forum to ensure that your query has not already been addressed. We are sometimes unavailable due to other departmental, research or university duties. If you fail to reach us directly, please phone the secretary. In urgent cases you may also leave a message at a secretary for us to call you back. The best contact hours are between 9:00 and 13:00 in the mornings, except Wednesdays when we have our departmental meetings.

3.2   Department

Please note that the School of Computing has moved to Florida in 2013. The School of Computing can be contacted telephonically at 011 670 9200 or via e-mail with the e-mail address computing@unisa.ac.za. Should you be unable to reach any of the lecturers for COS1512, please leave a message and your contact details with one of the secretaries, who

can be contacted via the number given above. Remember to include the module code and your student number with the message.

3.3   University

Lecturers for this module are only responsible for content-related queries about the study material used for COS1512.

If you need to contact the University about matters not related to the content of this module, please consult the publication **Study @ Unisa** that you received with your study material. This brochure contains information on how to contact the University (e.g. to whom you can write for different queries, important telephone and fax numbers, addresses and details of the times certain facilities are open).

NB: Always have your student number at hand when you contact the University.

4   MODULE-RELATED RESOURCES

4.1   Joining myUnisa

If you have access to a computer that is linked to the internet, you can quickly access resources and information at the University. The *myUnisa* learning management system is Unisa's online campus that will help you to communicate with your lecturers, with other students and with the administrative departments of Unisa – all through the computer and the internet.

You can start at the main Unisa website, http://www.unisa.ac.za, and then click on the m*yUnisa* orange block. This will take you to the *myUnisa* website. To go to the *myUnisa* website directly, go to https://my.unisa.ac.za. When you are on the *myUnisa website,* click on the "Claim UNISA Login" at the right-hand side of the screen. You will then be prompted to give your student number to claim your initial myUnisa as well as myLife login details.

This module is presented following a blended approach in the sense that even though you will still receive some printed study material, most of the information needed to complete this module is available on *myUnisa. myUnisa* has inter alia the following tools which you will use regularly:

Assignments	This is a tool to manage your assignments; to submit, track and see marks obtained.
Official Study Material	Tutorial letters 101 and 301 as well as some past examination papers are available under Official Study Material.
Additional Resources	Additional tutorial letters such as solutions to assignments and the examination tutorial letter are published under Additional Resources. The Additional Resources tool also contains a variety of resources related to COS1512. For example the Study Guide (Tutorial Letter 102) and the Code::Blocks software.
Course Contact	The Course Contact tool facilitates e-mail communication between students and lecturers. Students use their myLife e-mail to send e-mails to their lecturers through myUnisa.
Frequently Asked Questions	Frequently asked questions, or FAQs, are listed questions and answers, all supposed to be frequently asked in some context, and pertaining to a particular topic.

Learning Units	The Learning Units tool contains learning units/lessons for COS1512 and represents the weeks in your study programme. Please use the weekly Learning Units to guide you in your studies.

Please consult the publication **Study @ Unisa** which you received with your study material for more information on *myUnisa.*

4.2 Other resources – Printed support materials

Because we want you to be successful in this blended online module, we also provide you with Tutorial Letter 101 in printed format. This will allow you to continue studying and do the assignments, even if you are not online.

- Tutorial Letter 101 will be sent to you at the beginning of the semester, but you do not have to wait to receive it to start studying – You can go online as soon as you register and all your study materials will be there.

- Therefore, Tutorial Letter 101 is not something that you need to wait for before you start with the module. It is only an **offline** copy of the formal content for the online module.

- This will give you the chance to do a lot of the studying for this module WITHOUT going online. This will save you money, of course, and you will be able to take as much time as you need to read -- and to re-read -- the materials and do the activities.

It is therefore very important that you log into myUnisa regularly. We recommend that you should do this at least every week, and preferably twice a week, to check for the following:

- **Check for new Announcements**. You can also set up your myLife email so that you receive the Announcement emails on your mobile device.
- **Do the Discussion forum activities**. For every unit in this module, we want you to share with the other people in your group in the activities. You can read the instructions there, and even prepare your answers but you need to go online to post your messages.
- **Do other online activities.** For some of the unit activities, you need to post something on the Blog or take a quiz or complete a survey in **Self Assessment**. Don't skip these activities because they will help you to complete the assignments and activities for the module.

We hope that this system will help you to succeed in this blended online module by giving you extra ways to study the materials and practice with all of the activities and assignments. At the same time, you **MUST** go online in order to complete the activities and assignments on time -- and to get the most from the online course.

Remember, the printed support materials are a back-up to everything that is found online, on myUnisa. There are no extra things there**. In other words, you should NOT wait for the Printed support materials to arrive to start studying.**

4.3 Prescribed books

The prescribed book for this module is:

Walter Savitch. Problem Solving with C++, 9 th edition. Pearson International Edition: Addison-Wesley, 2015.

You may also use the 7th or 8th edition of the prescribed book. We are aware that a 10th edition is expected at the end of 2017 or beginning of 2018. You may also use that ediction.

You are expected to purchase your own copy of the prescribed book. For contact details of official booksellers, please consult the list of official booksellers and their addresses in *Study @ Unisa*. If you have any difficulties with obtaining books from these bookshops, please contact vospresc@unisa.ac.za.

We will refer to the prescribed book as Savitch.

4.4   Recommended books

You do not have to consult any other textbooks apart from Savitch. However, some of you may want to read more widely, and consult alternative references. The following useful books are available in the Unisa library. Please note that the library does not have multiple copies of these books and that only limited waiting lists are kept.

DS Malik. C++ Programming: From Problem Analysis To Program Design. Course Technology, Thomson Learning, 2009.

HM Deitel and PJ Deitel. C++ How to Program. 8 th edition. Prentice Hall, 2008.

John R. Hubbard. Programming with C++. 2 nd edition. Schaum's Outlines, 2000.

4.5   Prescribed software

The prescribed software for this module is Code::Blocks 10.05. We will refer to the software as Code::Blocks. Code::Blocks includes the MinGW C++ compiler and an Integrated Development Environment (IDE), which we use to create program files. The prescribed software is provided on the CD Disk2018 that you should have received in your study package when you registered. The Disk2018 contains instructions on how to install the software, and how to use the IDE to write, compile and execute your programs. Click on the link for COS1512 and follow the instructions.

If you did not receive Disk2018 upon registration, you should download the software immediately from myUnisa so that you are able to start with your studies at once. The software is available under Additional Resources on the COS1512 webpage.

4.6   myUnisa Forum

Content-related queries should be posted on the COS1512 discussion forum on myUnisa rather than sent to the COS1512 e-mail address. In this way fellow students can also contribute and benefit. You can also contact the e-tutor to whom you are allocated with content-related queries (see section 5.1).

4.7   Tutorial letters

In addition to the Study Guide, the software and this tutorial letter, there will be other tutorial letters during the course of the semester. Some will provide additional information (Tutorial Letters 102, 103, etc.) whilst others will discuss Assignments 1 and 2 (Tutorial Letters 201 and 202). All tutorial letters will be available on *myUnisa* under Additional Resources. Note also that the solutions to the self-assessment assignment - Assignment 3 - are available online on the COS1512 website.

You only receive a printed copy of this tutorial letter (Tutorial Letter 101). All subsequent tutorial letters are only available on myUnisa under *Additional Resources.*

4.8   Additional Resources

Please check *Additional Resources* on myUnisa regularly for documents that will assist you if you have problems installing software, using the compiler, writing a program, etc. You will also find extra help for the examination there.

5 STUDENT SUPPORT SERVICES FOR THE MODULE

The Student Services Bureau of Unisa provides support for students in general academic matters, such as selecting appropriate modules, developing study skills, adapting to distance education, assistance for students with special needs or general difficulties with studies. See COSALLF/301/4/2018 and *Study @ Unisa* for contact information. Your *Study @ Unisa* brochure also contains other important information.

5.1   E-Tutors

Unisa offers online tutorials (e-tutoring) to students registered for modules at NQF level 5 and 6, this means qualifying first year and second year modules.

Once you have been registered for a qualifying module, you will be allocated to a group of students with whom you will be interacting during the tuition period as well as an e-tutor who will be your tutorial facilitator. Thereafter you will receive an sms informing you about your group, the name of your e-tutor and instructions on how to log onto myUnisa in order to receive further information on the e-tutoring process. If you login into myUnisa you will notice that your group site has been added there. Your tutor will be able to assist you there. For example, if you were allocated in group 4, the group site will be named COS1512-18-S1-4E. You can use the discussion forum to discuss module content issues with your tutor as well as with students belonging to that group. You will also find the contact details of your tutor. If you have content related problems (that is, problems with the material in your study guide that you do not understand), please contact your e-tutor.

Online tutorials are conducted by qualified e-tutors who are appointed by Unisa and are offered free of charge. All you need to be able to participate in e-tutoring is a computer with internet connection. If you live close to a Unisa Regional Centre or a Telecentre contracted with Unisa, please feel free to visit any of these to access the internet. E-tutoring takes place on myUnisa where you are expected to connect with other students in your allocated group. It is the role of the e-tutor to guide you through your study material during this interaction process. For you to get the most out of online tutoring, you need to participate in the online discussions that the e-tutor will be facilitating. Please contact your e-tutor with all content–related queries.

There are modules which students have been found to repeatedly fail, these modules are allocated face-to-face tutors and tutorials for these modules take place at the Unisa regional centres. These tutorials are also offered free of charge, however, it is important for you to register at your nearest Unisa Regional Centre to secure attendance of these classes.

This module is furthermore part of the "Extended Science Pathways" (ESP) programme in which students do their first-year semester modules over a year instead of a semester. You cannot apply to do the ESP programme as Unisa registrations place students to either mainstream or ESP.

5.2   Free computer and internet access

Unisa has entered into partnerships with establishments (referred to as Telecentres) in various locations across South Africa to enable you (as a Unisa student) free access to computers and the Internet. This access enables you to conduct the following academic related activities:

registration; online submission of assignments; engaging in e-tutoring activities and signature courses; etc. Please note that any other activity outside of these are for your own costing e.g. printing, photocopying, etc. For more information on the Telecentre nearest to you, please visit www.unisa.ac.za/telecentres.

5.3   Downloading study material and software

One of the requirements for study at the School of Computing is to have regular internet access to access *myUnisa* and your *myLife* e-mails. You are therefore expected to download any study material from the Internet that, for whatever reason, is not available on paper in time. You may download it from myUnisa. The study material is updated regularly, thus you need to check the COS1512 website at least twice a week on myUnisa.

Because COS1512 is a semester module, time is of the utmost importance. You should start studying the module immediately after registration. This tutorial letter, the Study Guide and the software are most important.

The ***Study Guide (Tutorial letter 102)*** is available on *myUnisa* unde*r Additional Resources*. Please download it from *myUnisa*. It is also incorporated in the Learning Units, which you should use to guide your studies week by week.

The ***software*** should also be downloaded from *myUnisa* under *Additional Resources* for COS1512, at once if you do not receive Disk2018 *immediately* after registration. Please note that it is not necessary to download the full contents of the CD. You need Code::Blocks only. You may copy it onto a memory stick and install it from there according to the instructions given on the COS1512 website.

When you want to use *myUnisa* for the first time, you have to register. Go to my.unisa.ac.za and click on "Join myUnisa". Then follow the instructions on the screen. You will get a password for future use. We also suggest that you get your myLife email address as soon as possible. See the *Study @ Unisa* brochure for instructions. The University communicates with you via this email address. You also get notified about important announcements for COS1512 via this email address. Please check your myLife email regularly.

5.4   Additional Resources on myUnisa

Apart from the Disk2018 content that is available on myUnisa under *Additional Resources,* you will find other resources such as old exam papers, extra examples of some programming constructs, etc.

5.5   Announcements on myUnisa

We urge you to access *myUnisa* on a regular basis. We put announcements on *myUnisa* regarding the module on a regular basis.

5.6   Installation of the software

Once you have access to a computer, you should install the software for this module on the computer. (If you will be using one of Unisa's computer laboratories, the software will already be installed). The software that you need for COS1512, namely a compiler and an IDE, are included on the CD-ROM disk that you should have received as part of your study package (Disk2018). The Learning Units contains full instructions on how to install the compiler and IDE and how to start using them.

6 MODULE-SPECIFIC STUDY PLAN

Use your *Study @ Unisa* brochure for general time management and planning skills.

6.1   Syllabus

In this module we cover the following chapters of Savitch:

Chapter	Sections covered
Chapter 1	1.1 and 1.2
Chapter 4	**Only** 4.6
Chapter 5	**Only** 5.5
Chapter 6	All sections
Chapter 8	8.1 and 8.3, **plus** the subsection *Converting Between string Objects and C Strings*, thus **excluding** 8.2 with the **exception** of the subsection ***Converting Between string Objects and C Strings***
Chapter 9	All sections **excluding** the optional subsections in 9.2
Chapter 10	All sections
Chapter 11	All sections, **plus** Appendixes 7 and 8
Chapter 12	12.1 and **only** the first two pages of 12.2
Chapter 14	14.1 and 14.2, thus **excluding** 14.3
Chapter 15	**Only** 15.1, thus **excluding** 15.2 and 15.3
Chapter 17	All sections

Note that some of the sections (in Chapters 1, 4 and 5) are omitted, because they have already been covered in COS1511. The other sections that are omitted fall outside the scope of this module.

6.2   Planning your academic year

In overview, the undergraduate academic year is as follows:

First semester		Second semester	
22 January	Academic year begins	9 July	Academic year begins
19 February	First assignment due	6 August	First assignment due
2 April	Second assignment due	17 September	Second assignment due
May/June	Examinations	November	Examinations

To get going with your studies, do the following:

- Read this tutorial letter (COS1512/101/3/2018) and Tutorial Letter COSALLF/301/4/2018.

- Obtain a copy of the prescribed book.

- Arrange for access to a computer.

We provide two study programmes, one for students who registered for the first semester, and one for students who registered for the second semester. We recommend that you use the study programmes as a starting point. You will probably need to adapt this schedule, taking into account your other modules and your personal circumstances.

Study programme for first semester registration:

Week	Date (Monday)	Activity	Remark
1	22 Jan	Install software, Study sections in chapters 1, 4 and 5	Do Questions 1 & 2 in Assignment 1
2	29 Jan	Study chapter 6	Do Questions 3 & 4 in Assignment 1
3	5 Feb	Study chapter 9	Do Question 5 in Assignment 1
4	12 Feb	Complete assignment 1	Due date 19 February
5	19 Feb	Study chapter 10	Do Questions 1 & 2 in Assignment 2
6	26 Feb		
7	5 Mar	Study chapter 11	Do Question 3 & 4 in Assignment 2
8	12 Mar	Study chapter 12	Do Questions 5 & 6 in Assignment 2
9	19 Mar	Study chapter 15	Do Question 7 in Assignment 2 Do Questions 1 & 2 in Assignment 3
10	26 Mar	Complete assignment 2	Due date 3 April
11	2 Apr	Study chapter 17	Do Questions 3, 4 & 5 in Assignment 3
12	9 Apr	Study chapter 8	Do Questions 6 & 7 in Assignment 3
13	16 Apr	Study chapter 14	Do Questions 8 in Assignment 3
14	23 Apr	Complete assignment 3	Self-assessment
15	30 April till exam	Revision	Study *all* tutorial matter, including solutions to assignments and material provided in Additional Resources. Do examination paper supplied in examination tutorial letter *on paper*.

Study programme for second semester registration:

Week	Date (Monday)	Activity	Remark
1	9 July	Install software,	Queries on software installation will only

		Study sections in chapters 1, 4 and 5	be answered up to 5 February
			Do Questions 1 & 2 in Assignment 1
2	16 July	Study chapter 6	Do Questions 3 & 4 in Assignment 1
3	23 July	Study chapter 9	Do Question 5 in Assignment 1
4	30 Jul	Complete assignment 1	Due date 6 August
5	6 Aug	Study chapter 10	Do Questions 1, 2 & 3 in Assignment 2
6	13 Aug		
7	20 Aug	Study chapter 11	Do Question 4 in Assignment 2
8	27 Aug	Study chapter 12	Do Questions 5 and 6 in Assignment 2
9	3 Sep	Study chapter 15	Do Question 7 in Assignment 2
			Do Questions 1 & 2 in Assignment 3
10	10 Sep	Complete assignment 2	Due date 2 September
11	17 Sep	Study chapter 17	Do Questions 3, 4 & 5 in Assignment 3
12	24 Sep	Study chapter 8	Do Questions 7 & 7 in Assignment 3
13	1 Oct	Study chapter 14	Do Questions 8 in Assignment 3
14	8 Oct	Complete assignment 3	Self-assessment
15	15 Oct till exam	Revision	Study *all* tutorial matter, including solutions to assignments and material provided in Additional Resources. Do examination paper supplied in examination tutorial letter *on paper*.

6.3 Hints on studying this module

Study each chapter in the prescribed book by following these steps:

- Read the corresponding discussion given in the Learning Unit for the week when you have to study the chapter. This discussion is also available in the Study Guide that can be downloaded from the COS1512 website on myUnisa under Additional resources.

