

CAB301 Assignment

Algorithms and Complexity

Bill Wen
2020 Semester 1

Contents

1.0 Display Top 10 Movie Algorithm.....	2
2.0 Algorithm Time Complexity	4
2.1 Best Case	4
2.2 Worst Case	4
2.3 Average Case.....	4
3.0 Functional Testing Results	5
3.1 Main Menu.....	5
3.2 Staff Menu	6
3.3 Member Menu.....	9
4.0 Appendix	12

1.0 Display Top 10 Movie Algorithm

See Appendix for the original code.

```
void topTenArray()
{
    IF BST is empty
        RETURN
    ELSE
        SET movieArray with getMovieArray()

    COMPUTE every movie in movieArray into alphabetical order using quickSortDescending()

    FOR all the movies in the movieArray up to ten movies
        PRINT movie
}

Movie[] getMovieArray()
{
    INIT movieArray
    FUNC perform recursiveIterate() on the root node
    RETURN movieArray
}

void recursiveIterate()
{
    SET node to movieArray with an index
    INCREMENT index

    IF the leftNode is empty
        THEN perform recursiveIterate() on the leftNode
    IF the rightNode is empty
        THEN perform recursiveIterate() on the rightNode
}
```

```

void quickSortDescending(titles, start, end)
{
    IF end is larger than start

        THEN FUNCTION SET variable pivot to partition(titles, start, end)

        THEN IF pivot is larger than 1
            THEN FUNCTION quickSortDescending(titles, start, pivot - 1)

        THEN IF pivot + 1 is smaller than end
            THEN FUNCTION quickSortDescending(titles, pivot +1, end)

    }

}

int partition(titles, start, end)
{
    FUNCTION perform getTimesBorrowed() to array titles[start] and assign to pivot

    WHILE true
        WHILE titles[start].getTimesBorrowed() is larger than pivot
            INCREMENT start

        WHILE titles[end].getTimesBorrowed() is smaller than pivot
            DECREMENT end

        IF start is smaller than end
            THEN IF titles[start].getTimesBorrowed() is equal to
                titles[end].getTimesBorrowed()

                THEN RETURN end

            THEN SWAP title[start] with title[end]

        ELSE
            RETURN end
}

```

2.0 Algorithm Time Complexity

The entire method involves three algorithms, iterating through the binary search tree to return each movie, quick sort and iterating through each movie in the sorted array and printing it. The first and latter algorithms both have an time efficiency of $O(n)$ which is of an inconsequential time taken. Thus will be omitted from the final time efficiency result.

2.1 Best Case

The best case scenario is when the pivot happens to be in the center of the list every time. Therefore, each sub-list will be of size $\log_2 n$ until the size reaches 1. This will result in the algorithm using $O(n \log n)$ time.

$$O(n \log n)$$

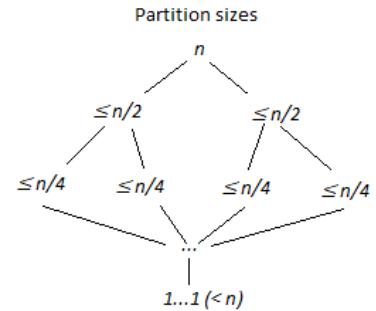


Figure 1 Best Case

2.2 Worst Case

The worst case scenario is when the pivot happens to be the largest or smallest element in the list. If this happens repeatedly the size of each partition will be $n - 1$ before a size of 1 is reached. This will result in $O(n^2)$ time.

$$O(n^2)$$

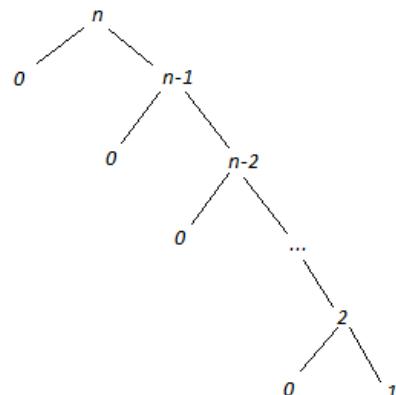


Figure 2 Worst Case

2.3 Average Case

In calculating the average case using percentiles, we can assume that if every pivot point occurs roughly in the middle between the 75th and 25th percentile it will split the list with at most an imbalance of 25% and 75%. Assuming such pivot points will be chosen every time, the list will only have to be partitioned at most $\log_{4/3} n$ iterations until reaching a size of 1 which will result in an efficiency of $O(n \log n)$.

