Library Management System

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|**Advanced Algorithms and Computational Complexity**|

|Assignment-1 |

Content

Introduction

The app concentrates on the implementation of the Data structure and algorithm on the C# platform. This app is built based on satisfying the functional requirements along with good efficiency and structure. The app is built is based for a Community Library to manage the Movie DVDs. As the app is for the community to deal with the movies we will also have to manage the members and their borrowings. The app stores the movie collection in a hashtable format to protect the data and increase the efficiency of the system. The Member collection is stored in the array format to store the details of the members.

The app is designed in the C# console platform which is shared by the staff and the member. The staff has their login credentials fixed to Username: staff and the Password:today123. On the other hand, the members have a Pin that is set for them by the staff to log in. The Staff has their menu and the Members have their menu. To reach this menu the passcode or the pin is important. The Menu is designed according to the ask from the Community.

The software has 9 files in all that include the 5 interfaces and their implementation classes provided to make the app. The 5 interfaces are iMovie, iMovieCollection, iMember, iMemberCollection, and ToolLibrarySystem. 5 classes implement these interfaces namely Movie, MemberCollection, Member, MemberCollection, and ToolLibrary respectively. Apart from these classes, there is a staffMenu class for Staff Functionality, memberMenu class for Member Functionality, Hashtable class for hashtable implementation, and Program class to display all Main Menu.

Design and Analysis of Algorithm:

Analysis of the algorithm

Main Menu:

The main menu is used for separating the Staff Menu and the Member Menu. The main menu doesn't have much algorithm complexity and the code is very simple. There is just a conditional if

statement that runs through the Writeline file and executes the staff Menu function or Menu function when selected the option. Since it a not a nested loop but two separate loops any Constant in the complexity is removed.

2 * for j ← 0 to n – 1 {

 if statement()

 if B S1 Θ(m)

 else S2 Θ(n) }

Since the value of the if statement is O(1) then the algorithm is O(n). The algorithm is O(n) for the loop. The algorithmic complexity is kept simple and the efficiency is kept as Theta O(n).

StaffMenu and Member Menu:
The Staff men and the Member menu always perform the subfunctions in them and don't have any complexity so the values are O(1) for the complexity.

Movie and Member(Classes with Interface):
iMovie and iMember Interfaces have just values dedicated to them and don't perform any function in their classes. O(1) will the efficiency of these classes.

Movie Collection:
Movie collection has a collection of functions and some functions have some complexity statements and some don't have any. So separating the functions that don't perform much on the system we have: Add, Delete and Clear.

DisplayAll: Function has two for loops that perform a specific task keeping the complexity simple as O(n).

DisplayMovie, AddDVDs: For Loop mixed with a simple Conditional statement. The complexity of the function remains at Theta O(n).

Bool Search and iMovie toArray(): The loops have simple if-else and for loop block respectively and hence keeping complexity at O(n)

Display Top 3 Movies:
The sorting algorithm used in this build is "Quicksort" (as the values are less than 16) in the collection. The values that are present vary the type of sorting that is used by the algorithm. Since the number of values that are present in the Test table is less "Quicksort" is used as it helps to check quickly. The two values that are selected at the Pivot end are selected and the value according to the descending order of the No of Borrowings is calculated and put in order. The Unique or the extra feature that is added in the sorting is the use of second sorting if the values in the first sort are the same meaning that if the No of Borrowings is the same then the Name of the Movie is checked and put in the order. The values are then restricted to a top 3 as Requested by the user. The efficiency of the algorithm is O(nlogn).

Pseudocode notations:

Method (left,right)

If (right-left) <=0{

return }

Else{

pivot = Array[right]

 partition = Function(left, right, pivot)

QuickSortMethod(left,partition-1)

QuickSortMethod (partition+1,right) }

End if the values reach the middle point and are sorted

 end Method

The main concept behind this being the program simultaneously sorting both the ends of the Pivot and then stop when the array reaches the middle point. The values are swapped if the order is not correct hence sorting the algorithm.

Hashtable:

The most important part of the program is to build a new Hashtable function. The values that are present in the Movie collection folder are to be stored in this Hashtable. Hashtable is one of the quickest forms of Insertion, Deletion, and searches with the efficiency of almost as O(1). The values are stored in the form of Key, Value pair that makes the searching as quick as the single-time search. Out of the four methods that can be used to make Hashtable this Console is using the Division method to make the hashing function. The value of the key Is taken as $h(k)= k$ mod M. The given interfaces have Title from the movie as the key element which is a string hence Hashing through a mod is a bit different from the usual method. The hashing takes place through a method called Polynomial Hashing that makes use of $hash(h)=\sum_{i=0}^{n-1}s[i]\cdot p^i$ mod m. The values are then probed into the table where the values are stored in a Linked list format. The list takes in <string, object> values as the movie.title and the movie (object)are string and object values respectively. The Probing that is used in this algorithm is Linear Probing. The values are put into the list as they come increasing the index every time a new value comes into the system. Since the movie name is the key which is a string and almost no two movies have the same name this method is chosen.

