



ALGORITHMS AND COMPLEXITY

Report



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1. Pseudo-code

1.1. Merge

// This program merges left and right sub arrays into input array.

Algorithm Merge (input array, left, middle, right)

Create array right-Array of size (middle - left + 1)

Create array left-Array of size (right - middle)

Call copyArray (input, left, leftArray, 0, middle - left + 1);

Call copyArray (input, middle + 1, rightArray, 0, right - middle);

// Merge the left and sub arrays back into input [left...right]

i \leftarrow 0

j \leftarrow 0

For k \leftarrow left to right+1 do

 if (i counter is equal to size of leftArray)

 input[k] \leftarrow rightArray[j]
 j \leftarrow j+1

 EndIf

// Copy right array into input array when i counter is equal to size of right array

 else if (j counter is equal to size of rightArray)

 input[k] \leftarrow leftArray[i]
 i \leftarrow i+1

 EndElseif

// Copy left array into input array when j counter is equal to size of right array

 else if (Number of borrows in leftArray[i] \leq Number of borrows in rightArray[j])

 input[k] \leftarrow leftArray[i]
 increment i counter by 1

 EndElseif

// Copy remainder of left array into input array if any

 else

 input[k] \leftarrow rightArray[j]
 increment j counter by 1

 EndElse

// Copy remainder of right array into input array if any

EndFor

End

1.2. MergeSort

Algorithm mergeSort (input array, left, right)
// Sorts input array into nondecreasing order, from position left to position right, inclusive.

```
If (left < right)
    Middle ← (left+right) /2

    MergeSort (input, left, middle);
    MergeSort (input, middle + 1, right);

    Call Merge (input, left, middle, right);
```

Endif

End

1.3.CopyArray

// Copies a range of elements from an Array starting at the specified source index and
pastes them to another Array starting at the specified destination index.

CopyArray (sourceArray, sourceIndex, destinationArray, destinationIndex, length)

```
For (I ← sourceIndex to sourceIndex + length)
```

```
    Do destination Array[destinationIndex] = sourceArray[i];
        destinationIndex ← destinationIndex+1
```

Endfor

End

1.4. Convert BST to array

```
// public method
PostOrderTraverse (r)
    If r is not empty
        i← i+1
        if movie is not empty
            unsort[i] ← movie
        endif
        PostOrderTraverse (r. Lchild)
        PostOrderTraverse (r. Rchild)
    Endif
End
```

//Convert BST into an array
called unsort array.

```
// private method
PostOrderTraverse ()
Create array called unsort with size of 100
i← -1
Call PostOrderTraverse (root)
End
```

1.5. displayTopTenMovie

Algorithm displayTopTenMovie ()

K ← 10

controlNumber ← 0;

counter ← 0

Create array called unsorted which contains unsorted movies.

Create array called current Movies with in size of number of movies

For I ← 0 to movieCounter

 currentMovie[i] ← unsorted[i]

Call MergeSort (currentMovie, 0, movieCounter - 1)

If movieCounter < 10

 controlNumber ← movieCounter;

ENDIF

Else

 controlNumber ← k

EndElse

 For i ← movieCounter -1 where i >= 0

 Do if controlNumber is equal to counter

 Break;

