# Tool Library Application

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CAB301 – Applied Project

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# Contents

# Introduction

The project teams were hired to develop a Tool-Library software system for a small not for profit organisation. It will be used to store information on members of the organisation and the tools the organisation has available to loan; along with providing an interface to manage members and loan/return tools.

This report will outline the design of the more sophisticated algorithms in the package, analyse their effectiveness and provide evidence of the rigorous testing that was undergone so the end users have documentation and peace of mind now, and into the future.

# Algorithm Design

## Merge Sort

The merge sort is made up of two algorithms, one which splits and compares the array ( *mergeArrs()* ), and one which recursively calls the splitting algorithm ( *mergeSort()* ).

$\boldsymbol{ALGORITHM}\ mergeArrs(inputArray, leftIndex, rightIndex, middleIndex)$

$//Given\ Array\ A, splits\ array, compares\ split\ arrays\ and\ merges\ them\ in\ sorted\ order$

$Len1 \leftarrow middleIndex - leftIndex + 1$

$Len2 \leftarrow rightIndex - middleIndex$

$leftArray = new\ A[0 \ldots Len1]$

$rightArray = new\ A[0 \ldots Len1]$

$\boldsymbol{for}\ i\ \leftarrow 1\ to\ len1\ \boldsymbol{do}$

$\quad leftArray[i] = inputArray[leftIndex + i]$

$\boldsymbol{for}\ j\ \leftarrow 1\ to\ len1\ \boldsymbol{do}$

$\quad rightArray[j] = inputArray[middleIndex\ + j\ + 1]$

$i, j\ \leftarrow 0$

$k = leftIndex$

$\boldsymbol{while}\ i < Len1\ \boldsymbol{and}\ j < Len2$

$\quad \boldsymbol{if}\ leftArray[i]\ \boldsymbol{comes\ before}\ rightArray[i]$

$\quad\quad inputArray[k]\ \leftarrow leftArray[i]$

$\quad\quad i\ \leftarrow i + 1$

$\quad \boldsymbol{else}$

$\quad\quad inputArray[k]\ \leftarrow rightArray[i]$

$j \leftarrow j + 1$

**while** $i < Len1$

$inputArray[k] \leftarrow leftArray[i]$

$i \leftarrow i + 1$

$k \leftarrow k + 1$

**while** $j < Len2$

$inputArray[k] \leftarrow rightArray[j]$

$j \leftarrow j + 1$

$k \leftarrow k + 1$

**ALGORITHM** $MergeSort(inputArray, leftIndex, rightIndex)$

$//recursively\ breakdown\ and\ compare\ each\ sub\ array\ in\ the\ input\ array$

$//\ and\ merge\ them\ together\ in\ sorted\ order$

**if** $leftIndex < rightIndex$

$middleIndex = leftIndex + (rightIndex - leftIndex)/\ 2$

**mergeSort**$(inputArray, leftIndex, middleIndex)$

**mergeSort**$(inputArray, middleIndex, rightIndex)$

**mergeArrs**$(inputArray, leftIndex, rightIndex, middleIndex)$

**return** $inputArray$

## Binary Search

Binary search recursively breaks an array down into smaller and smaller sub arrays, constantly moving toward the desired value.

**ALGORITHM** $binarySearch(\ inputArray[], leftIndex, rightIndex, searchTerm)$

$//\ Find\ index\ of\ "searchTerm"\ in\ inputArray$

**if** $rightIndex \geq leftIndex$

$middleIndex = leftIndex + (rightIndex - 1)\ /\ 2$

**if** $inputArray[middleIndex] = searchTerm$

**return** $middleIndex$

**else if** $inputArray[middleIndex] < searchTerm$

**return** $binarySearch(inputArray[], leftIndex, middleIndex - 1, searchTerm)$

**else if** $inputArray[middleIndex] > searchTerm$

$$\boldsymbol{return}\ binarySearch(inputArray[], middleIndex, rightIndex\ searchTerm)$$

$\boldsymbol{return} -1\ \ //searchTerm\ not\ in\ List$

### Displaying top Three Most Borrowed Tools

To Display the top three most borrowed tools, the tool collection is sorted (see above definition of merge sort) by the amount of time each tool has been borrowed. The first 3 elements in this sorted array are then displayed.

