# Contents

# Algorithms for displaying top 10 most frequently borrowed movies

The movie collection binary search tree (BST) is flattened to an array with a traversal algorithm, and the array is then sorted with a quicksort sorting algorithm based on the movies' borrowed count.

## Traversal algorithm used to flatten BST:

**ALGORITHM** GetArrayMovies()
// Flattens binary search tree to an array by inorder traversal
// Input: Global variables *root* which is the root node of the
//          BST, an empty array *arrayMovies[]*, amount of BST
//          nodes *moviesCount,* and *arrayMovies* index *arrayIndex*
// Output: Array *array[0…moviesCount-1]* filled with elements from BST

arrayMovies = new array[0…moviesCount-1] // create new empty array of size *moviesCount*
arrayIndex ←0
FlattenMovies(root)
**return** arrayMovies


**ALGORITHM** FlattenMovies(node)
// Traverses through BST nodes while adding each node to the global variable *arrayMovies*
// Input: Current BST node *node*, and global variables *arrayIndex* and *arrayMovies*
// Output: Updated *arrayMovies* with new node

**if** node != null **then**
          FlattenMovies(node.left) // traverse down left subtree
          arrayMovies[arrayIndex] ← node.movie
          arrayIndex ← arrayIndex + 1
          FlattenMovies(node.right) // traverse down right subtree


Analysis:


In the best, average, and worst-case scenario for flattening the BST, every node is visited once. Therefore, the time efficiency is: $O(n)$

Since a new array is created with its length the number of nodes, the space efficiency is: $O(n)$

## Quicksort sorting algorithm used to sort the array of movies by borrowed count:

**ALGORITHM** partition(arr[l..r], l, r)
// Partitions a subarray by Hoare's algorithm, using the first element
as a pivot
// Input: Subarray of array arr[0..n-1], defined by its left and right
//         indices l and r (l < r)
// Ouput: Partition of arr[l..r], with the split position returned as
//         the function's value

Movie p ← arr[l];
i ← l-1
j ← r+1
**repeat**
       **repeat** i ← i + 1 **until** arr[i] ≤ p // compare amount borrowed
       **repeat** j ← j − 1 **until** arr[j] ≥ p
       **if** i ≥ j **then**
              **return** j
       swap(arr[i], arr[j])

**ALGORITHM** quicksort(arr[l..r], l, r)
// Sorts a subarray by quicksort
// Input: Subarray of array arr[0..n-1], defined by its left and right
//         indices l and r
// Output: Subarray arr[l..r] sort in decreasing order

**if** l < r
s ← partition(arr, l, r) // split position
quicksort(arr, l, s)
       quicksort(arr,s+1, r)

Analysis:

**Worst-case-analysis**

A worst-case scenario will occur when there is an unbalanced partition where one of the subarrays returned is of size *n* - 1. This may occur if the pivot is either the largest element (in our case, the most borrowed) or the smallest (least borrowed). If this happens for every partition, the recursive call will compute an array of size 1 less than the previous. Therefore, *n*-1 nested calls are made before reaching an array size of 1. The time complexity for this can be expressed as so:

$$T(n) = n - 1 + n - 2 + \cdots + 2 + 1 = \frac{(n-1)n}{2}$$

This yields that:

$$T(n) \in \Omega(n^2)$$

$$O(n^2)$$

**Best-case analysis**

A best-case scenario will occur if there are two equal size subarrays after each partition. This will cause $logn$ nested calls before the reaching an array size of 1, where each call level only needs $O(n)$ time. Therefore, the time complexity is:

$O(nlogn)$

Average-case analysis

An average-case scenario is similar to a best-case scenario, except the subarrays are not perfectly balanced after each partition. The difference in sizes of the subarrays after a partition approaches a medium of equality after each nested call. An average-case scenario would approach that of the best-case, rather than the worst case. The time complexity is:

$O(nlogn)$

**Overall Efficiency of the quicksort algorithm:**

Time efficiency:

- Worst case:
    - $C_{worst}(n) \; \epsilon \; \Theta(n^2)$
- $Average \; case$:
    - $C_{avg}(n) \epsilon \; \Theta(nlogn)$

Space efficiency:

- No temporary storage needed

Not Stable

## Functional Tests

Main Menu - Staff login (correct):

```
Welcome to the Community Library
============Main Menu============
1. Staff Login
2. Member Login
0. Exit
================================
Please make a selection(1-2 or 0 exit):
1
Username:
staff
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):
```

Main Menu - Staff login (incorrect):

```
Welcome to the Community Library
============Main Menu============
1. Staff Login
2. Member Login
0. Exit
================================
Please make a selection(1-2 or 0 exit):
1
Username:
staff
Password:
random
Incorrect username or password.
============Main Menu===========
1. Staff Login
2. Member Login
0. Exit
================================
Please make a selection(1-2 or 0 exit):
```

Staff Menu – Add a new movie DVD:

```
============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
Movie title:
Saving Private Ryan
Starring:
Tom Hanks
Director:
Steven Spielberg
Duration:
169 min
Select from the following genres:
1. Drama
2. Adventure
3. Family
4. Action
5. Sci-Fi
6. Comedy
7. Animated
8. Thriller
9. Other
9
Select from the following classifications:
1. General (G)
2. Parental Guidance (PG)
3. Mature (M15+)
4. Mature Accompanied (MA15+)
4
Release Date:
19 November 1998
Copies available:
10
Movie added to library.
============Staff Menu===========
1. Add a new movie DVD
2. Remove a movie DVD
```