 Print movie title borrowed n times

 Counter ← counter +1

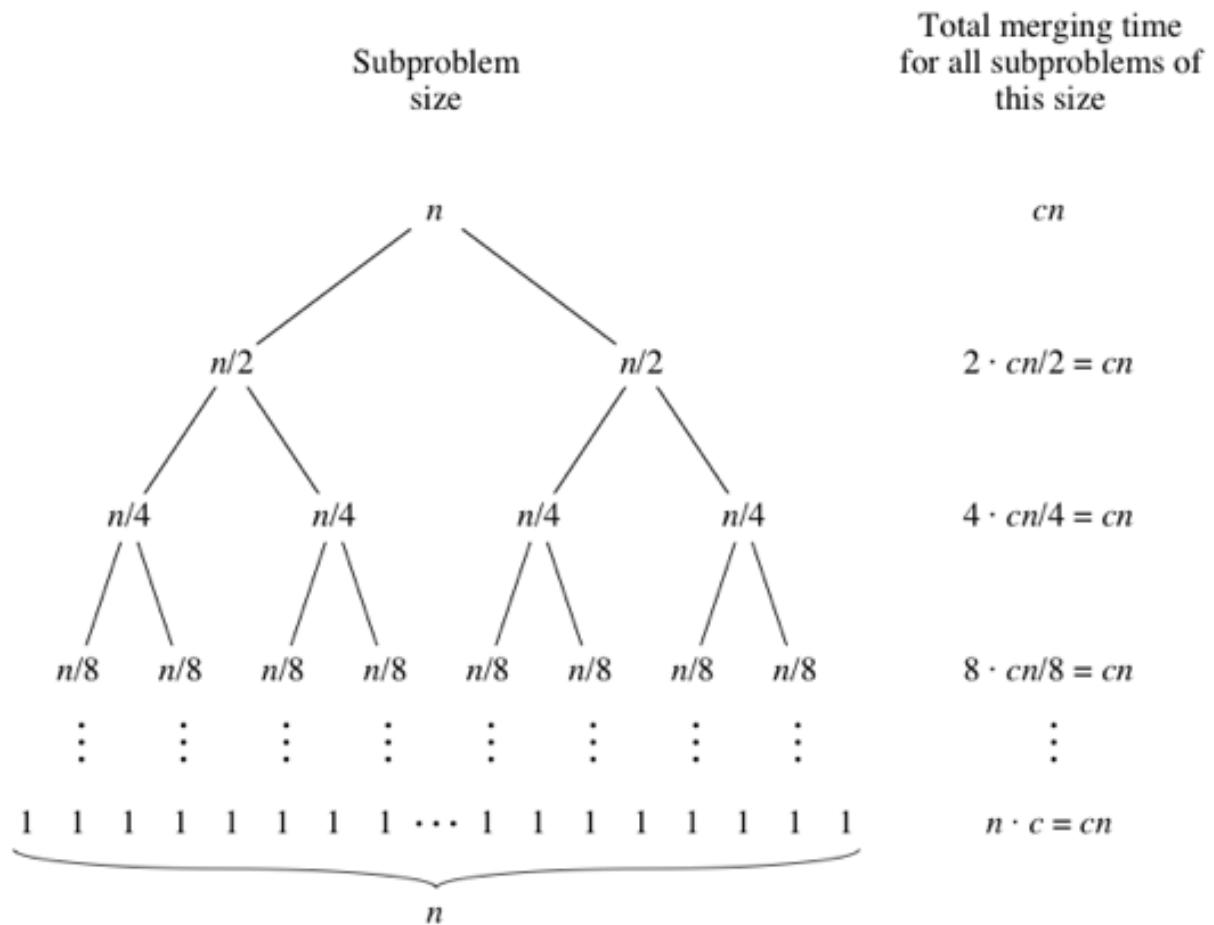
 i ← i-1

 ENDIF

ENDFor

End

2. Algorithm analysis



The number of subproblems doubles at each level of recursion, however, the merging time halves. Hence, the total merging is cn at each level of recursion.

Total time for mergeSort is the sum of the merging times for all the levels.

The height of above tree is $\lg n$.

Time complexity of merge sort of array of size (n):

$$T(n) = T(n/2) + T(n/2) + O(n) = 2 T(n/2) + O(n) \Rightarrow T(n) = cn \lg n.$$

Time complexity of left-array

Time complexity to merge both left and right Arrays.

Time complexity of right-array

2.1 Conclusion: ¹

Time efficacy of mergeSort algorithm is same in best, average and worst-case scenarios and is equal to:

$C_{worst}(n) \in \Theta(n \log n)$, where n is the length of the array.

$C_{avg}(n) \in \Theta(n \log n)$, where n is the length of the array.

Space efficiency: Need temporary space

MergeSort copies more than a constant number of elements at some time, we say that merge sort does not work in place. There are some systems where space is at a premium, and thus in-place algorithms are preferred.

Stable

¹ Lecture 5, slide 11.

3. Test

| # | Features | Test | pass |
|----|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1 | Display Main Menu | Display Main menu within 3 options. | ✓ |
| 2 | Staff login | Press number one to login as staff, username is staff and password is today123. Then you can see staff Menu. | ✓ |
| 3 | Staff incorrect login | If you enter username or password other than "staff" and "today123", needs to show error message. | ✓ |
| 4 | Add new Movie | In staff Menu press one; It will ask all the features about new movie. It will ask to enter movie title, starring actor, director, genre (option list), classification (option list), duration, release date, and number of copies available, Then, it will show staff menu. | ✓ |
| 5 | Remove movie that is already exist | In staff Menu press 2; Will ask movie title to remove that movie, along with the success remove message. | ✓ |
| 6 | Remove movie that is not already exist | In staff Menu press 2; will ask movie title if it is not exist, will show error message if that movie is not exist in community library. | ✓ |
| 7 | Register new member | In staff Menu press 3; Will ask to enter members' first name, last name, phone number and password. If the user not exist will show success message. | ✓ |
| 8 | Register member who already exist | In staff Menu press 3; Will ask to enter members' first name, last name; Will show you error message. | ✓ |
| 9 | Find registered member's phone number | In staff Menu press 4; will ask member's first name and last name and show that member's phone number. | ✓ |
| 10 | Return to main menu from staff menu | In staff Menu press 0 in order to go back to main menu. | ✓ |
| 11 | Member Login Successful | In main menu press 2; will ask user name and password; if it is correct will show you member menu. | ✓ |
| 12 | Member Login Unsuccessful | In main menu press 2; will ask user name and password; If it is wrong, will show you error message. | ✓ |

