

## CAB301 Algorithms and Complexity

### Assignment 1 – Community library manage application for DVDs

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**Section 1. an algorithm that you designed for implementing the function  
“Display the top 10 most frequently borrowed movie DVDs by the members  
in the descending order of the frequency”**

**1. ALGORITHM** BSTtoArray(Root)

*//Convert the Binary Search Tree to Array recursively*

*//Input: Current BST node which can be a root*

*//Output: An array which contains the item of each nodes*

movieArray <- New Empty Movie Array

index <- 0

**IF** root is not null

**If** the left child of root is not null

        BSTtoArray(Left child, movieArray)

    Array[index] = root.Item

    index <- index + 1

**If** the right child of root is not null

        BSTtoArray(Right child, movieArray)

**Return** movieArray

**2. ALGORITHM** sortedMovieToBST(Array, Start, End)

*//Input: An array which has sorted items of movie DVDs, start point and end point to operate.*

*//Output: Return the sorted binary search tree with same order of the input array*

**If** start > end

**Return** null

Tree <- new node of binary search tree with the value of array[start]

Tree.right <- sortedMovieToBST(array, start + 1, end)

**Return** tree

### 3. **ALGORITHM** Top10inOrder(Root)

*//Input: the tree of the MovieCollection*

*//Output: Print out binary search tree*

**If** (root == null) return null

Top10inOrder(root.left) *// Go to left child*

print detail of item of DVD

Top10inOrder(root.right) *// Go to right child*

### 4. **ALGORITHM** quickSort(Array, Start, End)

*//Input: The array of Movie from converting Binary Tree and start point and end point of sorting*

*//Output: Sorted array by descending order*

**If** start < end

Pivot <- the return value of function for partition(Array, start, end)

quickSort (array, start, pivot - 1) *// call the method for operating left side of tree*

quickSort (array, pivot + 1, end) *// call the method for operating right side of tree*

### **ALGORITHM** partition(Array, start, end)

*//Input: An array to store the value after sorting by descending order, start point and end point to sort.*

*//Output: Inclusive index of array to scan and swap the next value of array*

pivotVal <- The number of times to get borrowed from the last value of array

s <- (start point - 1)

**for** start **to** end **do**

*// If the time of rented is smaller than the value in the location of pivot*

**if** the number of times to get borrowed from array[i] >= pivotVal

s = (s + 1)

```

        swap array[s] and array[i]
    swap array[s + 1] and array[end]
    return s + 1

```

## Section 2. analysis of the time complexity of the algorithm

### *Time Complexity 1. BSTtoArray*

The number of sub problem is 2 which is  $a$ , the size of depth is  $\frac{n}{2}$  and the cost of work on outside of recursive is  $C$  which is the size of array and index.

As the Master's Theorem,

$$n^{\log_b a} = n^{\log_2 2} = n$$

$$T(n) = 2T\left(\frac{n}{2}\right) + C = O(n)$$

Hence, the time complexity is  $O(n)$ .

### *Time Complexity 2. sortedMovieToBST*

Let the size of the given array is  $n$ , the number of sub problem is 1 which is  $a$  and the size of sub problem is  $n - 1$ .

So, it is same as worst case of Quick sort,

$$\begin{aligned}
 T(n) &= T(n - 1) + C \\
 &= T(n - 2) + T(n - 1) + C \\
 &= T(n - 3) + T(n - 2) + T(n - 1) + C \\
 &\quad \dots \\
 &= T(0) + n * \frac{n + 1}{2} \\
 &= O(n^2)
 \end{aligned}$$

### *Time Complexity 3. Top10inOrder*

It is depth first traversal. Let the size of depth is  $\frac{n}{2}$  as it is binary search tree, the number

of sub problem is 2 and the constant times which needs to take when it prints out or move the root to left or right is  $C$ .