- Scan the chapter in Savitch to get an overview of what the chapter is about.

- Read the chapter again, making sure that you process the information. Relate the text to the given program listings. You will sometimes have to read a little ahead or read a whole section to make meaningful sense of a program listing or discussion. Many students merely read the code and not the accompanying text that explains the code.

- Remember to highlight or indicate all the words or phrases you think are key points the writer is making. You can use these and the headings to make your concept maps or summaries whichever you prefer.

- Take the source listing of the sample programs in the textbook, type it into a text file,

compile it and execute it. Observe the output produced. Some of the source listings of the examples can be found on the companion website that goes with your textbook. Appendix B contains instructions on how to gain access to the source listings. The Learning Units also contain links to some of the source listings.

- Do as many as possible of the self-check questions on a section as you study it. Answers to the self-check questions are available at the end of each chapter.

- Answer the assignment questions on the chapter. Implement all programming questions on your computer.

It is important to realise that the process of learning how to program follows a learning curve: The more programs you write, the more proficient you will become. Remember that COS1512 has a large practical component and that it is essential to gain a lot of programming experience. Programming modules also require much more time than other modules with no practical work. You will probably find that you need to work hard and consistently throughout the semester to develop the necessary programming skills. Plan to **spend at least 8 hours per week on this module**.

7 MODULE PRACTICAL WORK AND WORK-INTEGRATED LEARNING

This module does not require any work integrated learning. However, all the assignments require extensive practical work on a computer. The examination is a purely written examination and does not involve doing any work on the computer. There are no compulsory separate practicals that students need to attend during the year.

All COS1512 students must have access to a computer running Windows. The computer must have a CD-ROM drive. **Note that Windows 8 is the default operating system supported by Unisa.**

If you do not have a computer at home, gain access to one somewhere else, possibly at work, at a friend's home, or at one of Unisa's computer laboratories. The Unisa computer laboratories in Pretoria and at the regional offices are available to students for the practical work. You will receive a COSALL tutorial letter explaining where the laboratories are, the hours during which they are open and the booking procedure.

8 ASSESSMENT

8.1 Assessment plan

Assignments are seen as part of the learning material for this module. As you do the assignment, study the reading texts, consult other resources, discuss the work with fellow students or tutors or do research, you are actively engaged in learning. Looking at the assessment criteria given for each assignment will help you to understand what is required of you more clearly. The assessment criteria for each assignment correspond to a large extent to the learning outcomes specified in the Study Guide and Learning Units for the study material covered by the assignment.

Two sets of assignments for this year are given at the end of this tutorial letter. The first set of assignments have to be submitted by students registered for the first semester, and the second set of assignments have to be submitted by students registered for the second semester. The tutorial matter you have to master in order to complete each assignment appears in the study programme in Section 6 and at the start of each assignment. The Study Guide and Learning Units contain details on each section.

Give yourself enough time to do the assignments properly, bearing in mind that a single session in front of the computer will not be sufficient to complete a programming task. We suggest that you do the assignment question(s) on a specific chapter as soon as you have studied it. This will allow you to master the study material and to start timeously with your assignments.

The time constraints under the semester system do not allow us to accept late assignments.

All the assignments require practical work, i.e. programs that you have to implement on your computer. Submit the source code of each program, as well as the input and corresponding output for the program. Assignments1 and 2 have to be submitted by the due date. Assignment 3 is for self-assessment, i.e. you do not have to submit it to Unisa, but will 'mark' it yourself by comparing your attempt with the model solution.

You are required to submit your assignments electronically via myUnisa in **PDF** format. Please submit only **one** PDF file for an assignment. This PDF file should contain the **source code as well as the input and the output produced by that source code** for each question in the assignment. Tutorial Letter 103 under Additional Resources on the COS1512 website on myUnisa shows you how to create your assignment as a PDF file so that you can submit it electronically. There is also a video on how to create a PDF file for an assignment under Additional Resources on the COS1512 website.

Please note the following:

- Submit only one copy of a specific assignment.
- Each assignment has a unique number. Use the correct assignment number and unique number on myUnisa when submitting your assignments electronically.
- Please make sure that the assignment you submit contains the correct content.
- **Please do not encrypt your assignment file or mark it as 'Read only'.**
- Do not send assignments directly to any of the lecturers or to the COS1512 e-mail address.
- Assignments must reach UNISA on or before the due date.
- Check on myUnisa, or contact the Assignments Section to ensure that your assignment was received by UNISA.
- All programs must be implemented on a computer. Hand-written programs will not be marked.
- Copy your programs and output to **one** WORD document and convert it to PDF before you submit.
- Use **single spacing** for the document that you submit.
- **Only PDF files will be accepted.**
- Assignments may not be submitted by fax or e-mail

For detailed information on how to submit assignments electronically, refer to the *Study @ Unisa* brochure, which you received with your study package. Instructions on how to register to become a myUnisa user, are provided on the web site.

You will receive tutorial letters (201 and 202) discussing each assignment. The solution to assignment 3 is provided on the course website under Additional Resources. Work through the solutions and make sure that you understand them. When you receive your marked assignment back from Unisa, compare it to our solutions and make sure you understand the differences, and also why you lost marks. The assignments serve a very important learning function. Therefore, even if you do not submit a particular assignment, you should still complete it and compare your solution to ours as part of your study programme.

We may mark only selected questions in the assignment and not the entire assignment. However, as mentioned before, we discuss each assignment question in a detailed tutorial letter that you will receive after the due date.

When we mark assignments, we comment on your answers. Many students make the same mistakes and consequently we discuss general problems in the solutions to the assignments. As mentioned before, it is therefore**, important to work through these tutorial letters and to make sure you understand our solutions and where you went wrong.**

The marks you obtain for an assignment are converted to a percentage. If you for instance obtained 25 marks out of a possible 50 marks for Assignment 1, you received 50% for Assignment 1. For Assignment 1 this percentage in turn contributes a weight of 20% to the year mark, and for Assignment 2 this percentage contributes a weight of 80% to the year mark.

You are welcome to work in small groups. However, every member of the group must write and submit his or her own individual assignment. Therefore, discuss the problem, find solutions, etc. in the group, but then do your own programming and submit your own effort. You will learn to program only if you sit down in front of the computer, type in the code, debug the program and get it to work. It is unacceptable for students to submit identical assignments on the basis that they worked together. That is copying (a form of plagiarism) and none of these assignments will be marked. It is dishonest to submit the work of someone else as your own, i.e. to commit plagiarism. Such unethical behaviour does not become our profession.

Assignment assessment and semester mark calculation: Your mark for this module is made up of a semester mark (20%) and an examination mark (80%). The final semester mark is calculated based on your performance in assignments throughout the semester. Therefore, assignments not only give you the opportunity to evaluate your understanding of the materials covered in the module, but also contribute towards your final mark.

The weights allocated to the assignments for COS1512 are summarized as follows:

Assignment number	Weight
1 (compulsory)	20%
2	80%
3	0% (self-assessment)

To explain how this will work, assume that a student receives 75% for assignment 1, and 80% for assignment 2. His/her year mark will then be calculated as follows:

Assignment	Mark received (Percentage)	Weight	Contribution to semester mark	
			Mark(%) * Weight(%)	Contribution
1	75%	20%	75/100 * 20/100	0.15
2	80%	80%	80/100*80/100	0.64
			Total:	0.79

When the total of 0.79 is converted to 20% of the final mark, it will be 15.8%, thus the student's semester mark will be 15.8%. The examination will form the remaining 80% of the final mark for

the module. Note that the semester mark will not form part of the final mark for the supplementary examination.

The following formula will be used to calculate your final semester mark:

Semester mark (out of 100) x 20% + Examination mark (out of 100) x 80%

8.2   General assignment numbers

Assignments are numbered consecutively starting from 01 using Arabic numerals.   The assignments are marked and a percentage is awarded according to your achievement. These assignments have a very important learning function. Please attempt all assignments, and compare them to the solutions provided.

8.2.1   Unique assignment numbers

Assignment	Unique number
Assignment 1 Semester 1	869512
Assignment 2 Semester 1	706129
Assignment 1 Semester 2	787690
Assignment 2 Semester 2	714422

8.2.2   Due dates for assignments

The table below gives the due dates of the assignments for this module. Do not submit assignment 3 - it is a self assessment assignment.

Assignment	Due Date Semester 1	Due Date Semester 2	Weight
01	19 February	6 August	20%
02	3 April	17 September	80%
03	30 Apr - do not submit	15 October - do not submit	Self Assessment

Due to regulatory requirements (imposed by the Department of National Education) the following applies: To gain admission to the examination you have to submit an assignment before 6 April if you are registered for the first semester and before 31 August if you are registered for the second semester.

8.3   Submission of assignments

Students should submit assignments electronically via myUnisa. **Assignments are not accepted via fax or email**.

For detailed information and requirements as far as assignments are concerned, see *Study @ Unisa*, which you received with your study package. Follow the instructions given in Tutorial Letter COSALLF/301/4/2018, as well as the brochure *Study @ Unisa*, when submitting your

assignments. The URL for myUnisa is: http://my.unisa.ac.za/. Instructions on how to register to become a myUnisa user, and how you should format your assignments before you submit them electronically, are given on the web site. The two most important things to remember are that your submission must consist of a single PDF file, and that you may submit an assignment only once. Also, for COS512 use single line spacing in the documents that you submit.

The process to submit an assignment via myUnisa is briefly described below:

- Go to myUnisa at https://my.unisa.ac.za/.

- Log on with your student number and password.

- Choose the correct module (COS1512) in the orange block.

- Click on assignments in the menu on the left-hand.

- Click on the assignment number for the assignment that you want to submit.

- Follow the instructions.

PLEASE NOTE: Assignments can be tracked (e.g. whether or not the University has received your assignment or the date on which an assignment was returned to you) on myUnisa.

8.4 Assignments

FIRST SEMESTER ASSIGNMENTS

ASSIGNMENT 1 (FIRST SEMESTER)

UNIQUE NUMBER	**869512**
DUE DATE:	**19 February 2018**
TUTORIAL MATTER:	**Chapters 4 to 7 and 9 of the Study Guide**
	Chapters 4 (section 4.6), 5 (section 5.5), 6 and 9 (excluding the optional parts of section 9.2) of Savitch
WEIGHT:	**20%**
EXTENSION:	**None**

Answer all the questions. Submit all the programs you are required to write, as well as the **input and output** of all programs.

Copy the programs and the required input and output to ONE word processor file with single line spacing and convert it to a PDF file before you submit it. See Additional Resources on MyUnisa for instructions on how to create a PDF file.

WE DO NOT ACCEPT ANY MEMORY STICKS OR CDs.

Question 1

Write a program to determine the tuition fees for a student. The program should use two overloaded functions, each named `calcFees`, to determine the tuition fees for a student. Students who repeat a module pay a different fee for the modules which are repeated. The program should first ask if the student repeats any modules. If the student repeats, the program should ask for the number of modules which are repeated.

One of the overloaded functions should accept the number of modules enrolled for the first time and the fee for those modules as arguments (parameters), while the other function accepts arguments for the number of modules enrolled for the first time and the fee for those modules as well as the number of modules repeated and the fee for those modules. Both functions should return the tuition fees for the student.

Question 2

Write a program that converts from 24-hour notation to 12-hour notation. For example, it should convert 14:25 to 2:25 PM. The input is given as two integers. Verifies that a legitimate 24-hour notation has been input by using the `assert` statement.

Question 3

Write a program for your local bank to prepare a statement for a customer's checking account at the end of each month. The data is stored in a `.dat` file in the following format:

```
46780976 3750.40
W 250.00
D 1200.00
W 75.00
W 375.00
D 1200.00
I 5.50
W 400.00
W 600.00
D 450.50
W 35.65
```

The first line of code shows the account number followed by the account balance. For each line of code there is a transaction code and the transaction amount. The transaction codes are as follows:

W = Withdrawal

D = Deposit

I = Interests

The program has to display the account statement on the console. It should update the balance after each transaction. During the month, if at any time the balance goes below R 1000, a R25 service fee is charged. The program should print the following information: account number, opening balance at the beginning of the month, each transaction as it occurs, service fees when charged, interest paid by the bank and closing balance at the end of the month. Banking costs (i.e. total of all service fees incurred) are deducted at the end of the month. An example of the output your program should produce for the input file above, is shown below. Note that a deposit is shown as a credit ('Ct') on the statement:

Sample output:
```
Account number: 46780976

Opening balance: R3750.40

Transaction      Amount           Balance          Bank costs
Withdrawal        250.00          4000.00
Deposit          1200.00Ct        2800.00
Withdrawal         75.00          2725.00
Withdrawal       1375.00          1350.00
Deposit          1200.00Ct        1550.00
Interest            5.50          1555.50
Withdrawal        400.00          1155.50
Withdrawal        600.00           555.50             25.00
Deposit           450.00Ct        1005.50
Withdrawal         35.65           969.85
Banking costs      25.00           969.60

Closing balance: R969.60
```

Question 4

You have to write a program to read an input file character by character to help Peter solve the following activity in his activity book. The paragraph below is given:

```
We h2pe that 32u e5723ed the acti4it3. A6ter 32u ha4e c2mpleted the
acti4it3, 0e5d 32ur re0ult t2: The Acti4it3 C2mpetiti25, Betty Da4i0
0treet 99, Auckla5d Park, 8989, a5d 0ta5d a cha5ce t2 wi5 a hamper
c250i0ti51 26 c2l2uri51 a5d acti4it3 b22k0, c2l2uri51 pe5cil0 a5d
pe50.
```

Create an input file `activity.dat` with the paragraph above. The numbers 0 to 7 have to be replaced as follows:

0 must be replaced by `s`
1 must be replaced by `g`
2 must be replaced by `o`
3 must be replaced by `y`
4 must be replaced by `v`
5 must be replaced by `n`
6 must be replaced by `f`
7 must be replaced by `j`

Ask the user to input the names of the input and output files. Read the input file character by character, and write the character (if it stays the same) to the output file, or write the changed character to the output file. Call your output file `competition.txt`.
Allow the user to specify the names of the input and output files.

Question 5

(a)   What is a pointer?

(b)   What is a dereferencing operator?

(c)   What is the difference between assignment statements `p1 = p2;` and `*p1 = *p2;`

(d)   What is a dynamic variable?

(e)   What is the purpose of the `new` operator?

(f)   What is the purpose of the `delete` operator?

(g)   What is the freestore (also called the heap)?

(h)   What is the difference between dynamic variables and automatic variables?

(i)   What is a dynamic array?

(j)   What is the advantage of using dynamic arrays?

(k)   What is the relationship between pointers and arrays?

(l)   Write statements to do the following:

    i.   Define a pointer type `int_ptr` for pointer variables that contain pointers to `int` variables.

    ii.   Declare `p1` to be a pointer to an `int`.

    iii.   Dynamically allocate an integer variable and store its address in `p1`.

    iv.   Assign the value 23 to the variable that `p1` is pointing to.

    v.   Declare an `int` variable `a`.

    vi.   Let `p1` point to `a`.

    vii.   Free the memory allocated to the variable that `p1` is pointing to.

(m)   Write statements to do the following:

    i.   Define a pointer type `int_ptr` for pointer variables that contain pointers to `int` variables.

    ii.   Declare `p2` to be a pointer to an `int`.

    iii.   Obtain an integer value `nrElements` from the user indicating the number of elements to allocate.

    iv.   Dynamically allocate an array of `nrElements` integers and store its address in `p2`.

    v.   Declare an `int` array `a` with 500 elements.

    vi.   Assume `p2` has been initialized and copy the elements of `p2` one by one to the corresponding elements in `a`.

    vii.   Free the memory allocated to the variable that `p2` is pointing to.

(n)   Write a program that asks a user to enter the size of a dynamic array that stores exam marks obtained by students. Create the dynamic array and a loop that allows the user to enter an exam mark into each array element. Loop through the array, find the average mark for the exam and output it. Delete the memory allocated to your dynamic array before exiting your program.

ASSIGNMENT 2 (FIRST SEMESTER)

UNIQUE NUMBER	**706129**
DUE DATE:	**3 April 2018**
TUTORIAL MATTER:	**Chapters 10, 11, 12 and 15 of the Study Guide (Appendix D)**
	Chapters 10, 11, 12 (excluding "Creating a Namespace") and 15 (only 15.1 "Inheritance basics")
	Appendices 7 and 8 in Savitch
EXTENTION:	**None**
WEIGHT:	**80%**

Answer all the questions. Submit all the programs you are required to write, as well as the **input and output** of all programs.

Copy the programs and the required input and output to ONE word processor file with single line spacing and convert it to a PDF file before you submit it. See Additional Resources on MyUnisa for instructions on how to create a PDF file.

WE DO NOT ACCEPT ANY MEMORY STICKS OR CDs.

Question 1

Consider the following structure used to keep record of a student's scores:

```
struct Student
{
string name;
int quiz1;
int quiz2;
int midtermExam;
int finalExam;
}
```

A student is assessed according to the following policies:
1. The two quizzes are each marked out of 10.
2. The midterm exam and the final exam are each marked out of 100 marks.
3. The final exam counts for 50% of the grade, the midterm counts for 25%, and the two quizzes together count for a total of 25%. (Do not forget to normalize the quiz scores. They should be converted to a percentage before they are averaged in.)