| | | | |
|----|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| 13 | Display all movies | In member menu press 1, will show all the movies in community library in alphabetical order. | <input checked="" type="checkbox"/> |
| 14 | Display all movies if there is no movie | In member menu press 1; will show an error message. | <input checked="" type="checkbox"/> |
| 15 | Borrow movie DVD successful | In member menu press 2; will ask to enter movie title, then it will show success message if that movie is exist in community library with at least one copy and you have not borrowed more than 10 movies; will show success message. | <input checked="" type="checkbox"/> |
| 16 | Borrow movie that is not exist. | Will show error message | <input checked="" type="checkbox"/> |
| 17 | Borrow movie when you already borrowed 10 movies | Will show you error message. | <input checked="" type="checkbox"/> |
| 18 | Return movie if you already borrowed | In member menu press 3; enter movie title; will show success message if you already borrowed that movie. | <input checked="" type="checkbox"/> |
| 19 | Return movie if you have not borrowed any movie. | Will show you an error message. | <input checked="" type="checkbox"/> |
| 20 | List current borrowed movies (if user borrowed any). | In member menu press 4; it will show all the current movies hold by that member. | <input checked="" type="checkbox"/> |
| 21 | List current movies when you have not borrowed any movies. | Will show an error message. | <input checked="" type="checkbox"/> |
| 22 | Display Top 10 movies | In member menu press 5; it will show top 10 movies based on the number of borrowed movies. | <input checked="" type="checkbox"/> |
| 23 | Password 4 digits number. | Will display an error message if password is other than 4 digits numbers. | <input checked="" type="checkbox"/> |
| 24 | Add movie that already exist | Should ask the number of copies along with success message. | <input checked="" type="checkbox"/> |

| | | | |
|----|----------------------------------------------|-----------------------------------|-------------------------------------|
| 25 | Borrow a same movie that is already borrowed | It will display an error message. | <input checked="" type="checkbox"/> |
| 26 | Exit console | In Main menu press 0. | <input checked="" type="checkbox"/> |

3.1 Appendix (Screenshots)

1.

```
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):
```

2.

```
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]
[Enter username: staff
[Enter Password: today123

=====
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

3.

```
Welcome to the community Library
=====Main Menu=====
1. Staff Login
2. Member Login
0. Exit
=====
[Pleas e make a selection (1-2 or 0 to exit):1
[Enter username: staff
[Enter Password: 12345
try again!

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):
```

4.

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):1
Enter the movie title: avatar
Enter the starring actor(s): xxxx
Enter the director(s): xxxx

select the genre:
1. Drama
2. Adventure
3. Family
4. Action
5. ScienceFiction
6. Comedy
7. Thriller
8. other
Make selection(1-8):
2
select the Classification:
1. General
2. Parental_Guidance
3. Mature
4. MatureAccomplished
Make selection(1-4):
1
Enter the movie duration: 90
Enter the release date (year): 2012
Enter the number of copies: 3

avatar is added successfully to community.

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

5.

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):2
Enter the movie title: avatar
avatar deleted.

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

6.

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):2
Enter the movie title: someMovie
no movie found

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

7.

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
[Pleas make a selection (1-4 or 0 to return to Main Menu):3
[Enter member's first name: yasi
[Enter member's last name: gorji
[Enter member's Adress: gorge st, brisbane
[Enter member's Phone number: 1324567
[Enter member's password: 1111
yasi gorji has been successfully registered!

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

8.

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):3
Enter member's first name: yasi
Enter member's last name: gorji
Enter member's Adress: gorge st, brisbane
Enter member's Phone number: 1234567
Enter member's password: 1111
yasi gorji has been successfully registered!
```

9.

```
[jasmin — Visual Studio External Console — mono64 ▶ bash -c clear; cd "/Users..."]
=====
[Plese make a selection (1-4 or 0 to return to Main Menu):3
[Enter member's first name: yasi
[Enter member's last name: gorji
[Enter member's Adress: gorge st, brisbane
[Enter member's Phone number: 1234567
[Enter member's password: 1111
yasi gorji has been successfully registered!

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
[Plese make a selection (1-4 or 0 to return to Main Menu):4
[Enter member's first name: yasi
[Enter member's last name: gorji
yasi gorji's phone number is: 1234567

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
```

10.

```
yasi gorji, has already exist
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
[Plese make a selection (1-4 or 0 to return to Main Menu):0
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):
```

11.

```
=====Main Menu=====
1. Staff Login
2. Member Login
0. Exit
=====
[Pleas make a selection (1-2 or 0 to exit):2
[Enter your Username (lastnameFirstname): gorjiyasi
[Enter your Password 1111
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

12.