It is same with above proof for BSTtoArray method. Hence,

$$T(n) = 2T\left(\frac{n}{2}\right) + C = O(n)$$

*Time Complexity 4. quicksort and partition*

Best Time Complexity:  $\theta(n \log_2 n)$

Average Time Complexity:  $O(n \log_2 n)$  or  $C_{avg}(n) \in \theta(n \log n)$

Let the execution time is  $T(n)$  when the given array which contains number of item ( $Array[n]$ ) and the time of comparison is  $n$  before calling a recursion function, so,  $S(n) = n$ . The recursive function will be break when the items in array is smaller than 1, it can be represented when  $n^h = 1$ , the recursive function will not be called anymore. Hence,

$$h = \log_2 n, T(n) = O(n \log_2 n)$$

Or it can be represented like below as well.

When the pivot value can split the array with same lengths which can be represented as  $\frac{n}{2}$  and the constant times for storing the sorted values into other array and partitioning which is  $n$ . When  $k = \log_2 n$ ,

$$\begin{aligned} T(n) &= 2T(n/2) + n \\ &= 2\left(2T\left(\frac{n}{2}\right) + \frac{n}{2}\right) + n \\ &= 2^2\left(T\left(\frac{n}{2^2}\right)\right) + n + n \\ &\quad \dots \\ &= 2^k T\left(\frac{n}{2^k}\right) + n \\ &= nT\left(\frac{n}{n}\right) + n \log n \\ &= nT(1) + n \log_2 n \\ &= O(n \log_2 n) \end{aligned}$$

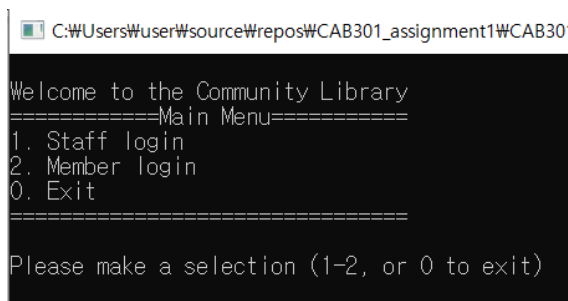
Worst time complexity:  $O(n^2)$  or  $C_{worst}(n) \in \theta(n^2)$

The worst cases of time complexity are when the data is already sorted by ascending or descending order when the data is given. So,

$$\begin{aligned}T(n) &= T(n-1) + C \\&= T(n-2) + T(n-1) + C \\&= T(n-3) + T(n-2) + T(n-1) + C \\&\dots \\&= T(0) + n * \frac{n+1}{2} \\&= O(n^2)\end{aligned}$$

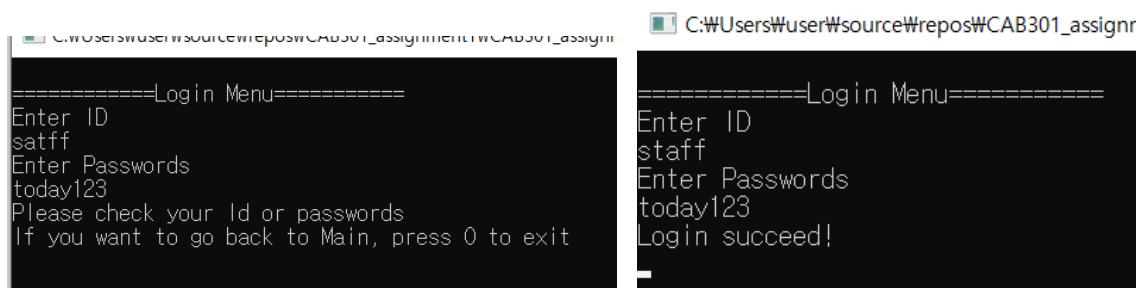
### Section 3. your functional testing results - screenshots for each of the functional tests.

#### <Main>



```
C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
Welcome to the Community Library
=====Main Menu=====
1. Staff login
2. Member login
0. Exit
=====
Please make a selection (1-2, or 0 to exit)
```

#### 1. Staff Login



```
C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Login Menu=====
Enter ID
staff
Enter Passwords
today123
Please check your Id or passwords
If you want to go back to Main, press 0 to exit

C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Login Menu=====
Enter ID
staff
Enter Passwords
today123
Login succeed!
```

As the Id of staff is 'staff' and the passwords of staff is 'today123', if staff entered different values, it shows error message on screen.

