



# CAB301 ASSIGNMENT REPORT TOOL LIBRARY SYSTEM

## Contents

Introduction .....	3
Design and Analysis of Algorithms.....	4
Top Three algorithm .....	4
Introduction .....	4
Pseudocode.....	4
Algorithm description .....	4
Efficiency analysis .....	4
Software Test Plans and Test Results .....	6
Unit Tests .....	6
Tests of functionality.....	6
Appendix .....	9
Test images .....	9
Staff login .....	9
Staff failed login .....	9
Member login.....	9
Member login wrong username .....	9
Member login wrong PIN.....	9
Adding a new tool .....	10
Adding tool stock .....	10
Adding a negative amount of tool stock.....	10
Removing tool stock.....	10
Removing a negative amount of tool stock .....	11
Removing too much tool stock .....	11
Member registration.....	11
Member removal .....	11
Finding member contact phone number .....	11
Finding member contact number with non-existent name.....	11
Going back to main menu .....	11
Display tools by category .....	12
Borrow tool from library .....	12
Trying to borrow a tool when 3 are already borrowed .....	12
Borrowing the same tool more than once.....	12
Return tool to library .....	12
List borrowed tools .....	12
List borrowed tools with no borrowed tools .....	12

Display most frequently borrowed tools .....	13
Display most frequently borrowed tools when no tools have been borrowed.....	13
Display most frequently borrowed tools when only 2 tools have been borrowed .....	13
Incorrect page is selected in menu .....	13
Incorrect entry in list selector is selected .....	13
Entering a string into an int input .....	13
Entering a mobile number with letters when registering.....	13
Entering a PIN of incorrect length when registering .....	13

## Introduction

For this assignment, a software system for managing a tool library system was built. This system allows for a number of different types of tools to be stored, and lets members of the library keep track of their borrowed tools digitally. There is also a section in the program for staff of the library to manage the contents of the library, for example by adding new tools or modifying the stock of existing tools.

The implementation of the system into a C# program was fairly simple, and there were no major problems in implementing the required functionality. However, some restrictions due to the interfaces which the program had to utilise were limiting, as these interfaces could not be modified. This was an issue since some of them did not contain all of the required functionality, most notably the ToolLibrarySystem interface, which did not contain some essential functions which were needed to complete some of the requested functionality. These issues could be circumvented by creating a database class which holds the program's data. This meant that the program could interact with the data to complete any functionality which was outside the scope of the given ToolLibrarySystem interface.

In the future, with the ability to modify the interfaces, a better solution than to expose the program's data as public would be to fully flesh out the ToolLibrarySystem interface and class with more methods for accessing and manipulating the data in the system. This would remove the need to do so directly from the program's code, ensuring the data cannot be incorrectly manipulated.

This report was written as a technical description of the program, providing extra information on algorithms and testing. The report will go through the key algorithms used in the program, with an explanation and justification of each algorithm's design, a pseudocode version of each algorithm, and an analysis of each algorithm's efficiency. It will also contain a test plan for the program, which will go over and validate all the functionality of the program.

# Design and Analysis of Algorithms

## Top Three algorithm

### Introduction

An algorithm was required to retrieve the top three most-borrowed tools in the system. The algorithm chosen was one which loops through the tools once and gets the most-borrowed tools while looping through. This was chosen rather than a sorting algorithm as it is a more efficient solution, since most sorting algorithms would have to sort the whole array before the top 3 most-borrowed tools could be selected. However, if the heap sort algorithm was used the sorting could have stopped after the three highest values were sorted. There were no challenges implementing the chosen algorithm as it was quite simple, and there are no bugs present.