$$O(n \log n)$$

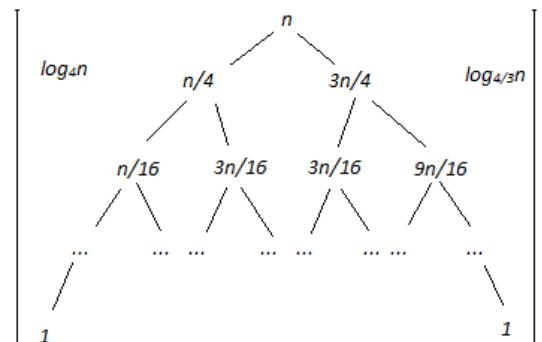


Figure 3 Average Case (Percentile)

3.0 Functional Testing Results

3.1 Main Menu

Test case: Choosing option not in range

Expected outcome: Error and prompting user to try again

Actual outcome: As expected

```
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):  
3  
Error: Invalid Input
```

```
Please make a selection (1-2, or 0 to exit):
```

Test case: Staff login

Expected outcome: Staff login screen

Actual outcome: As expected

```
Please make a selection (1-2, or 0 to exit):  
1  
  
Enter Username:
```

Test case: Member login

Expected outcome: Member login screen

Actual outcome: As expected

```
Please make a selection (1-2, or 0 to exit):  
2  
  
Enter Username:
```

Test case: Exit

Expected outcome: Exits app

Actual outcome: As expected

```
Press any key to close this window . . .
```

3.2 Staff Menu

Test case: Log in with incorrect information
Expected outcome: Error and denied access
Actual outcome: As expected

```
Enter Username:  
sf  
Enter Password:  
sf
```

Your logon information was incorrect.

```
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):

Test case: Log in with correct information
Expected outcome: Granted access
Actual outcome: As expected

```
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's phone number  
0. Return to main menu  
=====
```

Please make a selection (1-4, or 0 to return to main menu):

Test case: Adding movie
Expected outcome: Prompts user to type movie information and adds it
Actual outcome: As expected

```
=====Staff Menu=====  
1. Add a new movie DVD  
2. Remove a movie DVD  
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 return to main menu):  
1  
Enter the movie title:  
Jaws
```

Test case: Adding existing movie
Expected outcome: Asks user if they want to add copies
Actual outcome: As expected

```
Enter the movie title:  
Jaws  
Enter the number of copies you would like to add:
```

Test case: Adding movie copies

Expected outcome: Asks user to input copies to add and then add it

Actual outcome: As expected

```
Enter the movie title:  
Jaws  
Enter the number of copies you would like to add:  
5  
Jaws now has 6 copies available.
```

Test case: Removing non-existent movie

Expected outcome: Error

Actual outcome: As expected

```
Enter movie title:  
Anaconda  
Movie not found.
```

Test case: Removing movie

Expected outcome: Asks which movie and removes it

Actual outcome: As expected

```
Enter movie title:  
Jaws  
Movie has been removed.
```

Test case: Registering member

Expected outcome: Prompts user to enter member information and adds member

Actual outcome: As expected

```
Enter member's first name:  
Mike  
Enter member's last name:  
Chen  
Enter member's address:  
Nice Place  
Enter member's phone number:  
000  
Enter member's password (4 digits):  
1234  
Successfully registered. There are now 1 registered members.
```

Test case: Find member's phone number from name

Expected outcome: Return the correct phone number

Actual outcome: As expected

```
Enter member's first name:  
Mike  
Enter member's last name:  
Chen  
Mike Chen's phone number is: 000
```

Test case: Find non-existent member's phone number from name

Expected outcome: Error

Actual outcome: As expected

```
Enter member's first name:  
Ben  
Enter member's last name:  
Smith  
Member not found
```

Test case: Choose out of bounds option

Expected outcome: Error and prompts user to retry

Actual outcome: As expected

```
=====Staff Menu=====
1. Add a new movie DVD
2. Remove a movie DVD
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 return to main menu):
5
Error: Invalid Input
```

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

Test case: Return to main menu

Expected outcome: Returns to main menu

Actual outcome: As expected

```
Welcome to the Community Library.
=====Main Menu=====
1. Staff Login
2. Member Login
0. Exit
=====
```

3.3 Member Menu

Test case: Incorrect login

Expected outcome: Error and denied access

Actual outcome: As expected

```
Enter Username:  
Ben  
Enter Password:  
Ssmith
```

Logon information incorrect.