Staff Menu – Remove a movie DVD:

```
Movie added to library.
============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):
2
Title of movie to delete:
Saving Private Ryan
============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):
```

Staff Menu – Register a new member:

```
============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):
3
Surname:
John
Given Name:
Smith
Residential Address:
49 Orange Street, Brisbane
Contact Number:
0469133769
New password for member (4 digit integer):
1111
New member registered!
============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):
```

Staff Menu – Find a registered member's phone number:

```
============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):
4
Enter username of Member:
JohnSmith
Member's phone number: 0469133769
============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):
```

Staff Menu – 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's phone number
0. Return to main menu
===============================
Please make a selection(1-4 or 0 to return to main menu):
0
============Main Menu===========
1. Staff Login
2. Member Login
0. Exit
===============================
Please make a selection(1-2 or 0 exit):
```

Main Menu - Member login (correct):

```
============Main Menu===========
1. Staff Login
2. Member Login
0. Exit
===============================
Please make a selection(1-2 or 0 exit):
2
Username:
JohnSmith
Password:
1111
Successfully logged in.
==========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):
```

Main Menu - Member login (incorrect):

```
=============Main Menu============
1. Staff Login
2. Member Login
0. Exit
=================================
Please make a selection(1-2 or 0 exit):
2
Username:
JohnSmith
Password:
111
Incorrect password.
=============Main Menu============
1. Staff Login
```

Member Menu – Display all movies:

```
===========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):
1
Title: 12 Years a Slave | Starring: Chiwetel Ejiofor | Director: Steven McQueen | Duration: 2h 14 min | Genre: Drama | Clas

Title: Interstellar | Starring: Matthew McConaughey | Director: Christopher Nolan | Duration: 2h 49min | Genre: Sci-Fi | Cl

Title: Saving Private Ryan | Starring: Tom Hanks | Director: Steven Spielberg | Duration: 169 min | Genre: Other | Classif

===========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):
```

…

```
rama | Classification: Mature Accompanied (MA15+) | Release Date: 30 January 2014 | Copies Available: 10

Sci-Fi | Classification: Parental Guidance (PG) | Release Date: 6 November 2014 | Copies Available: 10

 | Classification: Mature Accompanied (MA15+) | Release Date: 19 November 1998 | Copies Available: 10
```

Member Menu – Borrow a movie DVD (exists):

```
==========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):
2
Title of movie to borrow:
Interstellar
Successfully borrowed movie.
==========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):
```

Member Menu – Borrow a movie DVD (does not exist):

```
==========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):
2
Title of movie to borrow:
Random Title
Movie with title 'Random Title' does not exist.
==========Member Menu==========
1. Display all movies
```

Member Menu – Borrow a movie DVD (already borrowed):

```
==========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):
2
Title of movie to borrow:
Interstellar
Movie already borrowed.
==========Member Menu==========
1. Display all movies
```

Member Menu – Return a movie 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 return to main menu):
3
Title of movie to return:
Interstellar
Movie has been returned.
===========Member Menu===========
1. Display all movies
```

Member Menu – Return a movie DVD (not borrowed):

```
===========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):
3
Title of movie to return:
Interstellar
This movie has not been borrowed.
===========Member Menu===========
```

Member Menu – Return a movie DVD (does not exist):

```
===========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):
2
Title of movie to borrow:
a
Movie with title 'a' does not exist.
===========Member Menu===========
1. Display all movies
```

**Member Menu – 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 return to main menu):
4
Title: Interstellar | Starring: Matthew McConaughey | Director: Christopher Nolan | Duration: 2h 49min | Genre: Sci-Fi | Classif

Title: Saving Private Ryan | Starring: Tom Hanks | Director: Steven Spielberg | Duration: 169 min | Genre: Other | Classificatio

Title: 12 Years a Slave | Starring: Chiwetel Ejiofor | Director: Steven McQueen | Duration: 2h 14 min | Genre: Drama | Classifica

===========Member Menu===========
1. Display all movies
```

…

```
i-Fi | Classification: Parental Guidance (PG) | Release Date: 6 November 2014 | Copies Available: 9

 Classification: Mature Accompanied (MA15+) | Release Date: 19 November 1998 | Copies Available: 9

ma | Classification: Mature Accompanied (MA15+) | Release Date: 30 January 2014 | Copies Available: 9
```

**Member Menu – Display top 10 most popular movies:**

```
===========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):
5
1) 12 Years a Slave
Copies borrowed: 3


2) Interstellar
Copies borrowed: 2


3) Saving Private Ryan
Copies borrowed: 1


===========Member Menu===========
1. Display all movies
```

Member Menu – Return to main menu:

```
===========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):
0
===========Main Menu============
1. Staff Login
2. Member Login
0. Exit
=================================
Please make a selection(1-2 or 0 exit):
```

Main Menu – Exit:

```
===========Main Menu============
1. Staff Login
2. Member Login
0. Exit
=================================
Please make a selection(1-2 or 0 exit):
0
Goodbye!
```