### Pseudocode

```
ALGORITHM TopThree(A[0..n-1])
    // Given an array A containing the amount of times each tool has been borrowed,
    // returns the top three most-borrowed tools.
    topBorrowed  $\leftarrow$  []

    for  $i \leftarrow 0$  to  $n - 1$  do
        for  $j \leftarrow 0$  to 3 do
            if not topBorrowed[j] or  $A[i] > \text{topBorrowed}[j]$  do
                for  $x \leftarrow 2$  to  $j$  do
                    topBorrowed[x + 1]  $\leftarrow$  topBorrowed[x]

                topBorrowed[j]  $\leftarrow$  A[i]
                break

    return topBorrowed
```

### Algorithm description

This algorithm takes in an array  $A$  containing the number of borrows for each tool in the system. The algorithm then creates an array *topBorrowed* which will store the top three most-borrowed tools. Then it loops through each tool in the array  $A$  and iterates three times to check against each place in the *topBorrowed* array. Then, it checks if either there's nothing in the current place, or if the times the tool has been borrowed is greater than the tool in the *topBorrowed* array at the given place. If one of these things is the case, this tool will take the current place. To do this, the tools in the *topBorrowed* array from the current place to the end of the array are shifted down one place to make room for the new value. Then, the new value is inserted at the current place. The loop then breaks, since a place has been found for the tool. This repeats until all of the tools have been looped through, and then the *topBorrowed* array is returned.

### Efficiency analysis

#### Time complexity

Since the algorithm only loops through the tools once, it has a time complexity of  $O(n)$ . The basic operation in the algorithm is the comparison between  $A[i]$  and *topBorrowed*[j]. The worst case

scenario for this algorithm would be when every tool has the same or a lower borrowed amount than the last.

This would result in the basic operation not being called for the first tool, since the first element is null, the operation being called once for the second tool, since the second element is null, twice for the third tool since the third is null, and three times for every subsequent tool. Therefore, the time complexity of the algorithm is  $t(n) = 1 + 2 + 3 * ((n - 1) - 2)$ , which simplifies down to  $O(n)$ .

### Empirical analysis

For a sample worst-case scenario run of the algorithm, 5 tools were added to the system with the borrowed amounts being the same for each tool, and the implemented version of the algorithm was called with them as the input. The number of times the basic operation was called was then collected, giving a value of 9. Checking this against the formula  $t(n) = 1 + 2 + 3 * ((n - 1) - 2)$  gives  $1 + 2 + 3 * ((5 - 1) - 2) = 9$ , which matches. This confirms the time complexity of the algorithm being  $O(n)$ .

Further validation of the time complexity of the algorithm was done by creating a test program which calls an implementation of the algorithm for increasing amounts of tools. As visible in the graph below, the execution times collected from this program confirm that the algorithm is of linear complexity.

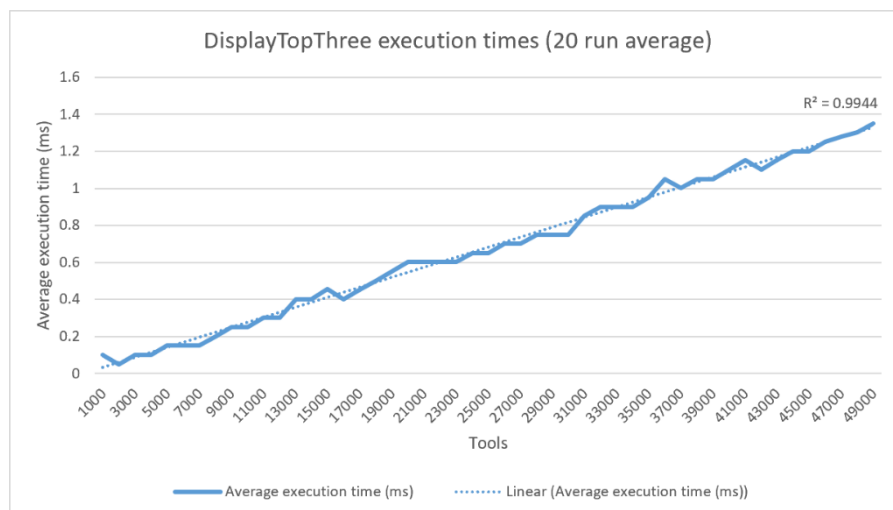


Fig 1: Execution times for the implemented top three algorithm

### Space efficiency

The only variable which is created and stored in this algorithm is the *topBorrowed* array. This means the algorithm has a constant space complexity, or a space complexity of  $O(1)$ .