```
=====Main Menu=====
1. Staff Login
2. Member Login
0. Exit
=====
[Pleas make a selection (1-2 or 0 to exit):2
[Enter your Username (lastnameFirstname): gorjiyasi
[Enter your Password 4325
user is invalid! Try again.
```

13.

```
=====
[Plese make a selection (1-5 or 0 to return to Main Menu):1
Number of movie and DVDs avaible in community library is: 4

Title: avatar
Starring: xxxx
Director: xxxx
Duration: 90 minutes
Genere: Adventure
Classification: General
Releasedate: 2012
Copies Avaiable: 3
Times Borrowed: : 0

Title: breaking bad
Starring: xxxxx
Director: xxxxx
Duration: 100 minutes
Genere: Drama
Classification: Mature
Releasedate: 2010
Copies Avaiable: 5
Times Borrowed: : 0

Title: fight club
Starring: xxxxx
Director: xxxx
Duration: 120 minutes
Genere: Action
Classification: Mature
Releasedate: 2014
Copies Avaiable: 4
Times Borrowed: : 0

Title: zombieland
Starring: xxxxx
Director: xxxx
Duration: 80 minutes
Genere: Thriller
Classification: MatureAccomplished
Releasedate: 2017
Copies Avaiable: 7
Times Borrowed: : 0
```

14.

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Pleas make a selection (1-5 or 0 to return to Main Menu):1
No movie or DVD avaialbe in community library.

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

15.

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Pleas make a selection (1-5 or 0 to return to Main Menu):2
[Enter movie title: avatar
you borrowed avatar

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

16.

```
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Please make a selection (1-5 or 0 to return to Main Menu):2
[Enter movie title: somemovie
This movie is not exist

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

17.

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Please make a selection (1-5 or 0 to return to Main Menu):2
[Enter movie title: movie11
You are not allowed to borrow more than 10 movies.

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

18.

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Pleas make a selection (1-5 or 0 to return to Main Menu):3
[Enter movie title: avatar
you've returned, avatar

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

19.

```
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Pleas make a selection (1-5 or 0 to return to Main Menu):3
[Enter movie title: somemovie
This movie is not borrowed! Try again.

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

20.

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):4
you are currently borrowing:
avatar

gone girl

zombieland

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
```

21.

```
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):3
Enter movie title: zombieland
you've returned, zombieland

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):4
You have not borrowed any movie yet.

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):
```

22.

```
=====
Please make a selection (1-2 or 0 to exit):2
Enter your Username (lastnameFirstname): gorjiyasi
Enter your Password 1111
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
Please make a selection (1-5 or 0 to return to Main Menu):5
gone girl borrowed 7 times.
breaking bad borrowed 5 times.
avatar borrowed 4 times.
zombieland borrowed 3 times.
fight club borrowed 2 times.
```

23.

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
[Please make a selection (1-4 or 0 to return to Main Menu):3
[Enter member's first name: fer
[Enter member's last name: hormozi
[Enter member's Adress: margaret st, brisbane
[Enter member's Phone number: 03263244
[Enter member's password: chdf
Password must contains only 4 digits without any letters or spaces

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
[Plese make a selection (1-4 or 0 to return to Main Menu):3
[Enter member's first name: niloo
[Enter member's last name: gorji
[Enter member's Adress: margaret st, brisbane
[Enter member's Phone number: 76543332
[Enter member's password: 123456
Password must contains only 4 digits without any letters or spaces

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

24.

```
=====
[Plese make a selection (1-2 or 0 to exit):1
[Enter username: staff
[Enter Password: today123

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):1
[Enter the movie title: avatar
[Enter the number of copies: 2
2 more copies are added for avatar movie.
Total number of available for avatar movie is: 5

=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
3. Register a new member
4. Find a registered member by phone number
0. Return to Main Menu
=====
Please make a selection (1-4 or 0 to return to Main Menu):
```

25.

```
=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Please make a selection (1-5 or 0 to return to Main Menu):2
[Enter movie title: movie1
you borrowed movie1

=====Member Menu=====
1. Display all movies
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Please make a selection (1-5 or 0 to return to Main Menu):2
[Enter movie title: movie1
You are not allowed to borrow a same movie twice!
```

26.

```
jasmin — Visual Studio External Console — 80x24
2. Borrow a movie DVD
3. Return a movie DVD
4. List current movie DVDs
5. Display top 10 most popular movies
0. Return to Main Menu
=====
[Please make a selection (1-5 or 0 to return to Main Menu):0
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):0
]
[Press any key to continue...
logout
Saving session...
...copying shared history...
...saving history...truncating history files...
...completed.

[Process completed]
```