## 2. Staff Menu

```
C:\Users\User\source\repos\CAB301_assignment1\CAB301

=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====

Please make a selection (1-4, or 0 to exit)
```

### 2.1 Add movie

```
C:\Users\User\source\repos\CAB301_assignment1\CAB301

=====
Please make a selection (1-4, or 0 to exit)
1
Enter Title:
a
Enter Starring:
a
Enter Director:
arin
Choose Genre by number:
1. Drama
2. Adventure
3. Family
4. Action
5. Sci-Fi
6. Comedy
7. Animated
8. Thriller
9. Others
e
Sorry, the selection has to be a number
Choose Genre by number:
```

```
C:\Users\User\source\repos\CAB301_assignment1\CAB

Enter Starring:
a
Enter Director:
arin
Choose Genre by number:
1. Drama
2. Adventure
3. Family
4. Action
5. Sci-Fi
6. Comedy
7. Animated
8. Thriller
9. Others
e
Sorry, the selection has to be a number
Choose Genre by number:
1
Choose Classification by number:
1. G
2. PG
3. M15+
4. MA15+
```

```
C:\Users\User\OneDrive\바탕 화면\CAB301_assignment1\CA

=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====

Please make a selection (1-4, or 0 to exit)
1
Enter Title:

Please enter the title
Enter Title:
```

If the staff puts empty value for title, it shows error message. However, the other thing for starring and director can be empty spaces or null value.

C:\Users\User\source\repos\CAB301\_assignment1\CAB:

```
arin
Choose Genre by number:
1. Drama
2. Adventure
3. Family
4. Action
5. Sci-Fi
6. Comedy
7. Animated
8. Thriller
9. Others
0
Sorry, the selection has to be a number
Choose Genre by number:
1
Choose Classification by number:
1. G
2. PG
3. M15+
4. MA15+
0
Sorry, the selection has to be a number
Choose Classification by number:
2
```

C:\Users\User\OneDrive\바탕 화면\CAB301\_assignment1\W

```
1. Drama
2. Adventure
3. Family
4. Action
5. Sci-Fi
6. Comedy
7. Animated
8. Thriller
9. Others
0
Sorry, the selection has to be a number
Choose Genre by number:
1
Choose Classification by number:
1. G
2. PG
3. M15+
4. MA15+
0
Sorry, the selection has to be a number
Choose Classification by number:
2
Enter Duration:

```

If the input is 0 or out of the given index of chooser, it shows error message to confirm the correct input my user.

```
1
Enter Duration:
d
Sorry, the duration has to be a number
Enter Duration:
2
Enter Released date:
1
Enter the number of copies:
d
Sorry, the number of copies has to be a number
Enter the number of copies:
1
Current DVDs in thie library are...

Title: A
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 4
Copies Available: 3
Times rented: 0

Title: ad
Starring: ad
Director: ad
Genre: 1. Drama
Classification: 1. G
Duration: 2
Released date: 2
Copies Available: 5
Times rented: 0

```

```
C:\Users\User\OneDrive\바탕 화면
Duration: 2
Released date: 2
Copies Available: 2
Times rented: 0

Title: A
Starring: a
Director: a
Genre: 1. Drama
Classification: 1. G
Duration: 1
Released date: 1
Copies Available: 1
Times rented: 0

Title: B
Starring: b
Director: b
Genre: 2. Adventure
Classification: 2. PG
Duration: 2
Released date: 2

C:\Users\User\OneDrive\바탕 화면\CAB301_assignment
2. PG
3. M15+
4. MA15+
1
Enter Duration:
2
Enter Released date:
2
Enter the number of copies:
5
Current DVDs in this library are...

Title: a
Starring: a
Director: a
Genre: 1. Drama
Classification: 1. G
Duration: 2
Released date: 2
Copies Available: 7
Times rented: 0

Please press any key to exit
```

As this application is working with depending on title, if the title of movie is same with the movie which has been already stored, even the other datas are not matched with new one and previous one, it added under the same title with inputing numbers of copies by user.