## Software Test Plans and Test Results

### Unit Tests

A number of unit tests were made to confirm the functionality of the system programmatically. These unit tests consisted of testing all of the functions in the ToolLibrarySystem which involved modifying data. A screenshot of the results from these tests can be seen below. (Do I have to say more?)

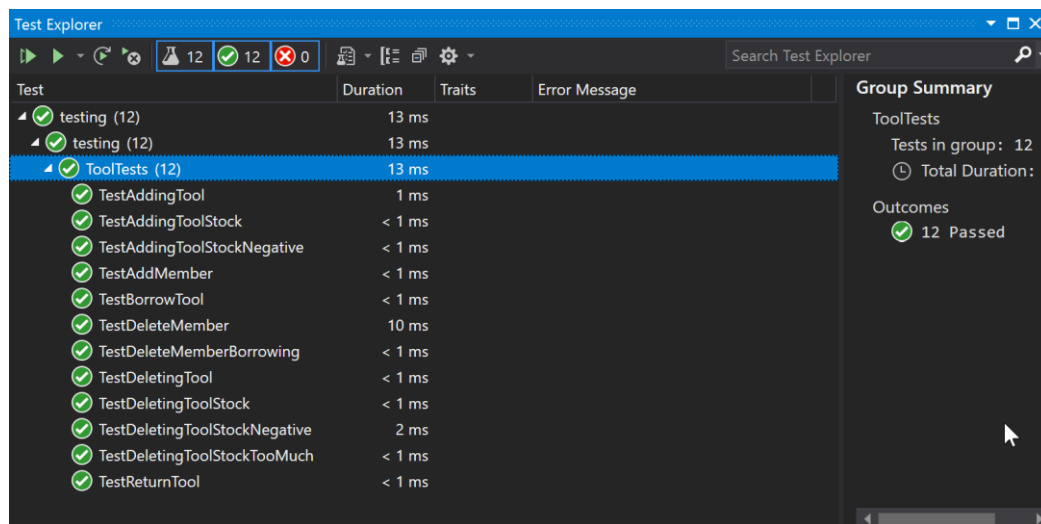


Fig 2: Results of unit tests

### Tests of functionality

Screenshots for each test scenario can be found in the appendix under Test Images.

Test scenario	Test data	Expected result	Result
<b>Menu pages</b>			
Staff login	Username: staff Password: today123	User is logged in as staff	Pass
Staff failed login	Username: staff Password: password	User is not logged in and a message is displayed	Pass
Member login	Username: KoyGrayson PIN: 1234	Member is logged in	Pass
Member login wrong username	Username: KovGrayson PIN: 1234	Member is not logged in and a message is displayed	Pass
Member login wrong PIN	Username: KoyGrayson PIN: 2549	Member is not logged in and a message is displayed	Pass
<b>Staff pages</b>			
Adding a new tool	Tool name: New tool Tool quantity: 10 Category: Gardening Tools Type: Lawn Mowers	The tool is added to the system	Pass
Adding tool stock	Category: Gardening Tools Type: Lawn Mowers Tool: New tool Additional stock: 12	The stock is added to the tool	Pass