Turn the student record into a class type rather than a structure type. The student record class should have member variables for all the input data. Make all member variables `private`. Include `public` member functions for each of the following:

- a default constructor that sets the student 's name to a blank string, and all the scores to 0;
- member functions to set each of the member variables to a value given as an argument to the function (i.e. mutators);
- member functions to retrieve the data from each of the member variables (i.e. accessors);
- and a function that calculates and returns the student's weighted average numeric score for the entire course.

Use this class in program which grades a student. The program should read in the student's name and scores and output the student's record as well as the student's average numeric score for the entire course. Use the keyboard to supply input and display the output on the screen. Test your program with the following input:

Student name: Johnny Applemac
Quiz 1: 7
Quiz 2: 5
Midterm exam: 65
Final exam: 73

Question 2 – a bit of theory and terminology

(a) What is the purpose of the keywords `public` and `private` in the class declaration?

(b) What is the difference between a class and an object?

(c) What does it mean to 'instantiate' an object?

(d) What is the purpose of a constructor?

(e) What is the difference between the default constructor and the overloaded constructor?

(f) What is the purpose of a destructor?

(g) What is the purpose of an accessor?

(h) What is the purpose of a mutator?

(i) What is the purpose of the scope resolution operator?

(j) What is the difference between the scope resolution operator and the dot operator?

(k) What is the difference between a member function and an ordinary function?

(l) What is an abstract data type (ADT)?

(m) How do we create an ADT?

(n) What are the advantages of using ADTs?

(o) What is separate compilation?

(p) What are the advantages of separate compilation?

(q) What is a derived class?

(r) What is the purpose of inheritance?

Question 3

Consider the following class declaration:

```
class PersonType
{
     public:
          PersonType();
          PersonType(string n, int id, string bd);
     private:
          string name;
          int ID;
          string birthday;
};
```

Explain what is wrong with the following code fragment and write code to correct it:

```
int main()
{
     PersonType family[20],
                 newBaby("Anny Dube", 20180912, "2 Sept");
//Assume family has been initialised
     for (int i = 0; i < 20; i++)
        if (family.birthday[5] == newBaby.birthday)
             cout << family.name[5] << " share a birthday with "
                   <<newBaby.name;
     return 0;
}
```

Question 4

Consider the following class declaration:

```
class Date{
   public:
      //constructors
      Date();
      Date(int day, int month, int year);
      //accessors
      int getDay() const;
      int getMonth() const;
      int getYear() const;

      //mutators
      void setDay(int day);
      void setMonth(int month);
      void setYear(int year);
      //operators to calculate next and previous days
      Date &operator++();
      Date &operator--();
      bool operator<(const Date &d);
   private:
      //the current day month and year
```

```
            int theday;
            int themonth;
            int theyear;
            //return the length of current month, taking into
            //account leap years
            int monthLength();
    };
```

Implement and test the `Date` class, taking the following guidelines into account:

a)   The default constructor should initialise the date to 14 September 1752.
b)   The overloaded constructor should initialise the date with the given day, month and year.
c)   The functions `getDay()`, `getMonth()` and `getYear()` should return the current day, month and year respectively.
d)   The functions `setDay()`, `setMonth()` and `setYear()` should change the current day, month or year to the given value.
e)   The operator ++ should advance the date by one, and return the new date.
f)   The operator -- should set the date back by one day, and return the new date.
g)   The operator < should calculate whether the receiving date object (left argument) precedes the parameter date (right argument).
     For example, Date(1,1,2002) < Date(1,3,2002).
h)   The private member function `monthLength()` should return the length of the current month, taking into account leap years. A year is a leap year if it is either (i) divisible by 4, but not by 100, or (ii) divisible by 400. In a leap year, February has 29 days, otherwise it has 28 days.
i)   Also overload the insertion operator << to output a date to the screen. For example, the date in (a) above should be written as: 14 September 1752.

     Test the `Date` class in a C++ program that will do the following:
     • Declare a new `Date` object called `d1`.
     • Display the day, month and year of `d1` on the screen.
     • Change the date to 28 February 2000.
     • Advance this date by one and display the new date on the screen.
     • Now change the date to 1 January 2002.
     • Set this date back by one and display the new date on the screen.
     • Finally change the date to 31 December 2002.
     • Advance this date by one and display the new date on the screen.
     • Declare a second date object `d2(1,1,2003)`.
     • Determine if `d1` is earlier than `d2` and write the result on the screen.
     • Operators ++, -- and < are declared as member functions in the class declaration above. Implement these operators as friend functions of class `Date` also. Run your program twice (each time with a different version of the overloaded operator ++, -- and <; comment the other versions out during each run).

Enrichment exercise:

Turn the `Date` class into an ADT, so that separate files are used for the interface and implementation. Use separate compilation to compile the implementation separate from the application program that tests the ADT.
PLEASE NOTE: The enrichment exercises do not form part of the assignment. It is for practice only.

Question 5

Define a class `PhoneCall` as an ADT that uses separate files for the interface and the implementation. This class represents a phone call and has three member variables:

- `number`, a string that holds the phone number (consisting of 10 digits) to which a call is placed

- `length`, an `int` representing the length of the call in minutes

- `rate`, a `float` representing the rate charged per minute.

In addition, the class should contain a default constructor that initializes `number` to an empty string, `length` to 0 and `rate` to 0. It should also contain an overloaded constructor that accepts a new phone number and sets `length` and `rate` both to 0, as well as a destructor that does not perform any action.

Include accessor functions that returns the values stored in each of an object of class `PhoneCall`'s member variables respectively.

Class `PhoneCall` also contains a member function `calcCharge()` to determine the amount charged for the phone call. Use the following prototype:

```
float calcCharge();
```

Overload the equality operator== as a `friend` function to compare two phone calls. Use the following prototype:

```
bool operator==(const PhoneCall & call1, const PhoneCall & call2)
```

This function returns `true` if both `call1` and `call2` have been placed to the same number and `false` otherwise.

Overload the stream extraction operator >> (implemented as a `friend` function) so that it can be used to input values of type `PhoneCall`, and the stream insertion << (implemented as a `friend` function) so that it can be used to output values of type `PhoneCall`.

Demonstrate the class in an application program (`main()`) that is used to determine the total amount spend on phone calls to a specific phone number in one month. Allow the user to enter the phone number for which the total amount spent should be determined. Use the overloaded constructor to initialise the `PhoneCall` object `theCall` to the number the user specified. The `PhoneCall` objects representing the calls made during one month is stored in a file `MyCalls.dat`. Use a `while` loop to read the phone calls from `MyCalls.dat`, use the overloaded equality operator== to compare the phone numbers read from `MyCalls.dat` one by one with `theCall`, and determine the total amount spend on phone calls to `theCall`, as well as the number of calls made to this number. Also determine the longest call made to `theCall` and display this call together with the total amount spent on calls to `theCall`, and the number of calls to `theCall`.

Test your program with the following data:

Phone calls in file `MyCalls.dat`:

```
0123452347      12    3.50
0337698210       9    3.15
```

```
0214672341      2     1.75
0337698210     15     3.15
0442389132      8     1.75
0232189726      5     3.50
0124395623      6     3.50
0337698210      2     3.15
0337698210      5     3.15
```

Phone number to test:
`0337698210`

Question 6

Overload the stream extraction operator >> for the class `Student` in Question 1 to read values for each member variable from a file. Also overload the stream insertion operator << to print the record for a student (name, two quiz scores, midterm score and final exam score) as well as the weighted average for the student either on the screen or to a file.

Use separate compilation and write a program that uses the overloaded extraction operator >> to read records for students from a file named `Student.dat` into an array. Assume that the file will never contain data for more than 20 students. Use the array to determine the weighted average for each student, as well as the average for all of the students (i.e. the class average). Display the output on the screen. Use the following data:
Peter Pan 5 3 45 51
Wendy Hill 7 5 63 58
Alice Mokgaba 8 6 51 67
Precious Petersen 5 7 49 46
Thumi Tebogo 4 7 69 65

Enrichment exercise:
Adapt the application program to use a vector instead of an array. It should not be necessary to change the class interface or implementation file in any way.

Question 7

Define a class `Student` with member variables for a student's name, student number, address and degree. All of these member variables are strings. Add appropriate constructors and accessors for class `Student` and include the following member functions:

- a member function `display_info()` that overloads the stream insertion operator << to display the values of all the member variables of a student.

- a member function `calcFee()` to calculate the initial registration fee for a student. For undergraduate students the initial registration fee is R500 and for postgraduate students the initial registration fee is R600. All undergraduate student degrees begin with a 'B' which will allow you to determine whether a student is an undergraduate or postgraduate student.

(a)   Implement class `Student`.

(b)   Test class `Student` in a driver program that does the following:

- instantiates an object of class `Student`, with the following details:

30

name: Mary Mbeli

student number: 12345678

address: Po Box 16, Pretoria, 0818

degree: BSc

- use the accessor functions to display the specifications of the instantiated object on the console

- display the specifications of the instantiated object on the console with the member function `display_info()`.

- calculate and display the fee for the student.

(c) Derive and implement a class `PostgradStd` from class `Student`. This class has an additional member variable, `dissertation` (the title of the Masters of doctorate the student is doing). Class `PostgradStd` also has an overloaded constructor and an accessor member to return the member variable `dissertation`. The class `PostgradStd` should override function `display_info()` in order to display the values of all the member variables of `PostgradStd`. The class `PostgradStd` should also override function `calcFee()` to determine the additional fee for a postgraduate student which is R12000.

Implement the overloaded constructor for the class `PostgradStd` by invoking the base class constructor.

(d) Test class `PostgradStd` in a driver program that does the following:

- instantiates an object of class `PostgradStd`, with the following details:

    name: Mary Mbeli

    student number: 12345678

    address: Po Box 16, Pretoria, 0818

    degree: PhD

    dissertation: How to get a PhD

- use the accessor functions to display the specifications of the instantiated object on the console

- display the specifications of the instantiated object on the console with the member function `display_info()`.

- calculate and display the outstanding fee for the student.

SECOND SEMESTER ASSIGNMENTS

ASSIGNMENT 1 (SECOND SEMESTER)

UNIQUE NUMBER	**787690**
DUE DATE:	**6 August 2018**
TUTORIAL MATTER:	**Chapters 4 to 7 and 9 of the Study Guide**
	Chapters 4 (section 4.6), 5 (section 5.5), 6, and 9 (excluding the optional parts of section 9.2) of Savitch
WEIGHT:	**20%**
EXTENSION:	**None**

Answer all the questions. Submit all the programs you are required to write, as well as the **input and output** of all programs.

Copy the programs and the required input and output to ONE word processor file with single line spacing and convert it to a PDF file before you submit it. See Additional Resources on MyUnisa for instructions on how to create a PDF file.

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Question 1

Peter wants to send a box containing a painting to London. The Post Office sends parcels to London via GlobalMail or DHL. If GlobalMail is chosen, the cost is R108 per kg if the parcel goes to zone 1 to 3 in London, and R130 per kg if the parcel goes to zone 4 to 6. If DHL is chosen, the actual weight is compared to the volumetric weight, and whichever is the higher weight, is used in the calculation. The volumetric weight is calculated by the formula (length * width * height) / 5000, where length, width and height is the size of the box in cm. The cost per kg for DHL is R70.

Write a program that will calculate the price to be paid for sending a parcel to London. The program must use two overloaded functions, each named `calcPostage`. The user must be asked if he wants to use GlobalMail or DHL. Define a `char` variable and ask the user to input 'd' for DHL or 'g' for GlobalMail. If he chooses GlobalMail, the zone must be requested. The program must validate that the zone is between 1 and 6. If he chooses DHL, the length, width and height of the box must be requested. The first function will receive two parameters, one of type `double` representing the weight of the parcel, and one of type `int`, representing the zone. The second function will receive four parameters of type double, representing the actual weight, and the length, width and height of the box in cms. The second function will first determine whether the actual weight or the volumetric weight is the highest, before calculating the cost. Both functions will return the cost in a variable of type `double`. The main function should then display the total cost. Define `const` variables where applicable.

Question 2

Write a C++ program to validate if someone is allowed to vote or not. The person who is allowed to vote should be at least 18 years old. The program should use the `assert` function to validate that the year of birth is not equal to the current year and also that the year of birth entered is not greater than the current year. The program should instruct the user to enter the year of birth. Run your program twice, once with a year of birth that represents a person younger than 18 years; and the second time with a year of birth that represents a person older than 18 years or at least 18 years old. Submit the output for both runs together with your source code.

Question 3

A restaurant has a special discount for families of at least 5 members. To get the discount, at least 4 members of the family must order the special steak dish on the menu, and the family must order at least 2 bottles of wine. The waiter serving the family must tell the families about the special discount. If the family order qualifies for the discount, the waiter gets an extra commission which is 3% of the total bill amount. Peter wants to know how much commission he earned for the evening.

Your task is to write a program that will read the file `orders.dat` and calculate the number of families that ordered the special, the extra commission earned by Peter, as well as the average spent per person (including all the people that he served for the evening).

Each line in the file contains the following data: the number of members in a family, the number of family members that ordered the special, the number of bottles of wine that the family ordered, and the total bill amount. Create the file `orders.dat` containing the orders of all the families that Peter served, as specified below. Declare variables of type `int` for the first three values and a variable of type `float` for the total bill amount.

```
5 2 2 670.60
6 4 2 890.80
2 2 0 220.00
10 8 1 1340.60
10 4 3 1430.70
4 0 0 460.30
5 3 1 700.00
7 5 2 1100.80
3 1 0 340.80
```

Using the input file above, your program should create the following results in the output file `result.dat`:

```
Displaying contents of result.dat :

Number of families that ordered the special: 3
Commission earned from the special meal: R102.67
Average spent per person for the evening: R137.59
```

```
Process returned 0 (0x0)    execution time : 0.080 s
Press any key to continue.
```

Question 4

Hector is in grade 3 and likes a girl in his class, Julia, very much. He has written a letter to her, but he needs you to help him to encode the letter, so that if someone in the class gets hold of it, they won't be able to understand it. Write a program that reads an input file with the letter character by character. Change the following characters:

```
t (or T)  gets changed to  1Y
h (or H)  gets changed to  1O
j (or J)  gets changed to  1X
d (or D)  gets changed to  1B
a (or A)  gets changed to  1S
p (or P)  gets changed to  1M
I (or I)  gets changed to  1Q
```

The rest of the characters remain the same. Read the file character by character, and write the character (if it stays the same) to the output file, or write the changed version to the output file. Call your output file `encode.txt`.

Create an input file called `letter.txt` with Hector's letter:

```
Dear Julia,
You are the most beautiful girl that I have ever seen. I was wondering
if  you  would  like  to  come  and  visit  me.  My  mother  will  make  us
pancakes  with  ice  cream.  My  dog,  Bella,  just  had  three  beautiful
puppies.  Mom  says  I  may  only  keep  one  of  them.  I  would  like  you  to
help  me  choose  one,  because  they  are  all  so  cute  and  adorable.  And
just  because  you  are  my  special  friend,  you  may  also  have  one  if  you
want.
Your friend,
Hector.
```

Question 5

(b)   What is a pointer?

(b)   What is a dereferencing operator?

(c)   What is the difference between the assignment statement `p1=p2;` and `*p1 = *p2;`

(d)   What is a dynamic variable?

(e)   What is the purpose of the `new` operator?

(f)   What is the purpose of the `delete` operator?

(g)   What is the freestore (also called the heap)?

(h)   What is the difference between dynamic variables and automatic variables?

(i)   What is a dynamic array?

(j)   What is the advantage of using dynamic arrays?

(k)   What is the relationship between pointers and arrays?

(l)   Write statements to do the following:

   viii.   Define a pointer type `int_ptr` for pointer variables that contain pointers to `int` variables.

   ix.   Declare `p1` to be a pointer to an `int`.

   x.   Dynamically allocate an integer variable and store its address in `p1`.

   xi.   Assign the value 23 to the variable that `p1` is pointing to.

   xii.   Declare an `int` variable `a`.

   xiii.   Let `p1` point to `a`.

   xiv.   Free the memory allocated to the variable that `p1` is pointing to.

(m)   Write statements to do the following:

   viii.   Define a pointer type `int_ptr` for pointer variables that contain pointers to `int` variables.

   ix.   Declare `p2` to be a pointer to an `int`.

   x.   Obtain an integer value `nrElements` from the user indicating the number of elements to allocate.

   xi.   Dynamically allocate an array of `nrElements` integers and store its address in `p2`.

   xii.   Declare an `int` array `a` with 500 elements.

   xiii.   Assume `p2` has been initialized and copy the elements of `p2` one by one to the corresponding elements in `a`.

   xiv.   Free the memory allocated to the variable that `p2` is pointing to.

(n)   Write a program that asks a user to enter the size of a dynamic array that stores exam marks obtained by students. Create the dynamic array and a loop that allows the user to enter an exam mark into each array element. Loop through the array to calculate the highest mark obtained and output it. Delete the memory allocated to your dynamic array before exiting your program.

