CAB301 Algorithms and Complexity

Assignment

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Development of a Software Application for a Tool Library

In this project you will develop a software application to solve a real-world problem. To implement this software application, you will need to use some of the data structures and algorithms covered in this unit, to store, manage and manipulate data. It will be necessary to design algorithms, to solve the computational problems arising during the development process, and to analyse the time efficiency of the algorithms.

Development of a Software Application for a Tool Library

- Due Date: 24 May 2021
- Weighting: 60%
- Group or Individual: Individual

Information about tools

- Tools in the community library are divided into nine (9) Categories:
  1. Gardening tools
  2. Flooring tools
  3. Fencing tools
  4. Measuring tools
  5. Cleaning tools
  6. Painting tools
  7. Electronic tools
  8. Electricity tools
  9. Automotive tools

Information about tools

- In each of the nine (9) categories, there are a few Tool Types. For example,
  - Painting Tools (a Category)
    1. Sanding Tools
    2. Brushes
    3. Rollers
    4. Paint Removal Tools
    5. Paint Scrapers

Information about tools

- In each of the tool types, there may be multiple Tools with different names. For example
  - Sanding Tools (a Tool Type)
    - Irwin 125mm Orbital Sander (5)
    - Rocket Sanding Block Holder (2)
    - PowerFit 120 Triangular Sander (1)

Information about members

- Users must join membership first before they can use the system to borrow tools.
- The following information about a member will be kept in the system:
  - First name
  - Last name
  - Contact phone number
  - Password
- A member cannot borrow more than three (3) tools at the same time

High-level object-oriented design of the system

- The system analysis has already been done and a high-level object-oriented design has been completed.
- Five (5) reusable classes have been identified and the public methods in each of the reusable classes have been defined in five (5) interfaces.

Tool class

- Design and implement a class, *Tool,* which implements the *iTool* interface to be provided. In this software application, each tool is represented by an object of class *Tool*.

Name: Irwin 125mm orbital sander
Quantity: 5
Available Quantity: 3
Number of Borrowings: 2

ToolCollection class

- Design and implement a class, *ToolCollection,* which implements the *iToolCollection* interface that has been provided with this assignment specification.
- In this software application, an object of the *ToolCollection* class is used to store and manipulate a collection of *Tool* objects.
- This class must use an **Array** to store a collection of *Tool* objects.
- An object of this class can be used to store a collection of tools that are being rented by a member or a collection of tools of a tool type.

Name: Irwin 125mm orbital sander **Quantity:** 5 **Available Quantity**: 3 **Number of Borrowings**: 2	**Name:** Rocket sanding block holder **Quantity:** 2 **Available Quantity**: 1 **Number of Borrowings**: 1	**Name:** Powerfit 120 triangular sander **Quantity:** 1 **Available Quantity**: 1 **Number of Borrowings**: 0

Member class

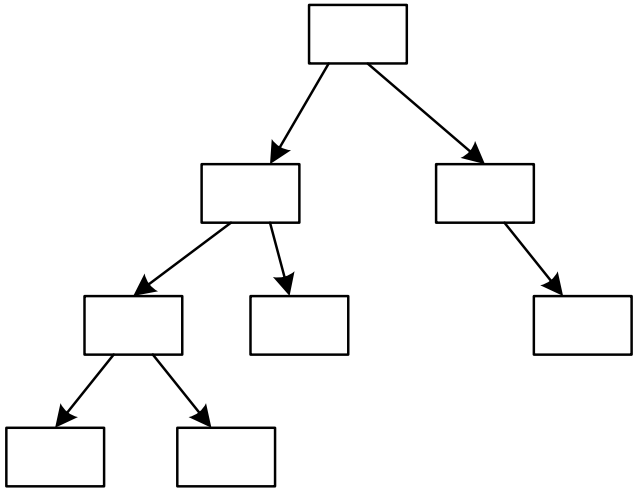
- Design and implement a class, *Member*, which implements the *iMember* interface that has been provided with this assignment specification. In this software application, each registered member is represented by an object of class *Member*.