Adding a negative amount of tool stock	Category: Gardening Tools Type: Lawn Mowers Tool: New tool Additional stock: -10	The stock is not added to the tool and a message is displayed	Pass
Removing tool stock	Category: Gardening Tools Type: Lawn Mowers Tool: New tool Stock to remove: 12	The stock is removed	Pass
Removing a negative amount of tool stock	Category: Gardening Tools Type: Lawn Mowers Tool: New tool Stock to remove: -10	The stock is not removed and a message is displayed	Pass
Removing too much tool stock	Category: Gardening Tools Type: Line Trimmers Tool: Bad Line Trimmer Stock to remove: 200	The stock is not removed and a message is displayed	Pass
Member registration	First name: Frank Last name: Walker Mobile number: 1300733000 PIN: 4832	The member is added	Pass
Member removal	User: Bob Jeff	The member is removed	Pass
Finding member contact phone number	First name: Grayson Last name: Koy	The member is found and their contact number is displayed	Pass
Finding member contact number with non-existent name	First name: Grayson Last name: Jeffingtons	The member is not found and a message is displayed	Pass
Going back to main menu		Goes back to the main menu	Pass
<b>Member pages</b>			
Display tools by category	Category: Gardening Tools Type: Line Trimmers	The tools in the selected category of the selected type are displayed	Pass
Borrow tool from library	Category: Gardening Tools Type: Line Trimmers Tool: Bad Line Trimmer	The tool is borrowed	Pass
Trying to borrow a tool when 3 are already borrowed		A message is displayed saying you cannot borrow any more tools	Pass
Borrowing the same tool more than once	Category: Gardening Tools Type: Line Trimmers Tool: Bad Line Trimmer	The tool is borrowed	Pass
Return tool to library	Tool: Bad Line Trimmer	The tool is returned	Pass
List borrowed tools		The member's borrowed tools are listed	Pass
List borrowed tools with no borrowed tools		A message saying that no tools have been borrowed is displayed	Pass

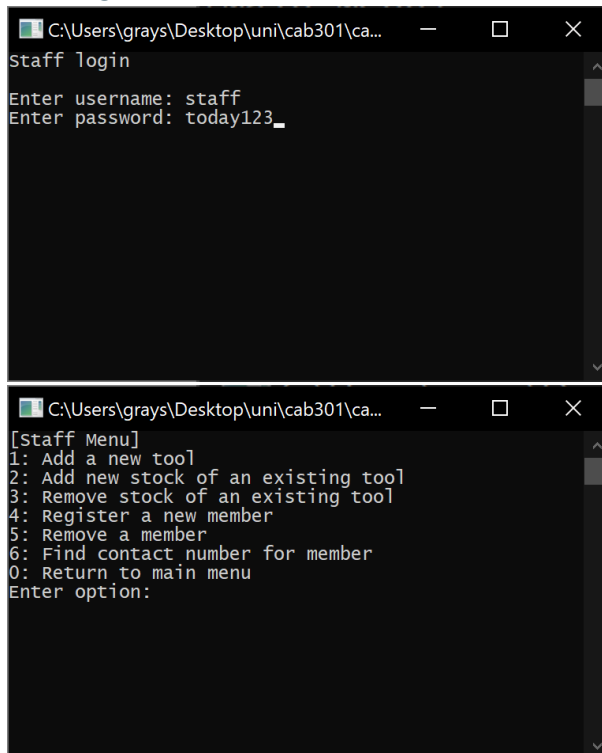


Display most frequently borrowed tools		The top 3 most frequently borrowed tools are displayed	Pass
Display most frequently borrowed tools when no tools have been borrowed		A message saying that no tools have been borrowed is displayed	Pass
Display most frequently borrowed tools when only 2 tools have been borrowed		The top 3 most frequently borrowed tools are displayed, with the third tool with no borrowings still being shown. (Check if this is what's supposed to happen)	Pass
<b>User input validation</b>			
Incorrect page is selected in menu	Page number: 4	A message is displayed telling the user to input a valid option, and input is requested again	Pass
Incorrect entry in list selector is selected	Selected index: 100	A message is displayed telling the user to input a valid option, and input is requested again	Pass
Entering a string into an int input	Int input: gdfdg	A message is displayed telling the user to input a valid number, and input is requested again	Pass
Entering a mobile number with letters when registering	Mobile number: 4239asadsd453	A message is displayed telling the user to input only numbers, and input is requested again	Pass
Entering a PIN of incorrect length when registering	PIN: 12345	A message is displayed telling the user to input a 4-digit pin, and input is requested again	Pass