ASSIGNMENT 2 (SECOND SEMESTER)

UNIQUE NUMBER	**714422**
DUE DATE:	**17 September 2018**
TUTORIAL MATTER:	**Chapters 10, 11, 12 and 15 of the Study Guide (Appendix D)**
	Chapters 10, 11, 12 (excluding "Creating a Namespace") and 15 (only 15.1 "Inheritance basics")
	Appendices 7 and 8 in Savitch
EXTENTION:	**None**
WEIGHT:	**80%**

Answer all the questions. Submit all the programs you are required to write, as well as the **input and output** of all programs.

Copy the programs and the required input and output to ONE word processor file with single line spacing and convert it to a PDF file before you submit it. See Additional Resources on MyUnisa for instructions on how to create a PDF file.

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Question 1

Consider the following structure used to keep employee records:

```
struct Employee
{
    string firstName;
    string lastName;
    float salary;
}
```

Turn the employee record into a class type rather than a structure type. The employee record class should have private member variables for all the data. Include public member functions for each of the following:
- a default constructor that sets the employee's first name and last name to a blank string, and his annual salary to 0;
- an overloaded constructor that sets the member variables to specified values;
- member functions to set each of the member variables to a value given as an argument to the function (i.e. mutators);
- member functions to retrieve the data from each of the member variables (i.e accessors);

Embed your class definition in a test program. The test program should create two Employee

objects and display each object's annual salary. Use the overloaded constructor to initialise one of the Employee records as Joe Soap with an annual salary of R145600.00. Obtain the following input values for the other Employee record from the keyboard:
Joanne Soape
R154460.66

Now give each employee a 10% raise and display each `Employee` object's annual salary again.

Question 2 – a bit of theory and terminology

(a)   What is the purpose of the keywords `public` and `private` in the class declaration?

(b)   What is the difference between a class and an object?

(c)   What does it mean to 'instantiate' an object?

(d)   What is the purpose of a constructor?

(e)   What is the difference between the default constructor and the overloaded constructor?

(f)   What is the purpose of a destructor?

(g)   What is the purpose of an accessor?

(h)   What is the purpose of a mutator?

(i)   What is the purpose of the scope resolution operator?

(j)   What is the difference between the scope resolution operator and the dot operator?

(k)   What is the difference between a member function and an ordinary function?

(l)   What is an abstract data type (ADT)?

(m) How do we create an ADT?

(n)   What are the advantages of using ADTs?

(o)   What is separate compilation?

(p)   What are the advantages of separate compilation?

(q)   What is a derived class?

(r)   What is the purpose of inheritance?

Question 3

3 (a)   Consider the following class declaration:

```
class ExamType
{
    public:
        ExamType();
        ExamType(string m, string v, int t, string d);
```

```
        private:
            string module;
            string venue;
            int time;
            string date;
    };
```

Explain what is wrong with the following code fragment and include code to correct it:

```
    int main()
    {
        ExamType exams[12];
        for (int i = 0; i < 12; i++)
            if (exams.module[i] == "COS1512")
                cout << "COS1512 will be written on "
                        << exams.date << " at " << exams.time;
        return 0;
    }
```

Question 4

The questions below refer to the following class declaration:

```
    #include <iostream>
    #include <string>
    using namespace std;
    class Chequebook
    {
    public:
        Chequebook();
        Chequebook(float AccountBalance);
        void Deposit (float Amount);
        void WithDraw (float Amount);
        float CurrentBalance() const;
        void Adjust();
    private:
        float Balance;
    };

    int main()
    {
        cout << "Enter the Account balance:";
        float amount;
        cin >> amount;
        Chequebook Chequebook1(amount);
        cout << "Account balance: R " << Chequebook1 << endl;
        cout << "Enter amount to deposit:"; cin >> amount;
        Chequebook1.Deposit(amount);
        cout << "Balance after deposit: R" << Chequebook1 << endl;
        cout << "Enter amount to withdraw:" ; cin >> amount;
        Chequebook1.WithDraw(amount);
        cout << "Balance after withdrawal: R " << Chequebook1 << endl;
        ++Chequebook1;
        cout << "Balance after adjusting: R" << Chequebook1;
```

```
        return 0;
   }
```

(a) Give implementations of both the default constructor and the second constructor.

(b) Implement the `Deposit()` and `WithDraw()` member functions. The `Deposit()` member function should increment the member variable `Balance` with the amount deposited, and the `WithDraw()` member function should decrement the member variable `Balance` with the amount withdrawn.

(c) Implement the `CurrentBalance()` member function. It should return the current balance of the cheque book.

(d) The member function `Adjust()` should increment the member variable `Balance` by R100. Give an implementation for this member function.

(e) Overload the stream insertion operator as a friend function. It should write the balance of the account to the given output stream.

(f) The statement `++Chequebook1;` should increment the member variable `Balance` of `Chequebook1` by R100. Give three different implementations for the overloaded operator **++** to accomplish this:
   - using the member function `Adjust()`
   - implementing the overloaded operator `++` as a friend function
   - implementing the overloaded operator `++` as a member function. Hint: See chapter 11 in the study guide, Tutorial letter 102 under Additional Resources on the COS1512 course website.

(g) Run your program three times (each time with a different version of the overloaded operator ++; comment the other two versions out during each run) with the following input:
```
400
200
300
```

Enrichment Exercise:

Turn the `Chequebook` class into an ADT, so that separate files are used for the interface and implementation. Use separate compilation to compile the implementation separate from the application file that tests the ADT.

PLEASE NOTE: The enrichment exercises do not form part of the assignment. It is for practice only.

Question 5

Define a class `Voter` as an ADT that uses separate files for the interface and the implementation. This class represents one voter voting in an election. This class has three member variables:

- `ID`, a string that holds the ID of the voter
- `nr_times_voted`, an integer value that indicates the number of times the voter has voted in the past
- `voted`, a Boolean value to indicate whether the voter has voted in the current election or not.

In addition, the class should contain a default constructor that initializes `ID` to an empty string, `nr_times_voted` to 0, and `voted` to `false`. It should also contain an overloaded constructor that creates a new voter and sets `ID` to a specified value, `nr_times_voted` to 0 and `voted` to `false`. The destructor should not perform any action.

Include accessor functions that returns the values stored in each of an object of class `Voter`'s member variables respectively, as well as a mutator function called `set_voted()` that sets the `voted` member variable of a `Voter` to `true`.

Overload the prefix increment operator++ (implemented as a `friend` function) to return the current instance of the class `Voter` after incrementing the `nr_times_voted` by 1. Use the following prototype:

```
Voter operator++(Voter& V);
```

Overload the stream extraction operator **>>** (implemented as a **friend** function) so that it can be used to input values of type `Voter`. Overload the stream insertion **<<** (implemented as a **friend** function) so that it can be used to output values of type `Voter`.

Demonstrate the class in an application program (`main()`) that is used to obtain a voter's ID from the user, find the voter on the voters' roll (kept in a file called `VotersRoll.dat`), check whether the voter has voted in the current election, and if not, prints a note that allows him/her to vote. If a voter has already voted, a message should indicate that the voter is not allowed to vote again. When the user votes, the **operator++** is used to increment the number of times the voter has voted, and the **set_voted()** member function is used to indicate that the voter has now voted in the current election.

While the voter's roll (file `VotersRoll.dat`) is processed, a new updated voters' roll (another file called `UpdatedVoters.dat`) is created simultaneously. Take care to make sure that all the voters on the original voters' roll also appear in the updated voters' roll.

Test your program with the following data:

VotersRoll.dat:

```
19810102009     1     0
19792003008     2     0
19851010890     3     1
19900909897     2     0
19561812567     6     0
19682703345     7     1
```

Voters that want to vote:
```
19810102009
19792003008
19851010890
19561812567
19682703345
```


Question 6

Overload the stream extraction operator >> for the class `Employee` in Question 1 to read values for an object of class `Employee` from a file. Also overload the stream insertion operator << to print the data for an employee record either on the screen or to a file.

40

Use separate compilation and write a program that uses the overloaded extraction operator >> to read records for employees from a file named `Employees.dat` into an array. Assume that the file will never contain data for more than 20 employees. Use the array to determine the average salary, as well as the highest salary and the lowest salary. Display the average salary, the highest salary and the lowest salary on the screen. Increase each employee's salary by 10 % and use the overloaded stream insertion operator << to display the updated `Employee` objects on the screen and also to write the updated `Employee` objects to a new data file. Use the following data:

Peter Pannier R134000
Lucas Radebe R75000
Albert Mokgaba R80000
Petrus Petersen R111120
Thabelo Tebogo R200453
Alexa Breda R231334
Jocasta Johnson R199181
Gian Grooteboom R60000

Question 7

Consider the following class:

```
class Package
{
public:
    Package(double the_cost, double the_weight,
            const string& the_sender, const string& the_receipient);
    double calculate_cost()const;//multiply weight by cost_per_kilogram
    string get_recipient() const;
    string get_sender() const;
protected:
    double cost_per_kilogram;
    double weight;
private:
    string sender;
    string recipient;
};
```

(a) Implement class `Package`.

(b) Test class `Package` in a driver program that does the following:

- instantiates an object of class `Package`, with the following details:

    sender: Charles Somerset

    receiver: Anne Barnard

    cost per kilogram: 12.75

    weight: 1.25

- use the accessor functions to display the names of the sender and receiver of the instantiated object on the console.

- Use the member function `calculate_cost()` to determine the cost of the package represented by the instantiated object. Display the calculated cost also on the console.

(c) Derive and implement a new class `TwoDayPackage` that inherits the functionality of the class `Package`. `TwoDayPackage` should redefine `calculate_cost()`, where a fixed fee is added to the weight-based cost. For example, a `TwoDayPackage` that has a weight of 10kg, a cost of R3.00 per kilogram and charged a fixed fee of R5.00 would cost R35.00 (10*3.00 + 5.00) to deliver. The class should include a member variable to represent the fixed fee. `TwoDayPackage` has an additional member function `Print()`, which outputs the cost_per_kilogram, weight, sender, recipient and the total cost of delivery of the package.

(d) Test class `TwoDayPackage` in a driver program that does the following:

- instantiates an object of class `TwoDayPackage`, with the following details:

  sender: Charles Somerset

  receiver: Anne Barnard

  cost per kilogram: 12.75

  weight: 1.25

- use the accessor functions to display the names of the sender and receiver of the instantiated object on the console.

- Use the member function `calculate_cost()` to determine the cost of the two_day_ package represented by the instantiated object, then display the calculated cost also on the console.

SELF ASSESSMENT ASSIGNMENT 3 (SEMESTER 1 AND SEMESTER 2)

TUTORIAL MATTER:	**Chapters 8, 14, 15 and 17 of the Study Guide (Appendix D)**
	Chapters 8, 14 (excluding section 14.3), 15 (excluding sections 15.2 and 15.3) and 17 of Savitch
WEIGHT:	**None**

This assignment is for **self-assessment**. Do not submit this assignment. The **solution** to this assignment appears in **Appendix C** of this tutorial letter.

Question 1

Examine the code fragment below and answer the questions that follow:

```
1: #include <iostream>
2: using namespace std;
3:
4: //----------------------------------------
5:
6: class A
7: {
8:   private:
9:      int x;
10:  protected:
11:     int getX();
12:  public:
13:     void setX();
14:};
15:
16:int A::getX()
17:{
18:   return x;
19:}
20:
21:void A::setX()
22:{
23:   x=10;
24:}
25:
26://----------------------------------------------
27:class B
28:{
29:  private:
```

```
30:      int y;
31:  protected:
32:      A objA;
33:      int getY();
34:  public:
35:      void setY();
37:};
38:
39:void B::setY()
40:{
41:  y=24;
42:  int a = objA.getX();
43:}
44:
45://---------------------------------------------
46:
47:class C: public A
48:{
49:  protected:
50:      int z;
51:  public:
52:  int getZ();
53:  void setZ();
54:};
55:
56:int C::getZ()
57:{
58:  return z;
59:}
60:
61:void C::setZ()
62:{
63:  z=65;
64:}
```

Answer the following questions based on the code fragment given above:

(a)   Is line 18 a valid access? Justify your answer.

(b)   Is line 32 a valid statement? Justify your answer.

(c)   Identify another invalid access statement in the code.

(d)   Class C has `public` inheritance with the class A. Identify and list class C's `private`, `protected` and `public` member variables resulting from the inheritance.

(e)   If class C had `protected` inheritance with the class A, identify and list class C's `private`, `protected` and `public` members variables resulting from the inheritance.

Question 2

Consider the class definitions below and answer the questions that follow:

44

```
class Date
{
public:
   friend ostream & operator<<(ostream & cout, const Date & d);
    Date(int y, int m,  int d);
private:
   int year, month, day;
};

class Publication
{
public:
        Publication(const string  & p, const Date & d,
        const string & t);
        Date GetDate( ) const;
        string GetPublisher( )const;
        string GetTitle() const;
private:
        string publisher;
        Date date;
        string title;
};
```

(a)   Implement the `Date` and the `Publication` classes.

(b)   Code the interface of a derived class `Book` for which the `Publication` class is the base class. The `Book` class has two additional member variables representing the `ISBN` number and the author of a book. Furthermore, the `Book` class contains member functions `getISBN( )` and `getAuthor( )` that return the ISBN number and the author respectively. The declaration must also include a constructor for the class `Book`.

(c)   Implement the `Book` class.

(d)   Recode the following interface such that class `Magazine`, derives from class `Publication`:

```
class Magazine
{
public:
   Magazine(const string & p, const Date & d, int ipy);
   int GetIssuesPerYear(  ) const;
   Date getDate( ) const;
   string getPublisher( )const
   string GetTitle() const;
private:
   int issuesPerYear;
   string publisher;
   Date date;
   string title;
};
```

(e)   Implement the `Magazine` class.

(f)   In a driver program embed code to do the following:

   (i) Declare an object B of type Book, with the following details:

        publisher: FisherKing

        date: 01/01/2000

        title: Global Warming

        isbn : 123456789

        author: Ann Miller

   (ii) Output all the details of Book B.

   (iii) Declare an object M of type Magazine, with the following details:

        publisher: Blue Marlin

        date: 02/02/2005

        title: The Earth and the Environment

        number of issues per year: 12

   (iv) Output all the details of Magazine M.

   (v) Write a statement to overload operator<< as a friend function to the class Book
        and add the following implementation to your code:

```
ostream & operator<<(ostream & out, const Book & B)
{
out<<B.title<<endl;
out<<B.publisher<<endl;
out<<B.date<<endl;
out<<B.author<<endl;
out<<B.ISBN<<endl;
}
```

   You should obtain the following compiler errors:

```
In function `std::ostream& operator<<(std::ostream&,
                                     const Book&)':
error: `std::string Publication::title' is private
error: `std::string Publication::publisher' is private
error: `Date Publication::date' is private
```

   Suggest two ways to fix this compiler problem.

Question 3

Write a function template for a function that has parameters for a partially filled array and for a value of the base type of the array. If the value is in the partially filled array, then the function returns the index of the first indexed variable that contains the value. If the value is not in the array, the function returns -1. The base type of the array is a type parameter. Notice that you

46

need two parameters to give the partially filled array: one for the array and one for the number of indexed variables used. Also write a suitable test program to test this function template.

Question 4

Write a template version of a search function for determining whether an array contains a particular value.

Question 5

Study the `Matrix` class interface and answer the questions that follow:

(Refer to the Notes at end of the question if you are unfamiliar with Matrices)

```
template<class Object>
class Matrix
{
 public:
        Matrix( int row  = 0, int col = 0 );
        void SetValue(Object value, int r, int c);
        Object GetValue( int r, int c) const;
        int GetRow() const;
        int GetCol() const;
        void OutPut(ostream & out) const;
 private:
        vector< vector<Object> > array;
        int rows;
        int cols;
};
```

(a)   Complete the implementation of the Matrix class where indicated:

```
template <class Object>
Matrix<Object>::Matrix (int row, int col)
{       rows = row;
        cols = col;
        array.resize(row);
        for (int r = 0; r < row; r++)
          array[r].resize(col);

}

//SetValue assigns row r and column c of the Matrix to value
template <class Object>
void Matrix<Object>::SetValue(Object value, int r, int c)
{
        //Complete code here
}
```

```
//GetValue returns the value in row r and col c of the Matrix
template <class Object>
Object Matrix<Object>::GetValue( int r, int c) const
{
        //Complete code here
}


//GetRow returns rows
template<class Object>
int Matrix<Object>::GetRow() const
{
        //Complete code here
}


//GetCol returns cols
template<class Object>
int Matrix<Object>::GetCol() const
{
        //Complete code here
}


//Outputs the matrix in a tabular format (see Notes for example)
template <class Object>
void Matrix<Object>::OutPut(ostream & out) const
{
        //Complete code here
}


//Operator+ is overloaded as a non-friend, non-member function. This
//function adds two Matrices (see Notes for example)
template<class Object>
Matrix<Object>    operator+(const    Matrix<Object>    &    x,    const
Matrix<Object> & y)
{
        //Complete code here
}
```

b)   Test your implementation by coding a main function to perform the following:

(i)   Declare three, 2 by 2 integer matrices, M1, M2, and M3;

(ii)   Store the following values in M1:

        1   2

        3   4

(iii)   Store the following values in M2:

        5   6

        7   8

(iv)   Store the sum of M1 and M2 in M3 using operator+.