$\boldsymbol{ALGORITHM}\ topThreeTools()$

$//\ Returns\ the\ top\ three\ most\ used\ tools$

$toolCollectionArray \leftarrow An\ array\ of\ all\ tool\ objects\ in\ the\ tool\ collection\ object$

$\boldsymbol{for}\ i \leftarrow 0\ \boldsymbol{to}\ 2$

$\boldsymbol{output}$ "#" $+ (\boldsymbol{i} + \boldsymbol{1})$
$+$ ": " $\boldsymbol{mergeSort}(toolCollectionArray, 0, Length\ of\ toolCollectionArray)[\boldsymbol{i}]$

## Algorithm Analysis

### Merge Sort

### Binary Search

For each iteration of the binary search, the array is split into a sub array that is half the size of the parent array. This can be modelled as:

$$len\ of\ array\ after\ "i"\ \ numberof\ iterations = \frac{n}{2^i}$$

After the program has finished all iterations, we know that the length of the array will be equal to one.

$$Therefore: 1 = \frac{n}{2^i}$$

We can the rearrange:

$$2^i = n$$

$$\log_2(n) = \log_2(2^i)$$

$$i = \log_2(n)$$

Therefore, the time complexity of the binary search algorithm can be modelled as:

$$O(n) = \log_2(n)$$

### Displaying top Three Most Borrowed Tools

This method uses a single for loop which is know to be

$$O(n)$$

The loop always iterates only three times, which can be modelled as:

# Software Test Plan

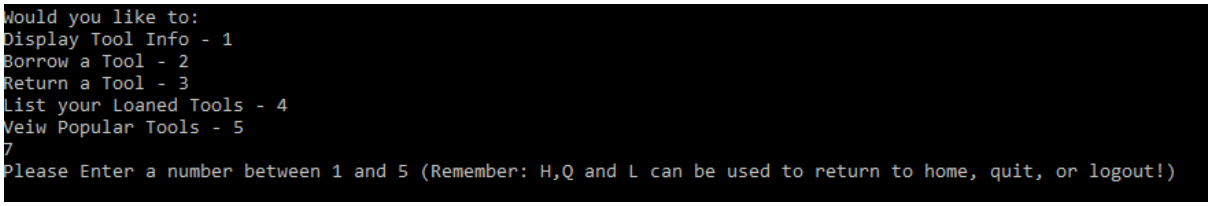
- Test plan is comprehensive – screenshots of all possible use cases for each of the functionalities
- Actual test data can be viewed from the screenshots
- Actual test results can be viewed from the screenshots

In order to fully test the software, all aspects were tested thoroughly. Each sub item in each menu has been tested with both valid and invalid data to ensure that the software never errors out, or functions incorrectly.

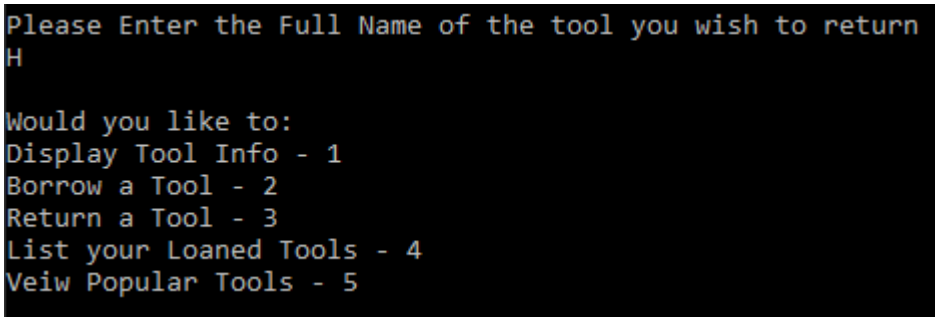
## Test Results

### Menu Input

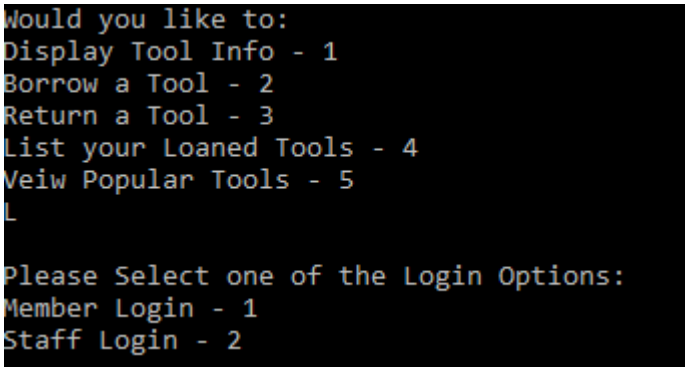
*Invalid Number*




*Return to Main Menu*




*Logout*




*Quit*

Cant be displayed with a screenshot as the program closes!