First Name: Maolin
Last Name: Tang
Contact Number: 12345678
Password: 1234

MemberCollection class

- Design and implement a class, *MemberCollection*, which implements the *iMemberCollection* interface that has been provided with this assignment specification.
- A collection of registered members can be stored in an object of class *MemberCollection*.
- This class must use a **Binary Search Tree** as a class member to store a collection of *Member* objects.
- An object of this class can be used to store all those registered members or to store a collection of members who are currently renting a particular tool.

MemberCollection class



Lchild pointer	**First Name:** Maolin **Last Name:** Tang **Contact Number:** 12345678 **Password**: 1234	Rchild pointer

ToolLibrarySystem class

- Design and implement a class, *ToolLibrarySystem,* which implements the *iToolLibrarySystem* interface that has been provided with this assignment specification.
- The software uses the implemented methods in the class to implement the functionalities of the software system.
- For example, the system uses the implemented method, *void add(iTool aTool)*, in this class to implement the functionality of adding a new tool to the system.

Menus

```
Welcome to the Tool Library
==========Main Menu==========
1. Staff Login
2. Member Login
0. Exit
==============================

Please make a selection (1-2, or 0 to exit):
```

```
Welcome to the Tool Library
===============Staff Menu================
1. Add a new tool
2. Add new pieces of an existing tool
3. Remove some pieces of a tool
4. Register a new member
5. Remove a member
6. Find the contact number of a member
0. Return to main menu
=========================================

Please make a selection (1-6, or 0 to return to main menu):
```

```
Welcome to the Tool Library
==============Member Menu===============
1. Display all the tools of a tool type
2. Borrow a tool
3. Return a tool
4. List all the tools that I am renting
5. Display top three (3) most frequentely rented tools
0. Return to main menu
=========================================

Please make a selection (1-5, or 0 to return to main menu):
```

Staff functionalities

- Add a new tool to the system
- Add new pieces of an existing tool to the system
- Remove some pieces of a tool from the system (the pieces of a tool cannot be removed if it is currently not in the tool library)
- Register a member with the system
- Remove a member from the system
- Given the name of a member, find the contact phone number of the member

Add a new tool to the system

- Display all the nine (9) tool categories
- Select a category
- Display all the tool types of the selected category
- Select a tool type
- Display all the tools of the selected tool type
- Add a new tool to the tool type
- Display all the tools in the selected tool type again

Add a new tool to the system

Name: Irwin 125mm orbital sander
Quantity: 5
Available Quantity: 3
Number of Borrowings: 2

Name: Rocket sanding block holder
Quantity: 2
Available Quantity: 1
Number of Borrowings: 1

Name: Powerfit 120 triangular sander
Quantity: 1
Available Quantity: 1
Number of Borrowings: 0

Name: Irwin 125mm orbital sander
Quantity: 5
Available Quantity: 3
Number of Borrowings: 2

Name: Rocket sanding block holder
Quantity: 2
Available Quantity: 1
Number of Borrowings: 1

Name: Powerfit 120 triangular sander
Quantity: 1
Available Quantity: 1
Number of Borrowings: 0

Name: Ozito 260w delta sander
Quantity: 2
Available Quantity: 2
Number of Borrowings: 0

Add new pieces of an existing tool to the system

- Display all the tool categories
- Select a category
- Display all the tool types of the selected category
- Select a tool type
- Display all the tools of the selected tool type
- Select a tool from the tool list
- Add the quantity of the tool

Add new pieces of an existing tool to the system

Add 2 rocket sanding block holders

Name: Irwin 125mm orbital sander **Quantity:** 5 **Available Quantity**: 3 **Number of Borrowings**: 2
Name: Rocket sanding block holder **Quantity:** 2 **Available Quantity**: 1 **Number of Borrowings**: 1
Name: Powerfit 120 triangular sander **Quantity:** 1 **Available Quantity**: 1 **Number of Borrowings**: 0