## 2.2 Remove a movie

```
C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1W\
Title: B
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 1
Copies Available: 3
Times rented: 0

Title: C
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 6
Copies Available: 5
Times rented: 0

Title: D
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 1
Copies Available: 3
Times rented: 0

Title: E
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 4
Copies Available: 3
Times rented: 0

Select movie to remove
Please enter the title of movie to remove
arin
Sorry, the title is incorrect. Please check the title
Please press any key to exit
```

```
Title: E
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 4
Copies Available: 3
Times rented: 0

Select movie to remove
Please enter the title of movie to remove
C
Please press any key to exit
```

As every searching is depends on title, if the title input is unmatched with any items of list, it shows error message. If it is successfully deleted, it just shows the message to exit.

## 2.3 Register a new member

```
C:\Users\User\source\repos\CAB301_assignment1\CAB3
=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====
Please make a selection (1-4, or 0 to exit)
Enter First Name:
A
Enter Last Name:
b
Enter Passwords by 4 digits:
2
Sorry, the passwords has to be 4 digits
Enter Passwords by 4 digits:
```

```
C:\Users\User\source\repos\CAB301_assignment1\CAB3
=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====
Please make a selection (1-4, or 0 to exit)
Enter First Name:
A
Enter Last Name:
b
Enter Passwords by 4 digits:
2
Sorry, the passwords has to be 4 digits
Enter Passwords by 4 digits:
df
Sorry, the passwords has to be 4 digits
Enter Passwords by 4 digits:
```

```

C:\Users\User\source\repos\CAB301_assignment1\CAB301_
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====
Please make a selection (1-4, or 0 to exit)
Enter First Name:
A
Enter Last Name:
b
Enter Passwords by 4 digits:
2
Sorry, the passwords has to be 4 digits
Enter Passwords by 4 digits:
df
Sorry, the passwords has to be 4 digits
Enter Passwords by 4 digits:
0000
Enter Address:
none
Choose Phone Number:
none
Please press any key to exit

```

The Address and Phone number do not have any requirement to enter. Both are can be digits or any strings.

```

C:\Users\User\source\repos\CAB301_assignment1\CAB301_a
=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====
Please make a selection (1-4, or 0 to exit)
3
Enter First Name:
a
Enter Last Name:
a
Enter Passwords by 4 digits:
0000
Enter Address:
a
Choose Phone Number:
a
Sorry, we cannot hold over 10 members :(
Please press any key to exit

```

If staff tried to register 11<sup>th</sup> member, it shows error message as this application cannot hold more than 10 members.

```

C:\Users\User\source\repos\CAB301_assignment1\CAB301_
=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====
Please make a selection (1-4, or 0 to exit)
3
Enter First Name:
A
Enter Last Name:
s
Enter Passwords by 4 digits:
0000
Enter Address:
2
Choose Phone Number:
2
This member is already registered
Please press any key to exit

```

If the staff tries to register the member who has same name with registered member, it shows error message at the end of registration.

## 2.4 Find a member's phone number

```

C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====
Please make a selection (1-4, or 0 to exit)
Enter first name:
A
Enter last name:
b
Contact number of A b is none
Please press any key to exit

C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Staff Menu=====
1. Add a new movie
2. Remove a movie
3. Register a new member
4. Find a registered member's phone number
0. Return to main menu
=====
Please make a selection (1-4, or 0 to exit)
Enter first name:
B
Enter last name:
b
Cannot find member detail, please check the name
Please press any key to exit

```

To get the member's phone number, the staff has to enter the correct first and last name of member. As the phone number does not care it is digits or string when the member was registered, it can be shown with any format such as 'none' like above.

### 3 Member login – This member's Id is Ab and passwords is 0000

```

C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Login Menu=====
Enter ID (ID is your FirstnameLastname)
Ab
Enter Passwords
0000
Login succeed!

C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Login Menu=====
Enter ID (ID is your FirstnameLastname)
A
Enter Passwords
c
Please check your Id or passwords
If you want to go back to Main, press 0 to exit

```

If the passwords are not digits or lesser than 4 digits, it show error messages on the screen.