## Appendix

### Test images

#### Staff login

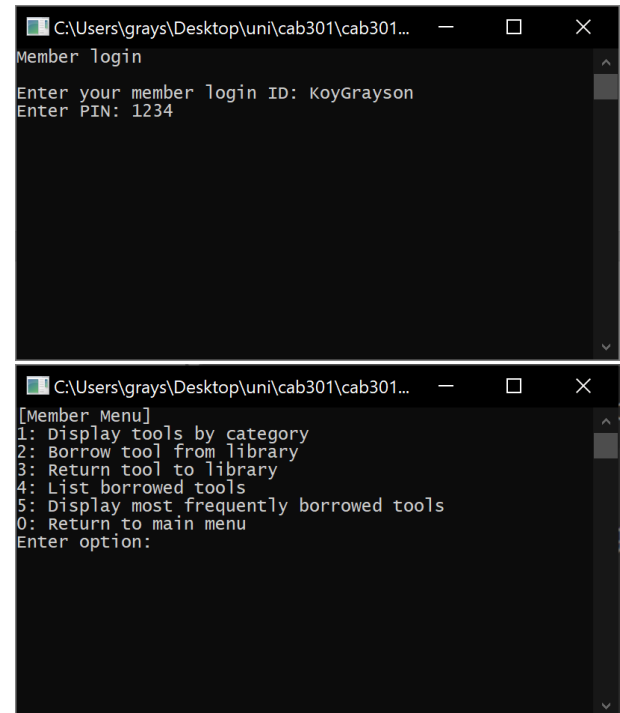


The first screenshot shows a terminal window titled "C:\Users\grays\Desktop\uni\cab301\ca..." with the text "staff login", "Enter username: staff", and "Enter password: today123\_". The second screenshot shows the same terminal window with the "[Staff Menu]" and a list of options: "1: Add a new tool", "2: Add new stock of an existing tool", "3: Remove stock of an existing tool", "4: Register a new member", "5: Remove a member", "6: Find contact number for member", and "0: Return to main menu". It ends with "Enter option:".

```
C:\Users\grays\Desktop\uni\cab301\ca...
staff login
Enter username: staff
Enter password: today123_

C:\Users\grays\Desktop\uni\cab301\ca...
[Staff Menu]
1: Add a new tool
2: Add new stock of an existing tool
3: Remove stock of an existing tool
4: Register a new member
5: Remove a member
6: Find contact number for member
0: Return to main menu
Enter option:
```

#### Member login

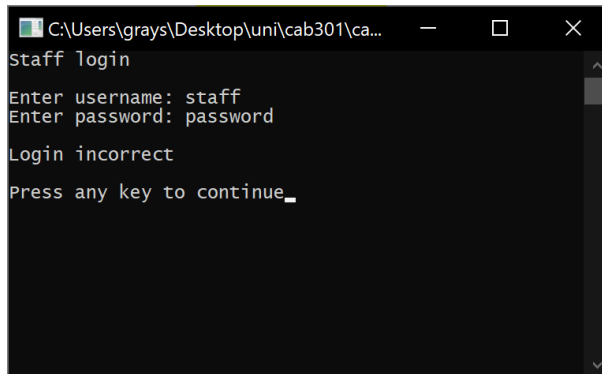


The first screenshot shows a terminal window titled "C:\Users\grays\Desktop\uni\cab301\cab301..." with the text "Member login", "Enter your member login ID: KoyGrayson", and "Enter PIN: 1234". The second screenshot shows the same terminal window with the "[Member Menu]" and a list of options: "1: Display tools by category", "2: Borrow tool from library", "3: Return tool to library", "4: List borrowed tools", "5: Display most frequently borrowed tools", and "0: Return to main menu". It ends with "Enter option:".

```
C:\Users\grays\Desktop\uni\cab301\cab301...
Member login
Enter your member login ID: KoyGrayson
Enter PIN: 1234

C:\Users\grays\Desktop\uni\cab301\cab301...
[Member Menu]
1: Display tools by category
2: Borrow tool from library
3: Return tool to library
4: List borrowed tools
5: Display most frequently borrowed tools
0: Return to main menu
Enter option:
```