Pseudocode notations:

Search:

Start Method(key)

If(list(key) != NULL)

List.Index = hashIndexKey

++hashIndexKey

hashIndexKey% = Size

Close method

Insert:

Method start

Title -> HashKey

Object –> HashValue

Get (HashKey)

While{

List.index!=NULL

List.key= HashKey

List.value= Hashvalue

++hashIndexKey

}

Else {

Error

Move next}

End method

Remove

Start Method(key)

If(list(key) != NULL)

List.Remove(key)

++hashIndexKey

hashIndexKey% = Size

Close method

The hashtable has other methods like Contains Key but the important ones are discussed here in detail.

Test Plan

Menu:

Staff Id and Password:

The staff Id- staff

Password- today123

```
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COMMUNITY LIBRARY MOVIE AND DVD MANAGEMENT
====================

 Main Menu
----------------------
Select from the following:

 1.Staff

 2.Member

 0.End the program

 Enter your choice ==>
1
Please Enter your Staff User Name
as
Please Enter your Staff Password
as
Please enter Correct details. 1 to continue or 0 to exit
1
Please Enter your Staff User Name
staff
Please Enter your Staff Password
today123

Staff Menu
----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
```

Predefined Data for Library Management System

Movie Collection:

Title	Genre	Classification	Duration	Availablecopies	Noborrowings
The Godfather	Thriller	MA15+	120	10	0
The Shawshank Redemption	Drama	PG	134	8	0
The Dark Knight	Drama	MA15+	112	8	0
12 Angry Men	Other	G	150	8	0
Schindler's List	Family	G	140	2	0

Member Collection:

FirstName	LastName	ContactNumber	Pin
Virat	Kohli	0432715253	0305
MS	Dhoni	0432746868	0108

Functionality Implementation:

- **Add DVDs of a new movie to the system**

  The new movie details onto the system

Title	Genre	Classification	Duration	Availablecopies	Noborrowings
Race3	**Thriller**	**MA15+**	**160**	**7**	**0**

Before Movie Collection:

After adding movie collection:

Race3 is added to the Movie collection at the bottom.

- Add DVDs of an existing movie to the system

Title	Genre	Classification	Duration	Availablecopies	Noborrowings
The Godfather	Thriller	MA15+	120	10	0

Adding 2 Copies to an existing movie The Godfather. The previous value is 10 after using function the quantity is increased by 2 and now the value is 12

```
Staff Menu
-----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
2
Enter title
The Godfather
Enter quantity
2
Title:The Godfather
Genre: Thriller
Classification: MA15+
Duration: 120
Availablecopies12
Noborrowings0
```

- Remove DVDs of a movie from the system – if all the DVDs of a movie are removed, the movie should also be removed from the system

Title	Genre	Classification	Duration	Availablecopies	Noborrowings
Schindler's List	Family	G	140	2	0

The First two iterations the console takes down the value by one and when the value reaches 0 the movie is deleted from the system and one can no longer can use the Movie file.

```
Select from the following:

1.Staff

2.Member

0.End the program

Enter your choice ==>
1

Staff Menu
-----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
3
Enter title
Schindler's List
Title:Schindler's List
Genre: Family
Classification: G
Duration: 140
Availablecopies1
Noborrowings0
```

```
Staff Menu
-----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
3
Enter title
Schindler's List
Title:Schindler's List
Genre: Family
Classification: G
Duration: 140
Availablecopies0
Noborrowings0
```

```
Staff Menu
----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
3
Enter title
Schindler's List
Sorry Movie not present
```

- Register a new member with the system. When a member is being registered via a staff member, a four-digit password is set for the member

Previous Member Collection:

FirstName	LastName	ContactNumber	Pin
Virat	Kohli	0432715253	0305
MS	Dhoni	0432746868	0108

Adding a new member

FirstName	LastName	ContactNumber	Pin
Aditya	Iyer	0432742969	1107

Adding a new member into the system

```
Staff Menu
----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
4
enter First Name
Aditya
enter Last Name
Iyer
Enter Contact Number
0432742969
enter Pin
1107
FirstName:Virat  LastName:Kohli ContactNumber:0432715253      Pin305
FirstName:MS     LastName:Dhoni ContactNumber:0432746868      Pin108
FirstName:Aditya          LastName:Iyer  ContactNumber:0432742969        Pin1107
```

Remove a registered member from the system

FirstName	LastName	ContactNumber	Pin
Aditya	Iyer	0432742969	1107

```
FirstName:Virat   LastName:Kohli ContactNumber:0432715253      Pin305
FirstName:MS      LastName:Dhoni ContactNumber:0432746868      Pin108
FirstName:Aditya          LastName:Iyer  ContactNumber:0432742969        Pin1107

Staff Menu
-----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
5
enter First Name
Aditya
FirstName:Virat   LastName:Kohli ContactNumber:0432715253      Pin305
FirstName:MS      LastName:Dhoni ContactNumber:0432746868      Pin108
```