## Login

### *Correct Login*

#### Member

```
Please Select one of the Login Options:
Member Login - 1
Staff Login - 2
1
Please Enter your Username:
Matt
Please Enter your Password:
Winsen

Would you like to:
Display Tool Info - 1
Borrow a Tool - 2
Return a Tool - 3
List your Loaned Tools - 4
Veiw Popular Tools - 5
```

#### Staff

```
Please Select one of the Login Options:
Member Login - 1
Staff Login - 2
2
Please Enter your Username:
staff
Please Enter your Password:
today123

Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
```

### *Incorrect Login*

```
Please Enter your Username:
staff
Please Enter your Password:
today
Username Inncorrect, Please try again
Please Enter your Username:
```

## Member Menu

### *Display Tool Info*

```
Would you like to:
Display Tool Info - 1
Borrow a Tool - 2
Return a Tool - 3
List your Loaned Tools - 4
Veiw Popular Tools - 5
7
Please Enter a number between 1 and 5 (Remember: H,Q and L can be used to return to home, quit, or logout!)
1
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
4
Select Tool Type

1. Sanding Tools
2. Brushes
3. Rollers
4. Paint Removal Tools
5. Paint Scrapers

4
No Tools of this Type found, please try again.

Would you like to:
Display Tool Info - 1
Borrow a Tool - 2
Return a Tool - 3
List your Loaned Tools - 4
Veiw Popular Tools - 5
```

Note, no tools were found as no tools of the given category/type were added to the system

*Borrow Tool*

```
Would you like to:
Display Tool Info - 1
Borrow a Tool - 2
Return a Tool - 3
List your Loaned Tools - 4
Veiw Popular Tools - 5
2
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
1
Select Tool Type

1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools

4
Please Enter the Full Name of the tool you wish to loan
Test
Search Failed, please try again
Tool with name "Test" does not exist. Please try again
Test1
Search Failed, please try again
Tool with name "Test1" does not exist. Please try again
Test18
Search Failed, please try again
Tool with name "Test18" does not exist. Please try again
Test3
Tool Loaned!
```

Note the error handing when user entered a tool that did not exist in the system.

*Return Tool*

```
Would you like to:
Display Tool Info - 1
Borrow a Tool - 2
Return a Tool - 3
List your Loaned Tools - 4
Veiw Popular Tools - 5
3
Please Enter the Full Name of the tool you wish to return
Test18
Search Failed, please try again
Tool with name "Test18" does not exist. Please try again
Test3
Tool Returned!
```

Again, note the error handing when user entered a tool that did not exist in the system.

*List Loaned Tools*

```
Would you like to:
Display Tool Info - 1
Borrow a Tool - 2
Return a Tool - 3
List your Loaned Tools - 4
Veiw Popular Tools - 5
4
Currently loaned tools are:
Tool Slot 0:
Name: Test3
Available Quantity(Out of Total Quantity: 4/4
Borrowed #: 1

Tool Slot 1: Empty
Tool Slot 2: Empty
```

Only one tool was loaned at this point.

*View Popular Tools*

```
Top Three Most Used Tools Are:

#0 Name: Test3
Available Quantity(Out of Total Quantity: 4/4
Borrowed #: 1

#1 Name: Test5
Available Quantity(Out of Total Quantity: 19/19
Borrowed #: 0

#2 Name: Test6
Available Quantity(Out of Total Quantity: 7/7
Borrowed #: 0

Would you like to:
Display Tool Info - 1
Borrow a Tool - 2
Return a Tool - 3
List your Loaned Tools - 4
Veiw Popular Tools - 5
```

Note, only one tool had been loaned at this time

## Staff Menu

*Adding Tool*

```
Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
1
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
1
Select Tool Type

1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools

4
Please Enter the Following details about the Tool:
Name:
Green Wheelbarrow
Quantity:
4
Success

Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
```

*Adding Tool Quantity*

```
Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
2
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
1
Select Tool Type

1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools

4
Please Enter Name of the Tool:
Green Wheelbarrow
Quantity to Add:
6
Success
```

*Remove Tool Quantity*

```
Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
3
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
1
Select Tool Type

1. Line Trimmers
2. Lawn Mowers
3. Hand Tools
4. Wheelbarrows
5. Garden Power Tools

4
Please Enter Name of the Tool:
Green Wheelbarrow
Quantity to Remove:
1
Success

Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
```

*Add a Member*

```
Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
4
Please Enter the Following details about the Member:
First Name:
Jeff
Last Name:
Jefferson
Phone #:
0481888415
PIN:
5555
Member Added Succesufully
```

*Get Members Contact Details:*

```
Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
6
Please Enter the Following details about the Member:
First Name:
Jeff
Last Name:
Jefferson
Firstname: Jeff
Lastname: Jefferson
Phone #: 0481888415
```

*Remove Member*

```
Would you like to:
Add a New Tool - 1
Add new Pieces of a Tool - 2
Remove Pieces of a Tool - 3
Regeister a Member - 4
Remove a Member - 5
Get Members Contact Info - 6
5
Please Enter the Following details about the Member:
First Name:
Jeff
Last Name:
Jefferson
Member Removed Succesufully
```