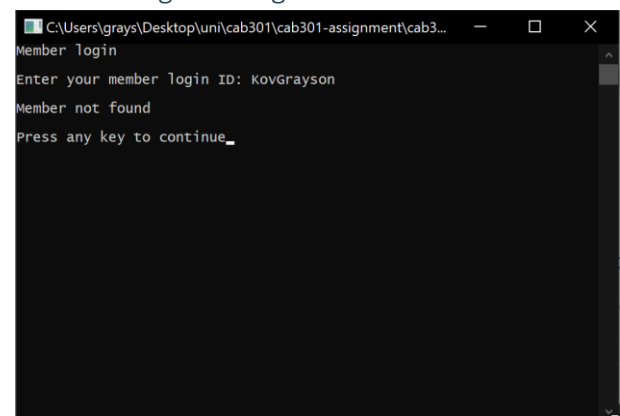
#### Staff failed login



The screenshot shows a terminal window titled "C:\Users\grays\Desktop\uni\cab301\ca..." with the text "staff login", "Enter username: staff", "Enter password: password", "Login incorrect", and "Press any key to continue\_".

```
C:\Users\grays\Desktop\uni\cab301\ca...
staff login
Enter username: staff
Enter password: password
Login incorrect
Press any key to continue_
```

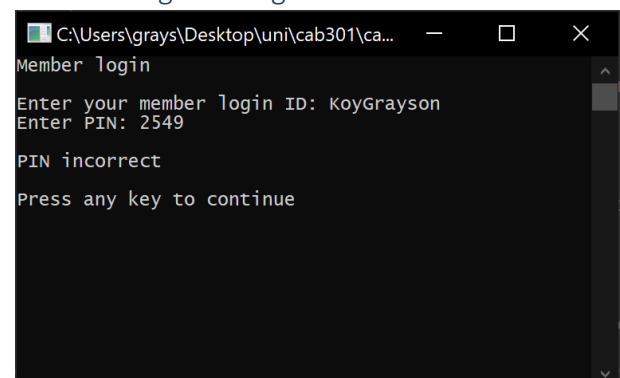
#### Member login wrong username



The screenshot shows a terminal window titled "C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab3..." with the text "Member login", "Enter your member login ID: kovGrayson", "Member not found", and "Press any key to continue\_".

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab3...
Member login
Enter your member login ID: kovGrayson
Member not found
Press any key to continue_
```

#### Member login wrong PIN



The screenshot shows a terminal window titled "C:\Users\grays\Desktop\uni\cab301\ca..." with the text "Member login", "Enter your member login ID: KoyGrayson", "Enter PIN: 2549", "PIN incorrect", and "Press any key to continue".

```
C:\Users\grays\Desktop\uni\cab301\ca...
Member login
Enter your member login ID: KoyGrayson
Enter PIN: 2549
PIN incorrect
Press any key to continue
```

### Adding a new tool

```
C:\Users\grays\Desktop\uni\cab301\cab301... - □ ×
Adding tool menu
Enter the name of the new tool (0 to exit): New tool
Enter the tool quantity: 10
Select tool category:
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
Tool category (0 to exit): 1
Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 2
Tool successfully added
Press any key to continue
```

### Adding a negative amount of tool stock

```
C:\Users\grays\Desktop\uni\cab301\cab301... - □ ×
Adding tool stock menu
Select tool category:
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
Tool category (0 to exit): 1
Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 2
Select tool to add stock for:
1. New tool - 22/22 available
Tool (0 to exit): 1
Enter the stock to add: -10
Please enter a valid amount
Enter the stock to add:
```

### Adding tool stock

```
C:\Users\grays\Desktop\uni\cab301\cab301... - □ ×
Select tool category:
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
Tool category (0 to exit): 1
Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 2
Select tool to add stock for:
1. New tool - 10/10 available
Tool (0 to exit): 1
Enter the stock to add: 12
12 stock added
Press any key to continue
```

### Removing tool stock