## 4 Member menu

### 4.1 Display all movies with alphabetical order

```

C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
1
B b arin 2. Adventure 3. M15+ 24/May 1 0
Please press any key to exit

```

```

3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
1
A a d 3. Family 1. G 24/May 1 0
B b d 1. Drama 1. G 24/May 1 0
C c d 8. Thriller 3. M15+ 24/May 1 0
D d d 6. Comedy 3. M15+ 24/May 1 0
E e d 6. Comedy 1. G 24/May 1 0
F f d 3. Family 2. PG 24/May 1 0
G g d 6. Comedy 1. G 24/May 1 0
O o d 1. Drama 3. M15+ 24/May 1 0
P p d 3. Family 2. PG 24/May 1 0
Q q d 8. Thriller 2. PG 24/May 1 0
R r d 6. Comedy 3. M15+ 24/May 1 0
T t d 1. Drama 2. PG 24/May 1 0
V v d 1. Drama 1. G 24/May 1 0
W w d 1. Drama 1. G 24/May 1 0
Please press any key to exit

```

C:\Users\User\source\repos\CAB301\_assignment1\CAB301\_

```

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
1
Title: A
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 4
Copies Available: 3
Times rented: 0

Title: ad
Starring: ad
Director: ad
Genre: 1. Drama
Classification: 1. G
Duration: 2
Released date: 2
Copies Available: 5
Times rented: 0

Title: B
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: 1
Copies Available: 3
Times rented: 0

```

These above pictures are for showing the alphabetical ordering in this application. When you run this, it will show like the picture of left.

## 4.2 Borrow a DVD

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====

Please make a selection (1-5, or 0 to exit)
B b arin 2. Adventure 3. M15+ 24/May 1 0
Select movie to borrow
Please enter the title of movie to borrow
_
```

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====

Please make a selection (1-5, or 0 to exit)
B b arin 2. Adventure 3. M15+ 24/May 1 0
Select movie to borrow
Please enter the title of movie to borrow
B
B has been borrowed!
Please press any key to exit
```

Before borrowing, the number of copies in this library is 1 and the times of borrowed is 0.

```
C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====

Please make a selection (1-5, or 0 to exit)
2
B b arin 2. Adventure 3. M15+ 24/May 1 0
Select movie to borrow
Please enter the title of movie to borrow
g
Sorry, the title is incorrect. Please check the title
```

When borrowing a DVD, the user must enter the correct title as every searching method in this application is running under the condition with the title and name except display top 10 function.

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====

Please make a selection (1-5, or 0 to exit)
B b arin 2. Adventure 3. M15+ 24/May 0 1
Please press any key to exit
```

After the DVD with title 'B' is borrowed by user, we can see the current copy in this library is turning to 0 and times of borrowed is 1.

```

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====

Please make a selection (1-5, or 0 to exit)
B b arin 2. Adventure 3. M15+ 24/May 0 1
Select movie to borrow
Please enter the title of movie to borrow
B
Sorry, you already have borrowed this DVD
Please press any key to exit

```

If the user tries to borrow the same movie, it shows error as the user cannot borrow same two DVDs at a time.

```

=====
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====

Please make a selection (1-5, or 0 to exit)
A s d 1. Drama 2. PG r 0 1
B s d 1. Drama 2. PG r 0 1
C s d 1. Drama 2. PG r 0 1
D s d 1. Drama 2. PG r 0 1
E s d 1. Drama 2. PG r 0 1
F s d 1. Drama 2. PG r 0 1
G s d 1. Drama 2. PG r 0 1
H s d 1. Drama 2. PG r 0 1
I s d 1. Drama 2. PG r 0 1
J s d 1. Drama 2. PG r 0 1
K s d 1. Drama 2. PG r 1 0
L s d 1. Drama 2. PG r 1 0
Select movie to borrow
Please enter the title of movie to borrow
K
Sorry, you cannot borrow over 10 DVDs
Please press any key to exit

```

When the user tries to borrow the movie DVDs over 10, it shows error message.

### 4.3 Return a DVD

C:\Users\user\source\repos\CAB301\_Assignment1\src\CAB301\_Assignment1

```

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
B b arin 2. Adventure 3. M15+ 24/May 0 1
Select movie to return
Please enter the title of movie to return
B
B has been returned!
Please press any key to exit

```