Name: Irwin 125mm orbital sander **Quantity:** 5 **Available Quantity**: 3 **Number of Borrowings**: 2
Name: Rocket sanding block holder **Quantity:** 4 **Available Quantity**: 3 **Number of Borrowings**: 1
Name: Powerfit 120 triangular sander **Quantity:** 1 **Available Quantity**: 1 **Number of Borrowings**: 0

Remove some pieces of a tool from the system

- Display all the nine (9) tool categories
- Select a category
- Display all the tool types of the selected category
- Select a tool type
- Display all the tools of the selected tool type
- Select a tool from the tool list
- Input the number of pieces of the tool to be removed
- If the number of pieces of the tool is not more than the number of pieces that are currently in the library, reduce the total quantity and the available quantity of the tool

Remove some pieces of a tool from the system

Remove 1 rocket sanding block holder

Name: Irwin 125mm orbital sander **Quantity:** 5 **Available Quantity**: 3 **Number of Borrowings**: 2
Name: Rocket sanding block holder **Quantity:** 2 **Available Quantity**: 1 **Number of Borrowings**: 1
Name: Powerfit 120 triangular sander **Quantity:** 1 **Available Quantity**: 1 **Number of Borrowings**: 0

Name: Irwin 125mm orbital sander **Quantity:** 5 **Available Quantity**: 3 **Number of Borrowings**: 2
Name: Rocket sanding block holder **Quantity:** 1 **Available Quantity**: 0 **Number of Borrowings**: 1
Name: Powerfit 120 triangular sander **Quantity:** 1 **Available Quantity**: 1 **Number of Borrowings**: 0

Member functionalities

- Display the information about all the tools of a tool type selected by the user. The information includes the name of the tools and the quantity of the tools currently in the tool library
- Borrow a tool from the tool library, given the name of the tool, if the tool is available in the tool library
- Return a tool to the tool library
- List all the tools that are currently holding by the member
- Display top three most frequently borrowed tools by all the members in the descending order by the number of times the tool has been borrowed. The display should include the name of the tool and the number of times that the tool has been borrowed by now.

Display the information about all the tools of a tool type selected by the user

- Display all the nine (9) tool categories
- Select a category
- Display all the tool types of the selected category
- Select a tool type
- Display the information about all the tools of the selected tool type

Display the information about all the tools of a tool type selected by the user

The tool type selected by the user is Sanding Tools

Name: Irwin 125mm orbital sander **Quantity:** 5 **Available Quantity**: 3 **Number of Borrowings**: 2
Name: Rocket sanding block holder **Quantity:** 2 **Available Quantity**: 1 **Number of Borrowings**: 1
Name: Powerfit 120 triangular sander **Quantity:** 1 **Available Quantity**: 1 **Number of Borrowings**: 0

Assignment requirements

- The software application must be a Console Application of Microsoft Visual Studio 2019 and the programming language must be C#.
- You must not use any third-party C# class libraries.
- All the data structures and algorithms used in the software application must be covered in this unit.

Technical report

Write a technical report, which is organised as follows:

- Table of contents
- Introduction
- Design and Analysis of Algorithms – design an efficient algorithm to solve the following computational problem(s) in the software application. Use the pseudocode notations introduced in Lecture 1 to describe your algorithm(s) and analyse the time efficiency of your algorithm(s).
  - Display top three (3) most frequently borrowed tools in the descending order by the number of times that a tool has been borrowed.

Technical report

- Software Test Plans and Test Results – design a test plan for each of functionality tests. In each of the test plan, please include the test scenarios/cases and test data for each of the test scenarios/cases. Please also provide your test results for each of the test scenarios/cases using screenshots.

Submissions

- Your submission should be a single zip file named by *your_student_number*.zip and comprises of a complete C# Console Application project and a technical report in PDF.
- Your submission must be submitted via the blackboard. Email submission is not accepted.
- You may resubmit your assignment as many times as you wish before the deadline. If you submit your assignment multiple times, we will only mark the last submission before the deadline.