```
C:\Users\grays\Desktop\uni\cab301\cab301... - □ ×
Removing tool stock menu
Select tool category:
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
Tool category (0 to exit): 1
Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 2
Select tool to remove stock for:
1. New tool - 22/22 available
Tool (0 to exit): 1
Enter the stock to remove: 12
12 stock removed
Press any key to continue
```

## Removing a negative amount of tool stock

```
C:\Users\grays\Desktop\uni\cab301\cab301... — □ ×
Removing tool stock menu

Select tool category:
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
Tool category (0 to exit): 1

Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 2

Select tool to remove stock for:
1. New tool - 10/10 available
Tool (0 to exit): 1

Enter the stock to remove: -10
Please enter a valid amount
Enter the stock to remove:
```

## Removing too much tool stock

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301... - □ ×
Removing tool stock menu

Select tool category:
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
Tool category (0 to exit): 1

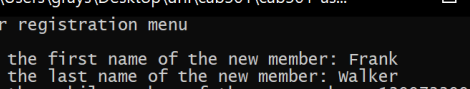
Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 1

Select tool to remove stock for:
1. Bad Line Trimmer - 100/100 available
2. Ultra Line Trimmer - 21/21 available
3. Luxury Line Trimmer - 47/47 available
4. Another Line Trimmer - 55/55 available
5. Unavailable Line Trimmer - 0/0 available
Tool (0 to exit): 1

Enter the stock to remove: 200
Quantity change for Bad Line Trimmer failed (removing too many)

Press any key to continue_
```

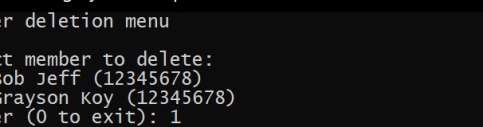
## Member registration



The screenshot shows a Windows command prompt window with the title bar "C:\Users\grays\Desktop\uni\cab301\cab301-as...". The window contains the following text:

```
Member registration menu  
Enter the first name of the new member: Frank  
Enter the last name of the new member: Walker  
Enter the mobile number of the new member: 1300733000  
Enter PIN: 4832  
Added member Frank walker (1300733000) successfully  
Press any key to continue
```

## Member removal



The screenshot shows a Windows command prompt window with the title bar "C:\Users\grays\Desktop\uni\cab301\ca...". The window contains the following text:

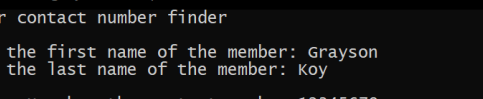
```
Member deletion menu

Select member to delete:
  1. Bob Jeff (12345678)
  2. Grayson Koy (12345678)
Member (0 to exit): 1

Deleted member Bob Jeff (12345678) successfully

Press any key to continue_
```

## Finding member contact phone number



```
C:\Users\grays\Desktop\uni\cab301\cab301-as...
Member contact number finder

Enter the first name of the member: Grayson
Enter the last name of the member: Koy

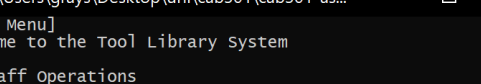
Grayson Koy has the contact number 12345678

Press any key to continue
```

## Finding member contact number with non-existent name

[illegible]

[Going back to main menu](#)



```
C:\Users\grays\Desktop\uni\cab301\cab301-as...
[Main Menu]
Welcome to the Tool Library System

1: Staff Operations
2: Member Operations
0: Exit Application
Enter option: _
```

## Display tools by category

```
C:\Users\grays\Desktop\uni\cab301\cab301-as...  -  □  X
Tool display menu
Select tool category:
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
Tool category (0 to exit): 1

Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 1

Tools in tool type 'Line Trimmers'
1. Bad Line Trimmer - 100/100 available
2. Ultra Line Trimmer - 21/21 available
3. Luxury Line Trimmer - 47/47 available
4. Another Line Trimmer - 55/55 available
5. Unavailable Line Trimmer - 0/0 available

Press any key to continue_
```

## Borrowing the same tool more than once

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab30...  -  □  X
Tool borrowing menu
Select tool category:
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
Tool category (0 to exit): 1

Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 1

Select tool to borrow:
1. Bad Line Trimmer - 99/100 available
2. Ultra Line Trimmer - 21/21 available
3. Luxury Line Trimmer - 47/47 available
4. Another Line Trimmer - 55/55 available
Tool (0 to exit): 1

Grayson Koy (12345678) borrowed tool Bad Line Trimmer successfully

Press any key to continue
```

## Borrow tool from library

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab30...  -  □  X
Tool borrowing menu
Select tool category:
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
Tool category (0 to exit): 1

Select tool type:
1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools
Tool type (0 to exit): 1

Select tool to borrow:
1. Bad Line Trimmer - 100/100 available
2. Ultra Line Trimmer - 21/21 available
3. Luxury Line Trimmer - 47/47 available
4. Another Line Trimmer - 55/55 available
Tool (0 to exit): 1

Grayson Koy (12345678) borrowed tool Bad Line Trimmer successfully

Press any key to continue_
```

## Return tool to library

```
C:\Users\grays\Desktop\uni\cab301\cab301-a...  -  □  X
Tool return menu
Select tool:
1. Bad Line Trimmer
Tool (0 to exit): 1

Tool 'Bad Line Trimmer' returned successfully

Press any key to continue_
```

## List borrowed tools

```
C:\Users\grays\Desktop\uni\cab301\cab301-a...  -  □  X
Borrowed tools for Grayson Koy (12345678)

Grayson Koy (12345678)'s borrowed tools
1. Bad Line Trimmer

Press any key to continue
```

## Trying to borrow a tool when 3 are already borrowed

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab30...  -  □  X
Tool borrowing menu

Cannot borrow any more tools

Press any key to continue_
```

## List borrowed tools with no borrowed tools

```
C:\Users\grays\Desktop\uni\cab301\cab301-a...  -  □  X
Borrowed tools for Grayson Koy (12345678)

Grayson Koy (12345678) is not borrowing any tools

Press any key to continue_
```

Display most frequently borrowed tools

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
Most frequently borrowed tools
Top 3 most frequently borrowed tools:
#1: Another Line Trimmer - 10 borrows
#2: Luxury Line Trimmer - 7 borrows
#3: Bad Line Trimmer - 4 borrows
Press any key to continue
```

Incorrect entry in list selector is selected

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
Tool display menu
Select tool category:
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
Tool category (0 to exit): 100
Please select a valid option
Tool category (0 to exit):
```

Display most frequently borrowed tools when no tools have been borrowed

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
Most frequently borrowed tools
No tools have been borrowed
Press any key to continue
```

Entering a string into an int input

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
Adding tool menu
Enter the name of the new tool (0 to exit): aaa
Enter the tool quantity: gdfdg
Please enter a valid number
Enter the tool quantity:
```

Display most frequently borrowed tools when only 2 tools have been borrowed

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
Most frequently borrowed tools
Top 3 most frequently borrowed tools:
#1: Bad Line Trimmer - 4 borrows
#2: Ultra Line Trimmer - 3 borrows
#3: Luxury Line Trimmer - 0 borrows
Press any key to continue
```

Entering a mobile number with letters when registering

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
Member registration menu
Enter the first name of the new member: jeff
Enter the last name of the new member: jeff
Enter the mobile number of the new member: 4239asadsd453
Please enter only numbers
Enter the mobile number of the new member:
```

Incorrect page is selected in menu

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
[Main Menu]
Welcome to the Tool Library System
1: Staff Operations
2: Member Operations
0: Exit Application
Enter option: 4
Please select a valid option
Enter option:
```

Entering a PIN of incorrect length when registering

```
C:\Users\grays\Desktop\uni\cab301\cab301-assignment\cab301-assignment.exe
Member registration menu
Enter the first name of the new member: jeff
Enter the last name of the new member: jeff
Enter the mobile number of the new member: 1234567890
Enter PIN: 12345
Only 4-digit pins are allowed
Enter PIN:
```