```

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
T t d 1. Drama 2. PG 24/May 0 2
Select movie to return
Please enter the title of movie to return
g
Sorry, the title is incorrect. Please check the title
Please press any key to exit

```

Returning a DVD is also working under the condition with searching by the movie's title. So, if the user enters different title with the list of borrowed DVD, it shows error message to user.

C:\Users\user\source\repos\CAB301\_Assignment1\src\CAB301\_Assignment1

```

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
You haven't been borrowed any DVDs yet
Please press any key to exit

```

If user has not borrowed any DVDs yet and user presses return menu, it shows error message.

#### 4.4 List current borrowed movie DVDs

```

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
B b arin 2. Adventure 3. M15+ 24/May 0 2
Please press any key to exit

```

C:\Users\user\source\repos\CAB301\_Assignment1\src\CAB301\_Assignment1

```

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
A a a 1. Drama 2. PG 1 0 1
B b 1 1. Drama 1. G 1 0 2
C 2 c 2. Adventure 2. PG c 0 1
Please press any key to exit

```

If the borrowed DVDs are over one, it displays by alphabetical order.

```
Please make a selection (1-5, or 0 to exit)
4
Title: B
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: r
Copies Available: 1
Times rented: 1

Title: D
Starring: s
Director: d
Genre: 1. Drama
Classification: 2. PG
Duration: 100
Released date: r
Copies Available: 1
Times rented: 1
Please press any key to exit
```

This is actual running screen.

#### 4.4 Display top 10 most popular movies

Example 1.

```
C:\Users\User\source\repos\CAB301_assignment1\CAB301
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
A s d 1. Drama 2. PG r 1 6
B s d 1. Drama 2. PG r 0 1
C s d 1. Drama 2. PG r 1 3
D s d 1. Drama 2. PG r 0 1
E s d 1. Drama 2. PG r 1 1
F s d 1. Drama 2. PG r 0 1
G s d 1. Drama 2. PG r 0 1
H s d 1. Drama 2. PG r 0 1
I s d 1. Drama 2. PG r 1 2
J s d 1. Drama 2. PG r 1 0
K s d 1. Drama 2. PG r 1 0
L s d 1. Drama 2. PG r 1 0
Please press any key to exit

C:\Users\User\source\repos\CAB301_assignment1\CAB301
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
5
A borrowed 6 Times
C borrowed 3 Times
I borrowed 2 Times
D borrowed 1 Times
E borrowed 1 Times
F borrowed 1 Times
G borrowed 1 Times
H borrowed 1 Times
B borrowed 1 Times
J borrowed 0 Times
Please press any key to exit
```

Left picture is current all movies in the library (It is different format with actual running screen as this picture has to show the alphabetical order before sorting). Right picture is when the user choses to display top 10 popular movies frequently borrowed with descending order depends on how may time it has been borrowed.

Example 2.



```
C:\Users\User\source\repos\CAB301_assignment1\CAB301_assignment1>
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
1
A s d 1. Drama 2. PG r 1 1
B s d 1. Drama 2. PG r 0 1
C s d 1. Drama 2. PG r 1 3
D s d 1. Drama 2. PG r 0 1
E s d 1. Drama 2. PG r 1 1
F s d 1. Drama 2. PG r 0 1
G s d 1. Drama 2. PG r 0 1
H s d 1. Drama 2. PG r 0 1
I s d 1. Drama 2. PG r 1 2
J s d 1. Drama 2. PG r 1 0
K s d 1. Drama 2. PG r 1 0
L s d 1. Drama 2. PG r 1 5
Please press any key to exit

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current borrowed movie DVDs
5. Display top 10 most popular movies
0. Return to main menu
=====
Please make a selection (1-5, or 0 to exit)
4
L borrowed 5 Times
C borrowed 3 Times
I borrowed 2 Times
D borrowed 1 Times
E borrowed 1 Times
F borrowed 1 Times
G borrowed 1 Times
H borrowed 1 Times
B borrowed 1 Times
A borrowed 1 Times
Please press any key to exit
```

It's the second case of display top 10 movies.

## Reference

A. Levitin. *Introduction to the Design and Analysis of Algorithms*. Addison-Wesley, third edition, 2012. Sections 5.1, 5.2 and 6.4