(v)   Output all three matrices.

Notes:

In mathematics, a matrix (plural matrices) is a rectangular table of numbers or, more generally, a table consisting of abstract quantities that can be added and multiplied. For example, a 4 by 3 matrix is represented as:

$$
\begin{array}{ccc}
6 & 6 & 6 \\
5 & 3 & 2 \\
3 & 1 & 2 \\
2 & 7 & 9
\end{array}
$$

Two matrices can be added if, and only if, they have the same dimensions. (That is, both matrices have matching numbers of rows and columns.) We define their sum by constructing a third matrix whose entries are the sum of the corresponding entries of the original two matrices. For example:

$$
\begin{array}{ccc}
4 & 3 & 4 \\
1 & 2 & 3 \\
2 & 2 & 1
\end{array}
\; + \;
\begin{array}{ccc}
2 & 2 & 1 \\
1 & 3 & 2 \\
3 & 4 & 5
\end{array}
\; = \;
\begin{array}{ccc}
6 & 5 & 5 \\
2 & 5 & 5 \\
5 & 6 & 6
\end{array}
$$

Question 6

Write a program that inputs two C string variables, `first` and `last`, each of which the user should enter with his or her name. First, convert both C strings to lowercase. Your program should then create a new C string that contains the full name in pig latin with the first letter capitalized for the first and last name. The rules to convert a word into pig latin are as follows:

If the first letter is a consonant, move it to the end and add "ay" to the end.

If the first letter is a vowel, add "way to the end.

For example, if the user inputs "Erin" for the first name and "Jones" for the last name, then the program should create a new string with the text "Erinway Onesjay" and print it.

Question 7

(a) Write a sorting function that is similar to Display 7.12 in Chapter 7 in Savitch, except that it has an argument for a vector of `int`s rather than an array. This function will not need a parameter like `number_used` as in Display 7.12, since a vector can determine the number used with the member function `size()`. This sort function will have only this one parameter, which will be of a vector type. Use the selection sort algorithm (which was used in Display 7.12).

(b) Write a program that reads in a list of integers into a vector with base type `int`. Provide the facility to either read this vector from the keyboard or from a file, at the user's option. If the user chooses file input, the program should request a file name. The output is to be a two-column list. The first column is a list of the distinct vector elements; the second column is a count of the number of occurrences of each element. The list should be sorted on entries in the first column, largest to smallest. Adapt the sorting function from (a) as necessary.

For example, for the input

```
-12 3 -12 4 1 1 -12 1 -1 1 2 3 4 2 3 -12
```

The output should be

```
N    Count
4    2
3    3
2    2
1    4
-1   1
-12  4
```

Question 8

Write a recursive function that returns the sum of the integers between any two integer numbers inclusive. For example if we want to calculate the sum of integers between the integer numbers 13 and 17 then the sum will be 13 + 14 + 15 + 16 + 17 = 75. This recursive function will expect two integer parameters and will return a double.

9 EXAMINATION

A 2 hour examination will be scheduled for this module. Please refer to the *my Studies @ Unisa* brochure for general examination guidelines and examination preparation guidelines.

10 FREQUENTLY ASKED QUESTIONS

What if I cannot find the prescribed book?

Do not contact the lecturers if you have problems obtaining the textbook. If you have any difficulties with obtaining books from the official booksellers bookshops, please contact vospresc@unisa.ac.za.

You can also buy an e-book version of Savitch at www.coursesmart.com.

What if I fail to submit my assignment on time?

A grace period is allowed for submission difficulties via MyUnisa. If the MyUnisa system is down when you try to submit an assignment, do not contact the lecturers. Wait until the problem has been solved and submit as soon as possible. We are usually aware of the problems with MyUnisa. If you submit late for any other reason, include a note with the assignment with the reasons for the late submission. No assignment will be marked (i.e. a mark of ZERO will be awarded) after the solutions for the particular assignment have been published. This is usually a week or two after the due date.

How do I request an extension? (Do not!)

Please do not phone, fax or email for an extension. Submit the assignment as soon as possible, and include a note of explanation.

What if there are mistakes in the marking of assignments? (Do NOT re-submit to Assignments Department!)

We use a team of external markers that are sub-contracted for the purpose of marking assignments during the year. There are close to 500 students enrolled for the module. For this reason, inconsistency in the marking style of individual markers may be encountered. We request that students only query assignment marking where the marks will change significantly (i.e. more than 5%). Please follow the RE-MAIL PROCEDURE below should you require that an assignment be remarked. If your marks are added incorrectly or a question is not marked which we stated (in the solutions) was to be marked, or you feel strongly that you were penalised unfairly, follow the procedure below. If you phone we will just tell you to follow the RE-MAIL PROCEDURE.

The RE-MAIL procedure:

Scan your marked assignment and attach it to an e-mail, addressed to the module email, TOGETHER WITH A MESSAGE stating your marking dilemma with the specified questions of the assignment.

What if I don't receive my study material or I lose it?

All study material is downloadable from myUnisa web site for COS1512. Please download electronic copies (PDF files) of tutorial letters and the study guide from Official Study Material or Additional Resources**, and the CD from** Additional Resources.

May I send my assignment by email?

No. Assignments have to be registered. Students may submit assignments either by post or Mobile MCQ submission or electronically via myUnisa. Assignments are not accepted via fax or e-mail.

Have we received your assignment?

If you want to find out whether an assignment has been received by Unisa, marked or returned, look at the status of your assignment on MyUnisa.

11   CONCLUSTION

Do not hesitate to contact your lecturer or e-tutor by email if you are experiencing problems with the content of this tutorial letter or any aspect of the module.

I wish you a fascinating and satisfying journey through the learning material and trust that you will complete the module successfully.

Enjoy the journey!

COS1512 Team

12   APPENDIX A: THE SOFTWARE FOR COS1512

1.   Creating a project

Starting a new project

Launch the Project Wizard through *File->New->Project.* From the pre-configured templates for various types of projects, select **Console application** and click **Go**.
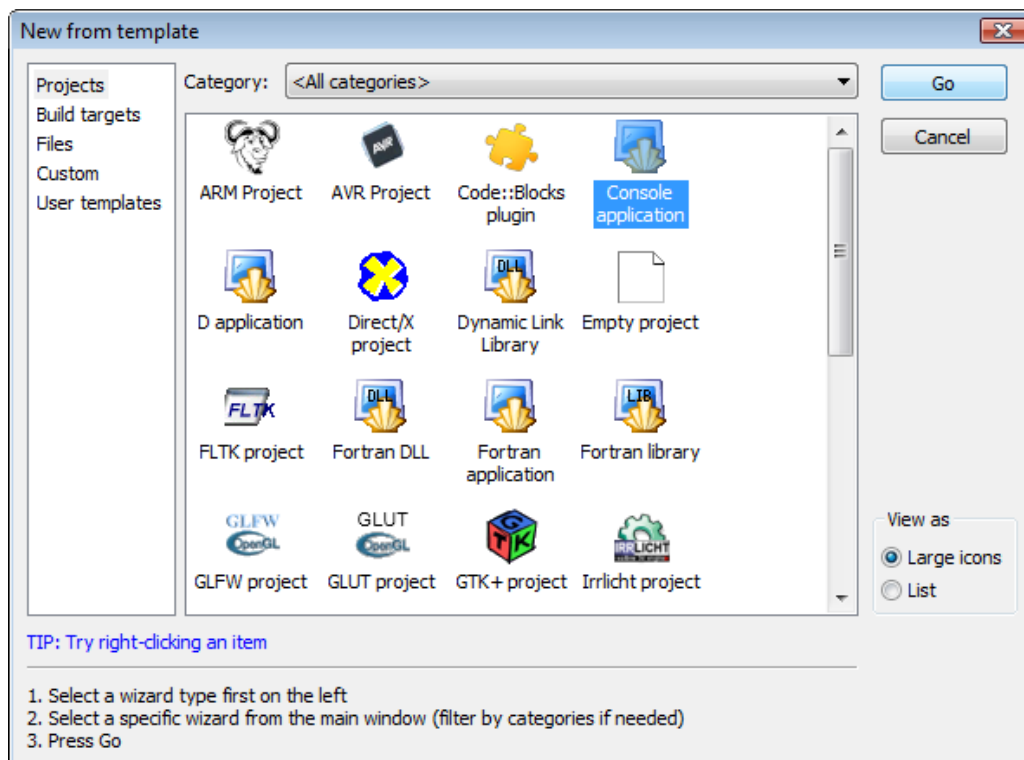
The console application wizard will appear next. Continue through the menus, selecting **C++** when prompted for a language. In the next screen, give the project a **name** and type or select a destination folder. As seen below, Code::Blocks will generate the remaining entries from these two.
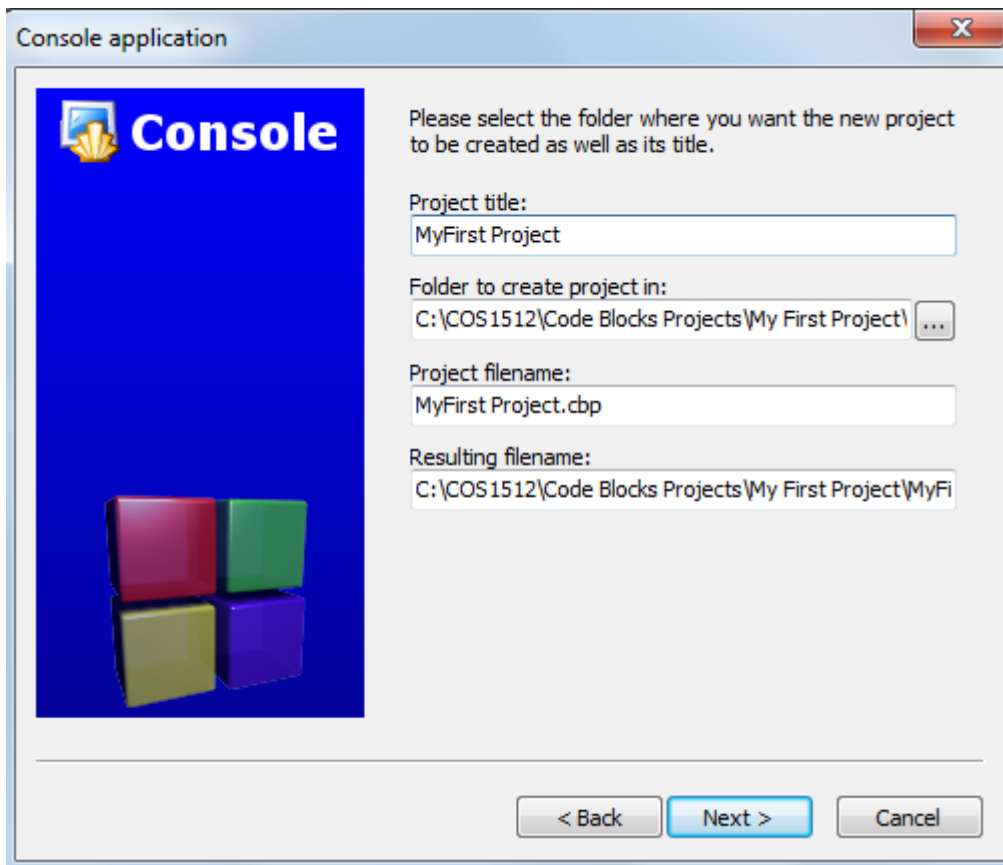
Finally, the wizard will ask if this project should use the default compiler (normally GCC) and the two default builds: **Debug** and **Release**. All of these settings are fine. Press finish and the project will be generated. The main window will turn gray, but that is not a problem, the source file needs only to be opened. In the **Projects** tab of the **Management** panel on the left expand the folders and double click on the source file **main.cpp** to open it in the editor.
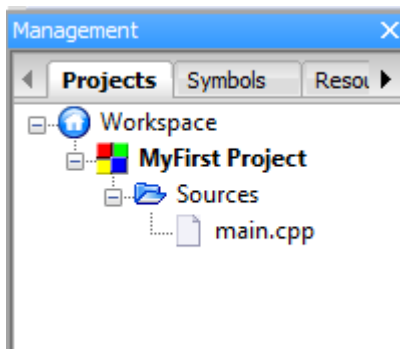
This file contains the following standard code.

main.cpp

```
1. #include <iostream>
2.
3. usingnamespacestd;
4.
5. int main()
6. {
7. cout<<"Hello world!"<<endl;
8. return0;
9. }
```
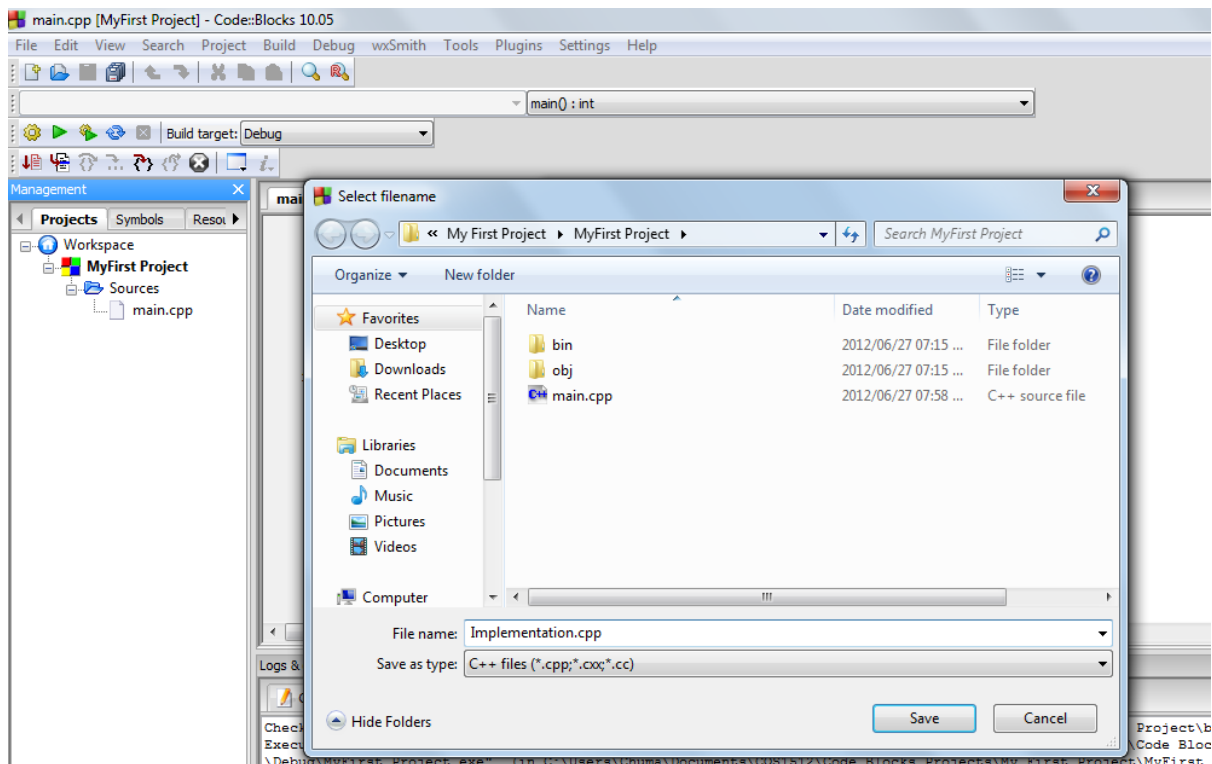
Adding a file to your project

To add the new file to the project, bring up the file template wizard through either *File->New->File...* or *Main Toolbar->New file (button)->File...*
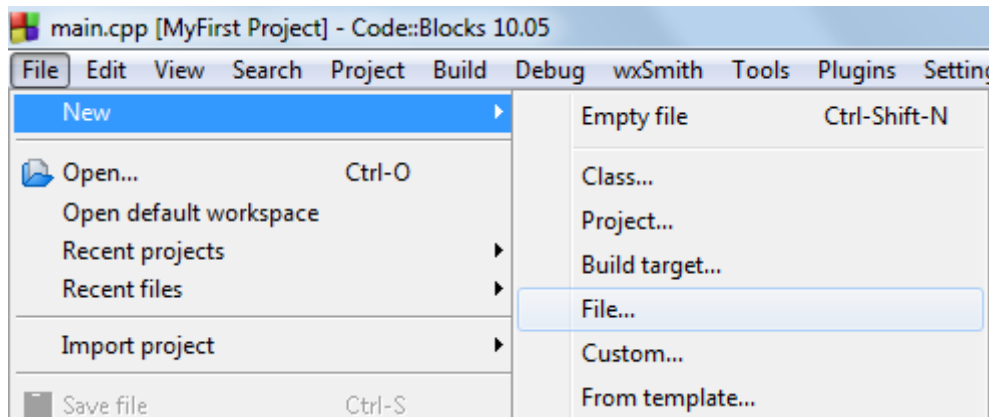
Select **C/C++ source** and click **Go**. Continue through the menus, same as what you have done before. The last menu will present you with several options. Enter the new filename and location (as noted, the full path is required). You can browse for the file by clicking the browse button (see below) to display the file browser window to save the file's location. Checking **Add file to active project** will store the filename in the **Sources** folder of the **Projects** tab of the **Management** panel. Checking any of the build targets will alert Code::Blocks that the file should be compiled and linked into the selected target(s). click **Finish** to generate the file.