- Find a member's contact phone number, given the member's full name

FirstName	LastName	ContactNumber	Pin
Virat	Kohli	0432715253	0305

```
FirstName:Virat   LastName:Kohli ContactNumber:0432715253      Pin305
FirstName:MS      LastName:Dhoni ContactNumber:0432746868      Pin108

Staff Menu
-----------------------
1. Add DVDs of new movie to the system
2. Add DVDs of existing movie to the system
3. Remove a DVD from the system
4. Register a new member to the system
5. Remove a registered member fromm the system
6. Find a member's Contact phone number, given the member's name
7. Find Members who are currently renting a particular movie
0. Return to main menu
Enter your choice
6
enter First Name
Virat
enter Last Name
Kohli
0432715253
```

Member Menu:

- Display all the information about all the movie DVDs in dictionary order of the movie title, including the number of the movie DVDs currently in the community library

```
1.Staff

2.Member

0.End the program

 Enter your choice ==>
2
Member Menu
-----------------------
1.Browse all the movies
2.Display all the information about a movie, given the title of the movie
3.Borrow a movie DVD
4.Return  a movie DVD
5.List current borrowing movies
6.Display the top 3 movies rented by the members
0.Return to main menu
Enter your choice
1
12 Angry Men: 8
Schindler's List: 2
The Dark Knight: 8
The Godfather: 10
The Shawshank Redemption: 8
```

- Display the information about a movie, given the title of the movie

Title	Genre	Classification	Duration	Availablecopies	Noborrowings
The Dark Knight	Drama	MA15+	112	8	0

```
Member Menu
-----------------------
1.Browse all the movies
2.Display all the information about a movie, given the title of the movie
3.Borrow a movie DVD
4.Return  a movie DVD
5.List current borrowing movies
6.Display the top 3 movies rented by the members
0.Return to main menu
Enter your choice
2
Enter Title
The Dark Knight
Title:The Dark Knight
Genre: Drama
Classification: MA15+
Duration: 112
Availablecopies8
Noborrowings0
```

- Borrow a movie DVD from the community library, given the title of the movie DVD

FirstName	LastName	ContactNumber	Pin
Virat	Kohli	0432715253	0305

```
Member Menu
----------------------
1.Browse all the movies
2.Display all the information about a movie, given the title of the movie
3.Borrow a movie DVD
4.Return  a movie DVD
5.List current borrowing movies
6.Display the top 3 movies rented by the members
0.Return to main menu
Enter your choice
3
Enter the movie to be borrowed
The Dark Knight
Enter Member First Name
Virat
The Movies rented by the MemberVirat are :
The Dark Knight
```

- Return a movie DVD to the community library, given the title of the movie DVD

FirstName	LastName	ContactNumber	Pin
Virat	Kohli	0432715253	0305

```
Member Menu
----------------------
1.Browse all the movies
2.Display all the information about a movie, given the title of the movie
3.Borrow a movie DVD
4.Return  a movie DVD
5.List current borrowing movies
6.Display the top 3 movies rented by the members
0.Return to main menu
Enter your choice
4
Enter the movie to be returned
The Dark Knight
Enter Member First Name
Virat

The Movies rented by the Member Virat are :
Member Menu
----------------------
```

- List current movie DVDs that are currently borrowing by the registered member

```
Member Menu
----------------------
1.Browse all the movies
2.Display all the information about a movie, given the title of the movie
3.Borrow a movie DVD
4.Return  a movie DVD
5.List current borrowing movies
6.Display the top 3 movies rented by the members
0.Return to main menu
Enter your choice
5
Enter Member First Name
Virat
The Movies rented by the MemberVirat are :
The Dark Knight
Member Menu
```

- Display the top three (3) most frequently borrowed movie DVDs by the members in the descending order of their frequency. The display should include the title of the movie and frequency (the number of times that the movie DVDs have been borrowed by registered members by now)

Just for the sake of Showing frequently borrowed movie the No of borrowing in the list has been changed to:

Title	Genre	Classification	Duration	Availablecopies	Noborrowings
The Godfather	Thriller	MA15+	120	10	5
The Shawshank Redemption	Drama	PG	134	8	2
The Dark Knight	Drama	MA15+	112	8	5
12 Angry Men	Other	G	150	8	1
Schindler's List	Family	G	140	2	0

```
 Enter your choice ==>
2
Member Menu
-----------------------
1.Browse all the movies
2.Display all the information about a movie, given the title of the movie
3.Borrow a movie DVD
4.Return  a movie DVD
5.List current borrowing movies
6.Display the top 3 movies rented by the members
0.Return to main menu
Enter your choice
6
(5, The Dark Knight)
(5, The Godfather)
(2, The Shawshank Redemption)
```

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