```
Welcome to the Community Library.  
=====Main Menu=====  
1. Staff Login  
2. Member Login  
0. Exit  
=====
```

Test case: Correct login

Expected outcome: Granted access

Actual outcome: As expected

```
Enter Username:  
ChenMike  
Enter Password:  
1234  
=====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  
=====
```

Test case: Display all movies

Expected outcome: Prints all movies and their information

Actual outcome: As expected

```
Title: Jaws  
Starring: Ben  
Director: Jack  
Genre: Drama  
Classification: Mature (M15+)  
Duration: 90  
Release Date: 2020  
Copies Available: 4  
Times Borrowed: 2
```

```
Title: Finding Nemo  
Starring: Jamie  
Director: Bill  
Genre: Thriller  
Classification: Mature Accompanied (MA15+)  
Duration: 30  
Release Date: 2021  
Copies Available: 1  
Times Borrowed: 0
```

Test case: Borrow non-existent movie

Expected outcome: Error

Actual outcome: As expected

```
Enter movie title:  
Jaws 2  
Movie does not exist.
```

Test case: Borrow movie with no copies available

Expected outcome: Error

Actual outcome: As expected

```
Enter movie title:  
Conjuring  
Conjuring is unavailable.
```

Test case: Borrow movie

Expected outcome: Movie borrowed and print message telling user what they are borrowing

Actual outcome: As expected

```
Enter movie title:  
Jaws  
You have borrowed Jaws.  
You are borrowing:  
Jaws
```

Test case: Return non-existent movie

Expected outcome: Error

Actual outcome: As expected

```
Enter movie title:  
Jaws 2  
Jaws 2 not found.
```

Test case: Return movie

Expected outcome: Movie returned

Actual outcome: As expected

```
Enter movie title:  
Jaws  
Movie DVD returned.
```

Test case: List all borrowed DVDs with no DVDs borrowed

Expected outcome: Print message saying no movies borrowed

Actual outcome: As expected

```
Please make a selection (1-5, or 0 to return to main menu):  
4  
You have no borrowed movies.
```

Test case: List all borrowed DVDs

Expected outcome: Print message saying what movies user is borrowing

Actual outcome: As expected

```
You are borrowing:  
Jaws, Shawshank Redemption
```

Test case: Display top 10 most popular movies

Expected outcome: Print message showing 10 most popular movies in order and times borrowed

Actual outcome: As expected

```
Ip Man borrowed 3 times.  
Jaws borrowed 2 times.  
Finding Dory borrowed 1 times.  
AVP borrowed 2 times.  
Shawshank Redemption borrowed 1 times.  
Getting a 7 borrowed 1 times.  
Finding Nemo borrowed 0 times.  
The Godfather borrowed 0 times.  
12 Angry Men borrowed 0 times.  
Passion of Christ borrowed 0 times.
```

Test case: Choose out of bounds option

Expected outcome: Error and prompts user to retry

Actual outcome: As expected

```
=====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 return to main menu):  
6  
Error: Invalid Input
```

```
Please make a selection (1-5, or 0 to exit):
```

Test case: Return to main menu

Expected outcome: Returns to main menu

Actual outcome: As expected

```
Welcome to the Community Library.  
=====Main Menu=====  
1. Staff Login  
2. Member Login  
0. Exit  
=====
```

4.0 Appendix

```
void topTenArray() // Displays top 10 in terms of popularity
{
    if (root == null)
    {
        Console.WriteLine("There are no movies.");
        return;
    }
    else
        movieArray = root.getMovieArray();

    quickSortDescending(movieArray, 0, movieArray.Length - 1);
    int moviesPrinted = 0;
    foreach (Movie movie in movieArray)
    {
        if (moviesPrinted >= 10)
        {
            return;
        }
        Console.WriteLine(movie.getTitle() + " borrowed " +
        movie.getTimesBorrowed() + " times.");
        moviesPrinted++;
    }
}

Movie[] getMovieArray() // Convert BST to array
{
    movieArray = new Movie[moviesInBST];
    index = 0;
    recursiveIterate();
    index = 0;
    return movieArray;
}

void recursiveIterate() // Function used by getMovieArray()
{
    movieArray[index] = data;
    index++;
    if (leftNode != null)
    {
        leftNode.recursiveIterate();
    }
    if (rightNode != null)
    {
        rightNode.recursiveIterate();
    }
}
```

```

void quickSortDescending(Movie[] titles, int start, int end) // Reversed quicksort
{
    if (start < end)
    {
        int pivot = partition(titles, start, end);
        if (pivot > 1)
        {
            quickSortDescending(titles, start, pivot - 1);
        }
        if (pivot + 1 < end)
        {
            quickSortDescending(titles, pivot + 1, end);
        }
    }
}

int partition(Movie[] titles, int start, int end) // Partitioning function
{
    int pivot = titles[start].getTimesBorrowed();
    while (true)
    {
        while (titles[start].getTimesBorrowed() > pivot)
        {
            start++;
        }

        while (titles[end].getTimesBorrowed() < pivot)
        {
            end--;
        }

        if (start < end)
        {
            if (titles[start].getTimesBorrowed()==titles[end].getTimesBorrowed())
            {
                return end;
            }

            Movie temp = titles[start];
            titles[start] = titles[end];
            titles[end] = temp;
        }
        else
            return end;
    }
}

```