Browse button
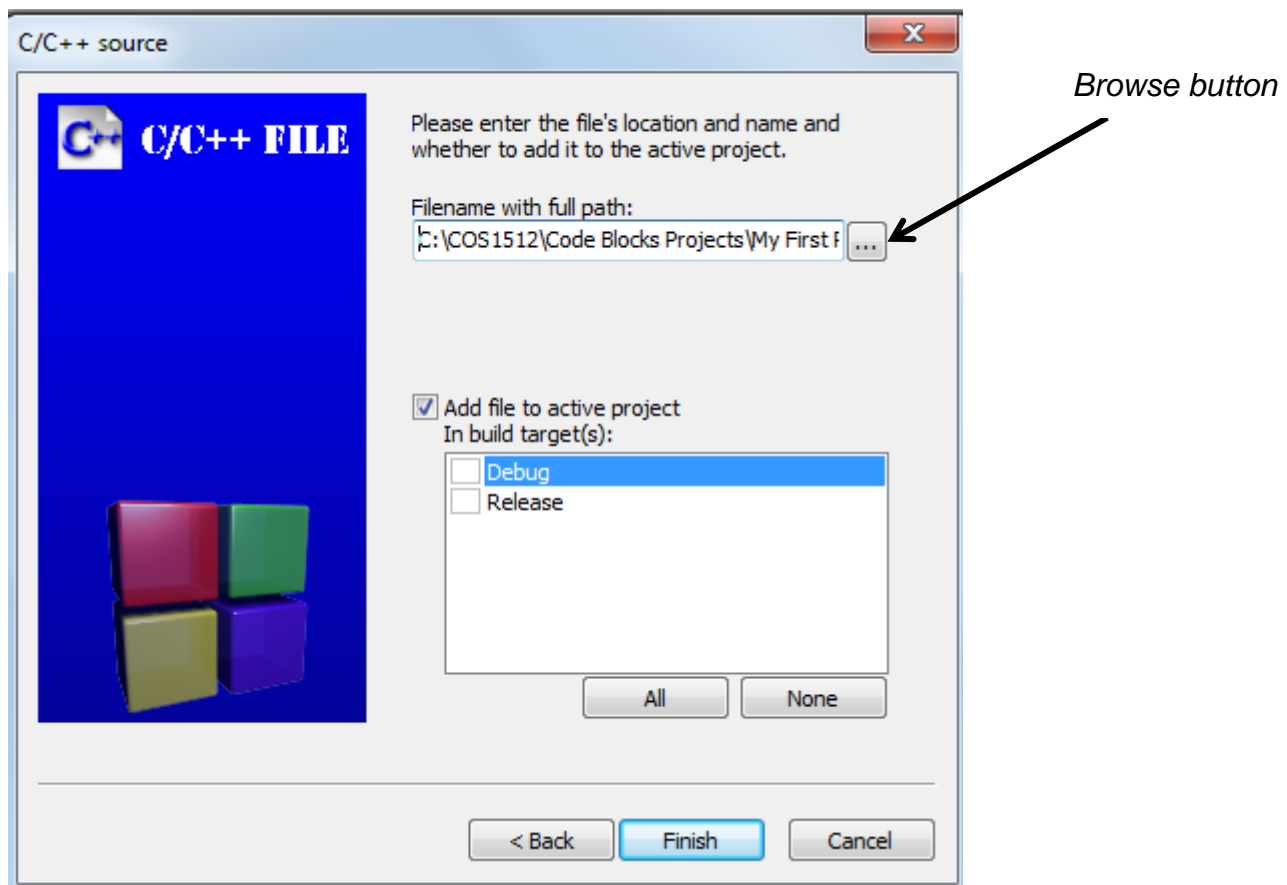
The newly created file should open automatically; if it does not, open it by double clicking on its file in the **Projects** tab of the **Management** panel. You can now add code to the new file. Be careful not to save your files with `.c` extension (this is not a C++ extension).


Adding a pre-existing file

Copy an existing file to your project folder or launch a plain text editor (for example Notepad), and add the following code.

Interface.h

```
1. #ifndef INTERFACE_H_INCLUDED
2. #define INTERFACE_H_INCLUDED
3.
4. void hello();
5.
6. #endif // INTERFACE_H_INCLUDED
```

Save this file as a header (**Interface.h**) in the same directory as the other source files in this project. Back in Code::Blocks, click *Project->Add files...* to open a file browser. Here you may select one or multiple files (using combinations of *Ctrl* and *Shift*). (The option *Project->Add files recursively...* will search through all the subdirectories in the given folder, selecting the relevant files for inclusion.) Select **Interface.h**, and click **Open** to bring up a dialog requesting to which build targets the file(s) should belong. For this example, select both targets.
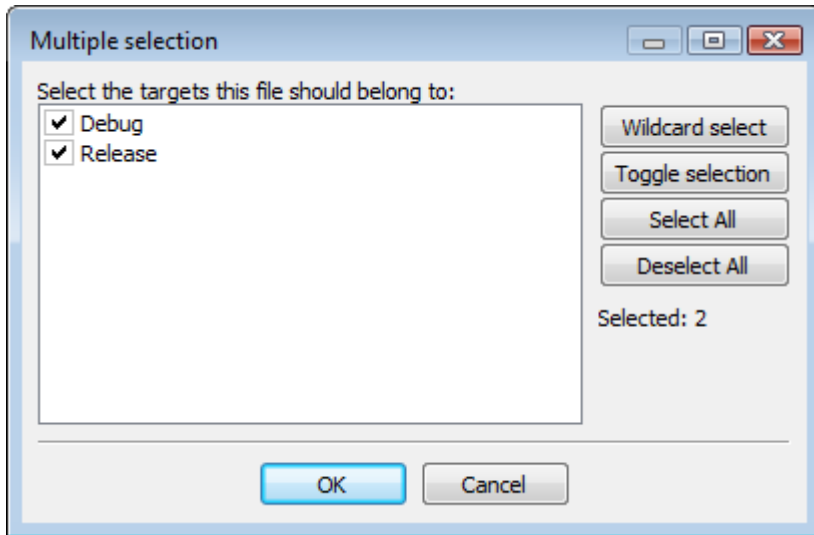
Note: if the current project has only one build target, this dialog will be skipped.

Returning to the main source (**main.cpp**) include the header file and replace the `cout` function to match the new setup of the project.

main.cpp

```
1. #include "Interface.h"
2.
3. int main()
4. {
5.     hello();
6. return0;
7. }
```

Press *Ctrl-F9* or *File->Build*, or *Compiler Toolbar->Build (button - the gear)* to compile the project. If the following output is generated in the build log (in the bottom panel) then all steps were followed correctly.

```
-------------- Build: Debug in MyFirst Project --------------

Compiling: main.cpp
Linking console executable: bin\Debug\MyFirst Project.exe
Output size is 913.10 KB
Process terminated with status 0 (0 minutes, 1 seconds)

0 errors, 0 warnings
```
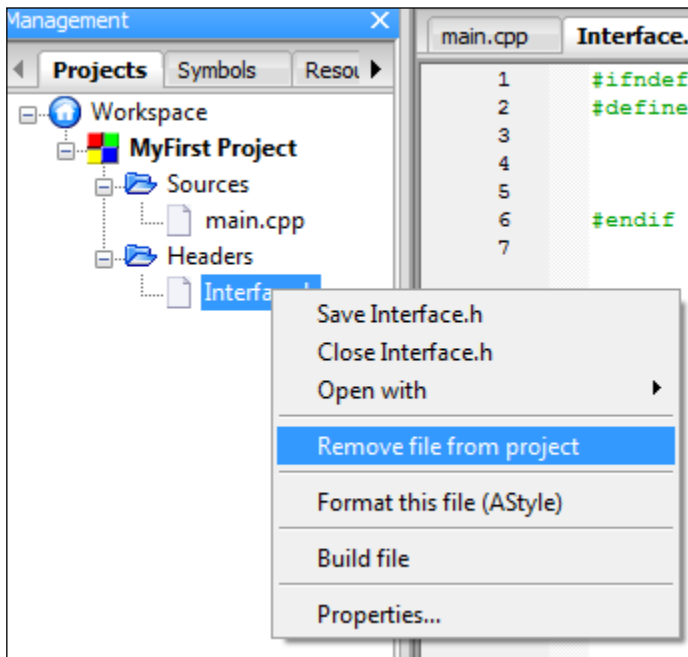
You can now "run" the project by either clicking the *Run* button or hitting *Ctrl-F10*.

Note: the option F9 *(for build and run) combines these commands, and may be more useful in some situations.*

Removing a file

You can remove a file by simply right-clicking on the file name in the **Projects** tab of the **Management** panel and selecting **Remove file from project**.

*Note: removing a file from a project does **not** physically delete it.*

2.   Printing

To print a C++ program, choose the "Print" option on the "File" menu of Code::Blocks. (If you are submitting an assignment via *myUnisa*, you don't need to print. Simply paste the code of your program into a word processor file.)

Printing the *output* of a program is somewhat trickier. There are (at least) two ways to print the output of a text-based program (a console application):

Method 1

To print the text from the I/O window after running your program, you can copy the text to a word processor (an editor). The steps involved are as follows:

- Position the mouse over the console window (the output window). Right-click, and choose Mark from the drop-down menu.

- Hold the Shift key down and use the arrow keys to mark (highlight) the text as a block.

- Press the Enter key to copy the highlighted text to the clipboard.

- You can now paste it in a word processor (editor) of your choice and print it.

Method 2

Sometimes the above method can be somewhat laborious and problematic, especially if there is so much output that it scrolls off the top of the screen. In this case, you can send the output directly to the printer (while the program is running) like this:

- Run your program, and when it has finished executing (and you are happy with the output) close the console window.

- Open a separate DOS window (or Command window) and change the directory to where your program is. (You'll need to type something like **cd \unisa\cos1512**.)

- Test whether your program is actually in the current directory by typing its name at the DOS prompt, eg. **first.exe** followed by <Enter>. If you get the message "Bad command or filename" you are either in the wrong directory or the name of the executable file is incorrect. You must be able to run the program from the DOS prompt before proceeding.

- Make sure that your printer is switched on, is "On-line" and has paper in it, etc.

- Press <Ctrl+P> to ensure that all the output generated from now on is sent to the printer.

- Type the name of the executable file, eg. **first.exe** and press <Enter> to run your program again.

- Enter any values that the program requires as input.

- When the program terminates, press <Ctrl+P> again to turn off the printing mode. All the output (and input) of the program should have been sent to the printer.

- Now you can close the console window.

  Unfortunately, this method won't help if you intend submitting your assignment via *myUnisa*. You'll have to use Method 1.

13   APPENDIX B: SOURCE LISTINGS OF THE SAMPLE PROGRAMS IN THE TEXTBOOK

The source code listings of the sample programs in the 8th and 9th edition of the text book can be found at the Companion Website for the text book. Go to www.pearsinternationaleditions.com/savitch, select the text book and then click on **Companion Website**. Click on the **Register** button, and type in the student access code found beneath the pull tab of the **ONLINE ACCESS** card in front of the text book.

The source code listings of the sample programs in the 7th edition of the text book can be found at http://www.aw.com/cssupport. Click on S under "Author Search", and then on "Savitch" in the resulting list of authors. Follow the link provided for the text book. Now double-click on "PSCPP6e-SourceCode.zip" and click on Open. A list of folders, one for each chapter, will be displayed. Each folder contains the source listings for Displays in the chapter. Display 9.06 for example will be listed as "09-06.cpp". If you double-click on the file, the source listing will open up in Code::Blocks.

14   APPENDIX C: GLOSSARY

The following link provides a glossary for English/Afrikaans IT terminology:

http://www.coetzee.org/woordelys/

15 APPENDIX D: Solution to assignment 3

Question 1

For this question you had to answer questions based on the following code fragment:

```
1:    #include <iostream>
2:    using namespace std;
3:
4:    //---------------------------------------
5:
6:    class A
7:    {
8:     private:
9:        int x;
10:   protected:
11:      int getX();
12:   public:
13:     void setX();
14:   };
15:
16:   int A::getX()
17:   {
18:     return x;
19:   }
20:
21:   void A::setX()
22: {
23:     x=10;
24:   }
25:
26:   //-----------------------------------------
27: class B
28:   {
29:     private:
30:      int y;
31:     protected:
32:        A objA;
33:        int getY();
34:     public:
35:       void setY();
37:    };
38:
39:   void B::setY()
40:   {
41:     y=24;
42:     int a=objA.getX();
43:    }
44:
45:   //-----------------------------------------
46:
47:   class C: public A
48:   {
49:        protected:
50:         int z;
```

60

```
51:     public:
52:        int getZ();
53:        void setZ();
54:     };
55:
56:     int C::getZ()
57:     {
58:        return z;
59:     }
60:
61:     void C::setZ()
62:     {
63:        z=65;
64:     }
```

Answer the following questions based on the code fragment given above:

(a)   Is line 18 a valid access? Justify your answer?

Yes.

The variable x is a private data member of the class A and therefore it can only be accessed by other member functions and operators of the class A. getX() is a member function of class A and therefore line 18 is a valid access.

(b)   Is line 32 a valid statement? Justify your answer.

Yes.

An object of class A has been included as a protected data member of class B.

(c)   Identify another invalid access statement in the code.

Line 42 (int a=objA.getX();) is invalid.

getx() is a protected member function of class A and can therefore only be accessed by other member functions and operators of the class A and by classes derived from class A.

(d)   Class C has public inheritance with the class A. Identify and list class C's private, protected and public data members resulting from the inheritance.

With public inheritance, the public and protected members of the base class A are inherited as public and protected members of the derived class C.

Private data members or member functions resulting from the inheritance: None

Protected data members or member functions resulting from the inheritance: getX()

Public data members or member functions resulting from the inheritance: setX()

(e)   If class C had protected inheritance with the class A, identify and list class C's private, protected and public data members resulting from the inheritance.

With `protected` inheritance, `public` and `protected` members of the base class become `protected` members of the derived class.

`Private` data members or member functions resulting from the inheritance: None

`Protected` data members or member functions resulting from the inheritance: `setX()` and `getX()`

`Public` data members or member functions resulting from the inheritance: None

Discussion:

When deriving a class from a `public` base class, `public` members of the base class become `public` members of the derived class and `protected` members of the base class become `protected` members of the derived class. A base class' `private` members are never directly accessible from a derived class, but can be accessed through calls to the `public` and `protected` members of the base class.

When deriving from a `protected` base class, `public` and `protected` members of the base class become `protected` members of the derived class. When deriving from a `private` base class, `public` and `protected` members of the base class become `private` members of the derived class. `Private` and `protected` inheritance are not "is-a" relationships [Reference: Study Guide Appendix D, chapter 15].

Question 2

For this question you had to answer questions based on the following code fragment:

```
class Date
{
public:
    friend ostream & operator<<(ostream & cout, const Date & d);
    Date(int y, int m,  int d);
private:
    int year, month, day;
};

class Publication
{
public:
    Publication(const string  & p, const Date & d,
    const string & t);
    Date GetDate( ) const;
    string GetPublisher( )const;
    string GetTitle() const;
private:
    string publisher;
    Date date;
    string title;
};
```

(a)   Implement the `Date` and the `Publication` classes.

File Name: Date.cpp

```
#include <iostream>
#include "Date.h"

using namespace std;

Date::Date(int y, int m, int d): year(y), month(m), day(d){}
ostream & operator<<(ostream & out, const Date & d)
{
out<<d.day<<"/"<<d.month<<"/"<<d.year<<endl;
}
```

File Name: Publication.cpp

```
#include <iostream>
#include <string>
#include "Date.h"
#include "Publication.h"

using namespace std;

Publication::Publication( const string  & p, const Date & d,
                    const string & t): publisher(p),date(d),title(t)
{ }

Date Publication::GetDate() const
{
    return date;
}

string Publication::GetPublisher()const
{
    return publisher;
}

string Publication::GetTitle() const
{
    return title;
}
```

(b)   Code the interface of a derived class `Book` for which the `Publication` class is the base
        class. The `Book` class has two additional data members representing the ISBN number
        and the author of a book. Furthermore, the `Book` class contains member functions
        `getISBN( )` and `getAuthor( )` that returns the ISBN number and the author
        respectively. The declaration must also include a constructor for the class `Book`.

```
#ifndef BOOK_H
#define BOOK_H
#include "Publication.h"
#include "Date.h"
#include <string>
```

```
using namespace std;

class Book: public Publication
{
public:
Book(const  string  &  p, const  Date  &  d, const  string  &  t,
                const string & auth, const string & isbn);
    string getAuthor()const;
    string getISBN()const;
private:
    string ISBN;
    string author;


};

#endif
```

(c)   Implement the `Book` class.

```
#include "Book.h"
#include <string>
using namespace std;
Book::Book(const  string  &  p, const  Date  &  d,  const   string & t,
                const string & auth, const string & isbn):
    Publication(p,d,t),
    ISBN(isbn), author(auth){}

string Book::getAuthor()const
{
    return author;
}

string Book::getISBN() const
{
    return ISBN;
}
```

Note, the constructors of the `Book` class call the `Publication` constructor (shown in bold) in their initializer lists. Constructing a derived class object by first constructing its inherited portion is a standard practice. (For a complete discussion on this subject - refer to pages 851 -853 (8th ed) of Savitch / pages 865-868 (7th ed) of Savitch, under the section entitled "Constructors in Derived Classes").

(d)   Recode the following interface such that class `Magazine`, derives from class `Publication`:

```
#ifndef MAGAZINE_H
#define MAGAZINE_H
#include "Publication.h"
class Magazine: public Publication
{
public:
```

```
Magazine(const string & p, const Date & d, const string & t,
         int ipy);
int GetIssuesPerYear(  ) const;

private:
int issuesPerYear;
};
#endif
```

Note how the class requires less code due to inheritance.

(e)   Implement the `Magazine` class.

```
#include "Magazine.h"
Magazine::Magazine(const   string   &   p,   const   Date   &   d,
const string & t, int ipy):Publication(p,d,t), issuesPerYear(ipy)
{}
int Magazine::GetIssuesPerYear()const
{
return issuesPerYear;
}
```

(f)   For this question you had to design a driver program to test your classes:

```
#include <iostream>
#include "Date.h"
#include "Publication.h"
#include "Book.h"
#include "Magazine.h"

using namespace std;
int main()
{
    Date date1(2000,1,1);
    Date date2(2005,2,2);

    Book B("FisherKing", date1, "Global Warming", "123456789",
    "Ann Miller");
    cout<<B.GetTitle()<<endl;
    cout<<B.GetPublisher()<<endl;
    cout<<B.GetDate()<<endl;
    cout<<B.getAuthor()<<endl;
    cout<<B.getISBN()<<endl;
    Magazine M("Blue Marlin", date2,
            "TheEarth and the Environment",12);
    cout<<M.GetTitle()<<endl;
    cout<<M.GetPublisher()<<endl;
    cout<<M.GetDate()<<endl;
    cout<<M.GetIssuesPerYear()<<endl;

    return 0;
}
```

(g)	Write a statement to overload operator<< as a friend function to the class `Book` and insert the following implementation to your code:

```
ostream & operator<<(ostream & out, const Book & B)
{
out<<B.title<<endl;
out<<B.publisher<<endl;
out<<B.date<<endl;
out<<B.author<<endl;
out<<B.ISBN<<endl;
}
```

You should obtain the following compiler errors:

```
In function `std::ostream& operator<<(std::ostream&,
                                      const Book&)':
error: `std::string Publication::title' is private
error: `std::string Publication::publisher' is private
error: `Date Publication::date' is private
```

Suggest two ways to fix this compiler problem.

Method 1: Use the accessor functions as shown below:

```
ostream & operator<<(ostream & out, const Book & B)
{
     out<<B.GetTitle()<<endl;
     out<<B.GetPublisher()<<endl;
     out<<B.GetDate()<<endl;
     out<<B.getAuthor()<<endl;
     out<<B.getISBN()<<endl;
}
```

Method 2: Change the member variables of `Publication` into `protected` access. As they are now `protected` and not `private` they become accessible to the derived class `Book`. The protected members of `Publication` become protected members of `Book`. They now can be directly accessed by member functions and friend functions of `Book`.

```
class Publication
{
public:
     Publication(const    string     &   p,    const    Date    &   d,
                const string & t);
     Date GetDate( ) const;
     string GetPublisher( )const;
     string GetTitle() const;
protected:
     string publisher;
     Date date;
     string title;
};
```

Full Programming Listing:

File name: Date.h

```
#ifndef DATE_H
#define DATE_H
#include <iostream>

using namespace std;
class Date
{
public:
     friend ostream & operator<<(ostream & cout, const Date & d);
     Date(int y, int m,  int d);
private:
     int year, month, day;
};

#endif
```

File name: Date.cpp

```
#include <iostream>
#include "Date.h"

using namespace std;

Date::Date(int y, int m, int d): year(y), month(m), day(d){}
ostream & operator<<(ostream & out, const Date & d)
{
     out<<d.day<<"/"<<d.month<<"/"<<d.year<<endl;
}
```

File name: Publication.h

```
#ifndef PUBLICATION_H
#define PUBLICATION_H
#include <string>
#include "Date.h"

using namespace std;
class Publication
{
public:
     Publication(const string  & p, const Date & d, const string & t);
     Date GetDate( ) const;
     string GetPublisher( )const;
     string GetTitle() const;
private:
     string publisher;
     Date date;
     string title;
};
```

```
#endif
```
File name:Publication.cpp

```cpp
#include <iostream>
#include <string>
#include "Date.h"
#include "Publication.h"
using namespace std;

string Publication::GetTitle() const
{
    return title;
}
Publication::Publication( const string  & p, const Date & d, const
string & t): publisher(p),date(d),title(t){}

Date Publication::GetDate() const
{
    return date;
}

string Publication::GetPublisher()const
{
    return publisher;
}
```

Filename: Book.h

```cpp
#ifndef BOOK_H
#define BOOK_H
#include "Publication.h"
#include "Date.h"
#include <string>

using namespace std;

class Book: public Publication
{
public:
    friend ostream & operator << (ostream & out, const Book & B);
    Book(const string & p, const Date & d, const string & t,
        const string & auth,const string & isbn);
    string getAuthor()const;
    string getISBN()const;
private:
    string ISBN;
    string author;
};

#endif
```

Filename: Book.cpp

```cpp
#include "Book.h"
#include <string>
using namespace std;

Book::Book(const string & p, const Date & d,  const  string & t,
           const string & auth, const string & isbn):
Publication(p,d,t),
ISBN(isbn), author(auth){}

string Book::getAuthor()const
{
    return author;
}

string Book::getISBN() const
{
    return ISBN;
}
ostream & operator<<(ostream & out, const Book & B)
{
    out<<B.GetTitle()<<endl;
    out<<B.GetPublisher()<<endl;
    out<<B.GetDate()<<endl;
    out<<B.getAuthor()<<endl;
    out<<B.getISBN()<<endl;
}
```

Filename: Magazine.h

```cpp
#ifndef MAGAZINE_H
#define MAGAZINE_H

#include "Publication.h"
class Magazine:public Publication
{
public:
    Magazine(const  string  &  p,  const  Date  &  d,  const string & t,
             int ipy);
    int GetIssuesPerYear(  ) const;
private:
    int issuesPerYear;
};
#endif
```

Filename: Magazine.cpp

```cpp
#include "Magazine.h"

Magazine::Magazine(const string & p, const Date & d, const string & t,
int ipy):Publication(p,d,t), issuesPerYear(ipy)
{}
```

69

```cpp
int Magazine::GetIssuesPerYear()const
{
      return issuesPerYear;
}


Filename: Test.cpp
#include <iostream>
#include "Date.h"
#include "Publication.h"
#include "Book.h"
#include "Magazine.h"

using namespace std;
int main()
{
      Date date1(2000,1,1);
      Date date2(2005,2,2);

      Book B("FisherKing", date1, "Global Warming", "123456789",
      "Ann Miller");
      cout<<B.GetTitle()<<endl;
      cout<<B.GetPublisher()<<endl;
      cout<<B.GetDate()<<endl;
      cout<<B.getAuthor()<<endl;
      cout<<B.getISBN()<<endl;
      Magazine M("Blue Marlin", date2,
                  "TheEarth and the Environment",12);
      cout<<M.GetTitle()<<endl;
      cout<<M.GetPublisher()<<endl;
      cout<<M.GetDate()<<endl;
      cout<<M.GetIssuesPerYear()<<endl;

      return 0;
}
```

Question 3

Discussion:

For this question, you had to define a function template that searches an array for a specific value and returns the index of the first occurrence of that value. The template should have parameters for a partially filled array and for a value of the base type of the array. If the value is in the partially filled array, then the function returns the index of the first occurrence of that value, otherwise the function returns -1. The base type of the array is a type parameter.

Function templates are special functions that can operate with generic types. This allows us to create a function template whose functionality can be adapted to more than one variable type or class without repeating the code for each type. For instance, with this program we used the same `search()` function for an array of `double`s (Doubles), an array of characters (Characters) and an array of integers (Integers). Without templates we would have had to write a separate `search()` function for each type of array. (Section 17.1 of Savitch has detailed explanations on the declarations of function templates.)

A template parameter is a special kind of parameter that can be used to pass a type as a parameter. The function templates can use these parameters as if they were regular types. The declaration for the `search()` function combined template parameters with a defined parameter type:

```
template<class T>

int search(T array[], int n, T target)
```

Be cautious when using template parameters - you cannot apply it without considering all the implications.

For example:

```
template<class T>

int search( T array[], T n, T target)
```

☞ This does not make sense as we want to run a loop `n` number of times to search the array for our target element - `n` must certainly be of type integer. Hence it does not make sense within this context to declare `n` as a template parameter.

Program Listing:

```cpp
#include <iostream>

//Precondition: the array base type must have operator== defined,
//&&   n <= declared size of the array argument.
//Postcondition: Function returns index of the first
//occurrence of target in array. If target is not in the
//array, the function returns -1

using namespace std;

template<class T>
int search( T array[], int n, T target)
{
  for ( int i = 0; i < n; i++ )
  {
    if (array[i] == target)
      return i;
  }
  return -1;
}


int main(){
    char Characters[14] = { 'M', 'A', 'P', 'C','E' };
    int Integers[14] = { 1, 4, 3, 5, 3, 6, 8, 9, 10, 7};
    double Doubles[14] = {2.99,8.77,4.88,6.44,3.45};

    cout << " C found at index "
        << search( Characters,5,'C')
        << " in array of characters"
        << endl;
```

```
        cout << " c found at index "
            << search( Characters,5,'c')
            << " in array of characters"
            << endl;
        cout << " 5 found at index "
             << search( Integers, 10, 5)
             << " in array of integers"
              << endl;
        cout << " 3.45 found at index "
            << search( Doubles, 10, 3.45)
            << " in array of doubles"
            << endl;
}
```

Output:

```
 C found at index 3 in array of characters
 c found at index -1 in array of characters
 5 found at index 3 in array of integers
 3.45 found at index 4 in array of doubles
Press any key to continue . . .
```

Question 4

Discussion:

For this question, you had to specify a template version of a search function to determine whether an array contains a particular value. Here only two of the parameters had to be template type parameters, namely the array type and the target (i.e. the element being searched). As discussed, with the previous question, it does not make sense to alter the other parameters into template type parameters. We also included a templatized `Output()` function to output an array of any type and to call the `search()` algorithm to further promote reuse.

Program Listing:

```cpp
#include <iostream>
#include <string>
using namespace std;

//Precondition: the array base type must have operator== defined,
//&&   n <= declared size of the array argument.
//Postcondition: Function returns true at the first
//occurrence of target in array. If target is not in the
//array, the function returns false

template<class T>
bool search( T array[], int n, T target)
{
    for ( int i = 0; i < n; i++ )
    {
        if (array[i] == target)
            return true;
    }
    return false;
```

```
}
//Precondition: the array base type must have operator<< defined,
//&&   n <= declared size of the array argument.

template <class T>
void Output(T array[], int n, T target, string s)
{
   if (search(array,n,target))
       cout << s << "does contain " << target <<endl;
   else
       cout << s << "does not contain " << target <<endl;
}

int main()
{
     char Characters[14] = { 'M', 'A', 'P', 'C','E' };
     int Integers[14] = { 1, 4, 3, 5, 3, 6, 8, 9, 10, 7};
     double Doubles[14] = {2.99,8.77,4.88,6.44,3.45};

     Output( Characters,5,'C', "Array Characters ");
     Output( Characters,5,'c', "Array Characters ");
     Output( Integers, 10, 5 , "Array Integers ");
     Output( Integers, 10, 15 , "Array Integers ");
     Output( Doubles, 10, 3.45, "Array Doubles ");
     Output( Doubles, 10, 3.455, "Array Doubles ");
}
```

Output:

```
Array Characters does contain C
Array Characters does not contain c
Array Integers does contain 5
Array Integers does not contain 15
Array Doubles does contain 3.45
Array Doubles does not contain 3.455
Press any key to continue . . .
```

Question 5

For this question, you had to implement the operations of a `Matrix` class template.

(a) The code to be inserted shown in bold.

Discussion:

Until now, we have placed the definition of the class (in the header file) and the definition of the member functions (in the implementation file) in separate files. However this does not work with class templates. As shown below both the interface and implementation are within the header file `Matrix.h`

File name: Matrix.h

```
#ifndef MATRIX_H
```

```cpp
#define MATRIX_H
#include <iostream>
#include <vector>
#include <cassert>
using namespace std;
template<class Object>
class Matrix
{
 public:
     Matrix( int r  = 0, int c = 0 );
     void SetValue(Object value, int row, int col);
     Object GetValue( int row, int col) const;
     int GetRow() const;
     int GetCol() const;
     void OutPut(ostream & out) const;
 private:
     vector< vector<Object> > array;
     int rows;
     int cols;
};

template <class Object>
Matrix<Object>::Matrix (int row, int col)
{
     rows = row;
     cols = col;
     array.resize(row);
     for (int r = 0; r < row; r++)
          array[r].resize(col);


}

template <class Object>
void Matrix<Object>::SetValue(Object value, int row, int col)
{
     array[row][col] = value;
}

template <class Object>
Object Matrix<Object>::GetValue(int row, int col) const
{
     return array[row][col];
}

template<class Object>
int Matrix<Object>::GetRow() const
{
     return rows;
}

template<class Object>
int Matrix<Object>::GetCol() const
{
     return cols;
```

74

```
}

template <class Object>
void Matrix<Object>::OutPut(ostream & out) const
{
    for (int r = 0; r < rows; r++)
    {
        for(int c = 0; c < cols; c++)
        {
            out<<array[r][c]<<'\t';
        }
        cout<<endl;
    }
}

template<class Object>
Matrix<Object> operator+(const Matrix<Object> & x,
                         const Matrix<Object> & y)
{
    int xrow = x.GetRow();
    int xcol = y.GetCol();
    assert( xrow == y.GetRow() && xcol == y.GetCol());
    Matrix<Object> temp(xrow,xcol);
    for (int r = 0; r < xrow; r++)
    {
        for(int c = 0; c < xcol; c++)
        {
            Object sum = x.GetValue(r,c) + y.GetValue(r,c);
            temp.SetValue(sum, r, c);
        }
    }
    return temp;
}

#endif
```

(b)   For this question you had to write a test program for your `Matrix` class:

```
#include <iostream>
#include "Matrix.h"
using namespace std;

int main()
{
    Matrix<int> M1(2,2);
    Matrix<int> M2(2,2);

    M1.SetValue(1,0,0);
    M1.SetValue(2,0,1);
    M1.SetValue(3,1,0);
    M1.SetValue(4,1,1);

    M2.SetValue(5,0,0);
```

```
        M2.SetValue(6,0,1);
        M2.SetValue(7,1,0);
        M2.SetValue(8,1,1);

        Matrix<int> M3(2,2);
        M3 = M1 + M2;

        M1.OutPut(cout); cout<<endl;
        M2.OutPut(cout);cout<<endl;
        M3.OutPut(cout);cout<<endl;

        return 0;
}
```

Output Produced:

```
1       2
3       4

5       6
7       8

6       8
10      12

Press any key to continue . ..
```

Note:

As shown above - we also have the possibility to write class templates, so that a class can have members that use template parameters as types. C++ class templates are used where we have multiple copies of code for different data types with the same logic. If a set of functions or classes have the same functionality for different data types, they become good candidates for being written as templates. C++ class templates are ideal for container classes (a class of objects that is intended to contain other objects). Examples of container classes will be the STL classes like `vector` (chapter 8, Savitch), and `list`. Once the code is written as a C++ class template, it can support all data types. (See section 17.2, Savitch for full explanations on Class Templates.) For instance the `Matrix` template above can accommodate a `Matrix` of any type, be it `string`s, `double`s, `int`s, etc.

Savitch limits his discussion to popular member functions of the STL vector class, such as `push_back`, `size`, `capacity`, `reserve` and `resize`. However there are other member functions such as:

> `empty` which returns true if the vector is empty and false otherwise

> `pop_back` which removes the last element of a vector

> `back` which returns the last element of the vector.

Question 6

Discussion:

In this program we use C-strings to read in the user's first and last name. Both C-strings are then converted to lowercase before the full name is converted to pig latin.

C-strings use the '\0' character to indicate the end of a C-string. The C-string variables used to store the first and last names for example are therefore declared as

```
char first[21], last[21];
```

to allow 20 characters each for the first and last names as well as one position for the '\0'.

The program uses two functions, `convertToLowerCase()` to convert a string to lowercase, and `pigLatin()` to convert a string to pig latin.

In function `convertToLowerCase()` we use the null character '\0' as sentinel in the `while` loop that converts each character to its lower case.

Program listing:

```
      #include <iostream>
#include <cstring>
using namespace std;

// void convertToLowerCase(char name[])
// Pre: name[] contains a C-string
// Post: name[] has been converted to lower case
void convertToLowerCase(char name[])

//void pigLatin(char name[])
// Pre: name[] contains a C-string
// Post: name[] has been converted to pig latin
void pigLatin(char name[])

int main()
{
    char first[21], last[21], newName[41], copyFirst[21],copyLast[21];
    cout << "Please enter your first name: ";
    cin >> first;
    cout << "Please enter your last name: ";
    cin >> last;
    //make a copy of the first and last name for output purposes
    strcpy(copyFirst, first);
    strcpy(copyLast, last);
    //convert first and last name to lowercase
    convertToLowerCase(first);
    convertToLowerCase(last);
    //convert first and last name to pig latin
    pigLatin(first);
    pigLatin(last);
    //create new string with first and last name in pig latin
    strcpy(newName, first);
    strcat(newName, " "); //add space between first and last name
```

```cpp
    strcat(newName, last);
    cout  <<  "Dear  "  <<  copyFirst  <<  "  "  <<  copyLast
        << " in pig latin your name is " << newName << endl;
    return 0;
}

void convertToLowerCase(char name[])
{
    int i = 0;
    while (name[i] != '\0')
    {
        name[i] = tolower(name[i]);
        i++;
    }
}

void pigLatin(char name[])
{
    char ch;
    if ((name[0] == 'a') || (name[0] == 'e') || (name[0] == 'i')
        || (name[0] == '0') || (name[0] == 'u'))
        {
            name[0] = toupper(name[0]);
            strcat(name, "way");
        }
    else
        {
            ch = name[0];
            for (int i = 0; i <= strlen(name); i++)
                name[i] = name[i+1];
            name[strlen(name)] = ch;
            strcat(name, "ay");
            name[0] = toupper(name[0]);
        }
    }
```

Input and corresponding output:

```
Please enter your first name: Erin
Please enter your last name: Jones
Dear Erin Jones in pig latin your name is Erinway Onesjay
Press any key to continue . . .
```

Question 7

7. (a) Discussion:

We adapted the sorting function to sort a vector from largest to smallest as follows:

The argument was changed from an `array` of `int`s to a `vector` of `int`s, as can be seen in the function headings:

`void sort(vector<int>& v)` and

```
int index_of_largest(const vector<int> v, int start_index)
```

Note that in order to return the sorted vector, it should be a reference parameter. Also note that since the size of a vector can be determined with the member function `size()`, the parameter `number_used` can be omitted from both functions.

We want to sort in descending order while the sorting function in Display 7.12 sorts in ascending order. Accordingly, both function and local variable names that refer to either `'smallest'` or `'min'` have been changed to `'largest'` or `'max'`. See for example function `index_of_largest` below:

```
int index_of_largest(const vector<int> v, int start_index)
{
    int max = v[start_index],
        index_of_max = start_index;
    for (int index = start_index + 1; index < v.size(); index++)
        if (v[index] > max)
        {
            max = v[index];
            index_of_max = index;
            //max is the largest of v[start_index] through v[index]
        }

    return index_of_max;
}
```

While these name changes aid in understanding the sorting order of the sorting function, it does not change the order in which the vector is sorted from ascending to descending. The crucial change to ensure that the sorting is done in descending order instead of ascending order, lies in changing the comparison
```
if (a[index] < min)
```
in function `index_of_largest` to
```
if (v[index] > max)
```

This change is highlighted in the code section above. The comments have also been adapted to reflect the changed sorting order.

7. (b) Discussion:

In this question you should have provided a facility to allow the user to specify whether input should be read from a file, or from the keyboard. Note that when input is read from the keyboard, we indicate the end of file character with CTRL Z, followed by pressing 'enter':

```
{         //read input from the console
    cout << "Please enter list of values. Press 'enter' "
        << "after each value. Use CTRL Z to end." << endl;
    read_vector(list,cin);
}
```

In function `read_vector()` inheritance is used so that input can be done both from a file or from the keyboard. The formal parameter corresponding either to `cin` (console input) or `fin` (file input) therefore has to be of type `istream`:

```
void read_vector(vector<int>& v, istream& in_stream);
```

See Section 10.4 in Savitch for more detail.

The distinct elements in the vector are extracted by using a boolean function `found()` to determine whether or not a specific element in the original vector (`list`) occurs in the vector of distinct elements (`distinct`). Should a specific element not occur in the vector of distinct elements, it is added to `distinct`.

```
//extract distinct elements in list into vector distinct
vector<int> distinct;
for (unsigned int i = 0; i < list.size(); i++)
{
    if (!found(list[i], distinct))
        distinct.push_back(list[i]);
}
```

The vector of distinct elements is then sorted, and a third vector (`occurrences`) with the same number of elements as `distinct` is declared and initialised to 0.

```
//sort vector distinct
sort(distinct);

//declare a vector with distinct.size()elements and initialise
//each to 0
vector<int> occurrences (distinct.size());
```

A function `count()` is used to count the number of times each distinct element (stored in vector `distinct`), occurs in the original list of elements (vector `list`).

```
//count occurrences for each element in vector distinct
for (unsigned int i = 0; i < distinct.size(); i++)
    occurrences[i] = count(distinct[i], list);
```

Finally, the corresponding elements in vectors `distinct` and `occurrences` are output next to each other to show the number of times each distinct element occurs in the original list. We show output for input from the keyboard as well as for input from a file.

Program listing:

```
#include <iostream>
#include <fstream>
#include <string>
#include <vector>
#include <cstdlib>
#include <cstring>

using namespace std;

void read_vector(vector<int>& v, istream& in_stream);
//to read input values from a stream (file or console) into vector v
bool found(int x, vector<int> v);
//to determine if x occurs in vector v

int count(int x, vector<int> v);
//to count the number of times x occurs in vector v
```
80

```
void sort(vector<int>& v);
//Precondition: number_used <= declared size of the vector v.
//The vector elements v[0] through v[v.size - 1] have values.
//Postcondition: The values of v[0] through v[v.size() - 1] have
//been rearranged so that v[0] >= v[1] >= ... >= v[v.size() - 1].

void swap_values(int& v1, int& v2);
//Interchanges the values of v1 and v2.

int index_of_largest(const vector<int> v, int start_index);
//Precondition: 0 <= start_index < v.size().
// Referenced vector elements have values.
//Returns the index i such that v[i] is the largest of the values
//v[start_index], v[start_index + 1], ..., v[v.size() - 1].

int main()
{
    vector<int> list;
    fstream fin;
    char answer;
    string filename;
    int next;
    cout << "Do you want to provide input via console or "
         << "using a file(c/f)?";
    cin >> answer;
    cout << endl;
    if (answer == 'f')   //read input from a file
    {
        cout << "Please enter filename: " << endl;
        cin >> filename;
        fin.open(filename.c_str());
        if (fin.fail())
        {
            cout << "Input file opening failed. \n";
            exit(1);
        }
        read_vector(list,fin);
        fin.close();
    }
    else        //read input from the console
    {
        cout << "Please enter list of values. Press 'enter' "
             << "after each value. Use CTRL Z to end." << endl;
        read_vector(list,cin);
    }

     //extract distinct elements in list into vector distinct
     vector<int> distinct;
     for (unsigned int i = 0; i < list.size(); i++)
     {
          if (!found(list[i], distinct))
              distinct.push_back(list[i]);
```

```cpp
    }
    //sort vector distinct
    sort(distinct);

    //declare a vector with distinct.size()elements and initialise
    //each to 0
    vector<int> occurrences (distinct.size());

    //count occurrences for each element in vector distinct
    for (unsigned int i = 0; i < distinct.size(); i++)
        occurrences[i] = count(distinct[i], list);

    //output
    cout << endl << 'N' << '\t' << "Count" << endl;
    for (unsigned int i = 0; i < distinct.size(); i++)
        cout << distinct[i] << '\t' << occurrences[i] << endl;

    return 0;
}

void read_vector(vector<int>& v, istream& in_stream)
{
    int next;
    while (in_stream >> next)
    {
        v.push_back(next);
    }
}

bool found(int x, vector<int> v)
{
    for (unsigned int i = 0; i < v.size(); i++)
    {
        if (x == v[i])
            return true;
    }
    return false;
}

int count(int x, vector<int> v)
{
    int counter = 0;
    for (unsigned int i = 0; i < v.size(); i++)
    {
        if (x == v[i])
            counter += 1;
    }
    return counter;
}

void sort(vector<int>& v)
{
    int index_of_next_largest;
```

```
    for (unsigned int index = 0; index < v.size() - 1; index++)
    {//Place the correct value in v[index]:
        index_of_next_largest =
                    index_of_largest(v, index);
        swap_values(v[index], v[index_of_next_largest]);
//v[0] >= v[1] >=...>= v[index] are the largest of the original
//vector elements. The rest of the elements are in the remaining
//positions.
    }
}

void swap_values(int& v1, int& v2)
{
    int temp;
    temp = v1;
    v1 = v2;
    v2 = temp;
}

int index_of_largest(const vector<int> v, int start_index)
{
    int max = v[start_index],
    index_of_max = start_index;
    for (int index = start_index + 1; index < v.size(); index++)
        if (v[index] > max)
        {
            max = v[index];
            index_of_max = index;
            //max is the largest of v[start_index] through v[index]
        }

    return index_of_max;
}
```

Output using console input:

```
Do you want to provide input via console or using a file(c/f)?c

Please enter list of values. Press 'enter' after each value. Use CTRL
Z to end.
-12
3
-12
4
1
1
-12
1
-1
1
2
3
4
```

```
2
3
-12
^Z

N        Count
4        2
3        3
2        2
1        4
-1       1
-12      4
Press any key to continue . . .
```

Output using file input:

```
Do you want to provide input via console or using a file(c/f)?f

Please enter filename:
Q6.dat

N        Count
4        2
3        3
2        2
1        4
-1       1
-12      4
Press any key to continue . . .
```

Question 8

For this question you had to write a recursive function that returns the sum of the integers between any two integer numbers inclusive. This recursive function expects two integer parameters and returns a double.

Program Listing:

```cpp
#include <iostream>
using namespace std;

double sum (int m, int n)
{
    if (m == n)
        return m;
    else
        return (m + sum ( m + 1, n ) );
}
int main()
{
  cout << "The sum between 13 and 17 is:";
  cout << sum (13,17) <<endl;;
  cout << "The sum between 13 and 13 is:";
  cout<<  sum(13,13) <<endl;
```

```
    cout << "The sum between 13 and 14 is:";
    cout<< sum(13,14) <<endl;

    return 0;
}
```

Output:

```
The sum between 13 and 17 is:75
The sum between 13 and 13 is:13
The sum between 13 and 14 is:27
Press any key to continue . . .
```

Discussion:

To solve this question, we need to determine the base case and the general case. The base case is when the solution can be obtained directly.

The base case:

If m is equal to n then we can immediately determine the sum to be m. For example the sum between 13 and 13 would be 13.

The general case on the other hand, is a little harder to deduce:

Consider the following example:
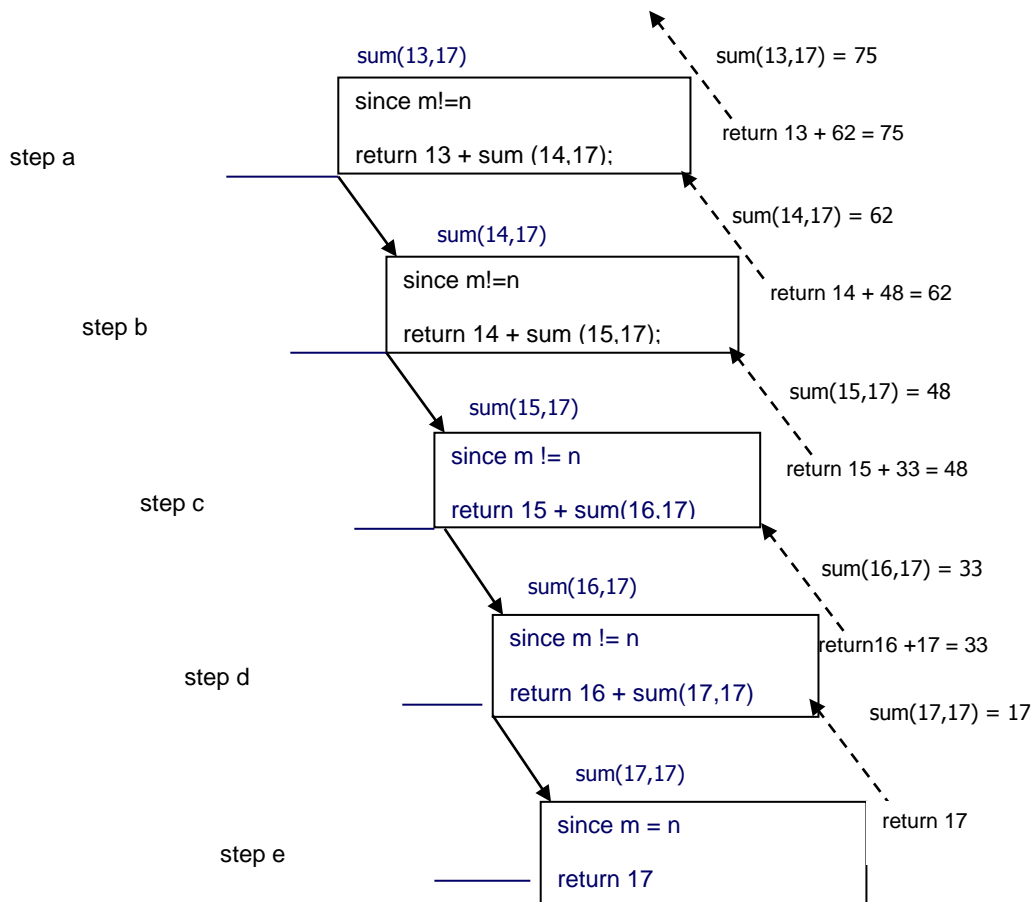
```
    sum(13,17) = 13 + 14 + 15 + 16 + 17
```

A more general formula can be written as:

```
    sum(m,n) = m+(m+1)+(m+2)+...+(n-2)+(n-1)+n
```

Recursively:

```
sum(m,n) = m + sum(m+1,n)
```

The diagram below represents the recursive calls that will take place if 13 and 17 were passed as parameters to the `sum()` function. That is, we want to determine the sum between 13 and 17. The diagram shows that each `sum(m,n)` induces calls to `sum(m+1,n)`. For instance,

since `sum(13,17) = 13 + sum(14,17)` - this induces calls to `sum(15,17)`, `sum(16,17)` and finally `sum(17,17)`. With regard to the diagram below, recursion works first along the downward arrows until a given point is reached at which an answer is defined (the base case), and then works along the dashed upward arrows, returning values back to the calling function. For function `sum()`, the base case is when `m == n`.

So eventually the recursive calls will stop at `sum(17,17)` - because an answer of 17 can be returned.

Hence `sum(16,17)` is:

`sum(16,17) = 16 + 17 = 33` hence `sum(16,17)` returns 33

So `sum(15,17)` is:

`sum(15,17) = 15 + sum(16,17) = 15 + 33 = 48` hence `sum(15,17)` returns 48

So `sum(14,17)` is:

`sum(14,17) = 14 + Sum(15,17) = 14 + 48 = 62` hence `sum(14,17)` returns 62

Therefore `sum(13,17)` is:

`sum(13,17) = 13 + sum(14,17) = 13 + 62 = 75` hence `sum(13,17)` returns 75

More on Recursion:

Understanding recursion is difficult. Let us consider an everyday example. Suppose you were given a huge bag of coins and you had to determine how much money was in the bag.

As the bag is large, you prefer not to do the work by yourself. However, you have many willing friends. You divide the bag of coins into two heaps of coins and ask your friend "Could you please add up this one heap of coins? I've only given you half, so there's half the work to do". You, then give the other half to another friend, and say the same thing. Once both are done, they will give their answer to you, and you add their results.

Thus, you have broken down the problem into two smaller parts, and asked your friends to do the work.

Now those friends are smart too, so they divide their heap of coins into two parts (now each has two heaps of ¼ of the size) and each asks two of their friends to help. When their friends are done, they return their answer, and the result is summed. Now assume that each of their friends does the same and enlists more friends to help and this process goes on and on. Eventually, there is a heap of only two coins, and these are divided once again and given to two more friends, and those friends, seeing how silly the problem is now, just tell the first friend the only value on the coin. There's no need to ask any more friends, because you're down to one coin (this is the base case).

Thus, recursion is all about breaking a problem down, and solving that, and that smaller problem is solved by breaking it down some more, and trying to solve that. Eventually, you reach an easy solution (the base case), and return the solution.

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