EbenLib (Library Management System)

[Group 6]

1. Introduction

The Ebenezer Community Library, located in Ashaiman, serves a wide range of users including students, researchers, and recreational readers. Despite housing thousands of books, the library continues to rely on manual processes for cataloguing and lending, using physical logbooks and handwritten entries. This system has proven to be inefficient, error-prone, and difficult to manage — leading to frequent issues such as lost books, untracked overdue returns, and unreliable inventory visibility.

In response to these challenges, our team was tasked with designing and implementing a **console-based Book Lending and Cataloguing System** that is both **offline-first** and built **entirely from scratch** using core programming constructs. The goal was to develop a solution that modernizes library operations without relying on any external databases, graphical interfaces, or third-party frameworks.

Our system — titled **EbenLib** — was developed entirely in Java using only built-in data structures and file storage mechanisms. It enables librarians to manage books, borrowers, lending activities, and fines, while also supporting advanced features such as report generation, search and sort algorithms, file export/import, and configurable system behavior. It is intended to be used as a lightweight and portable desktop tool that preserves data across sessions and ensures full control over library operations.

2. System Features

The EbenLib system is built as a modular, offline-first console application to support the essential operations of a local library. All features can be accessed via **interactive menus** or by typing **non-interactive commands** directly into the terminal. Key functionalities are described below:

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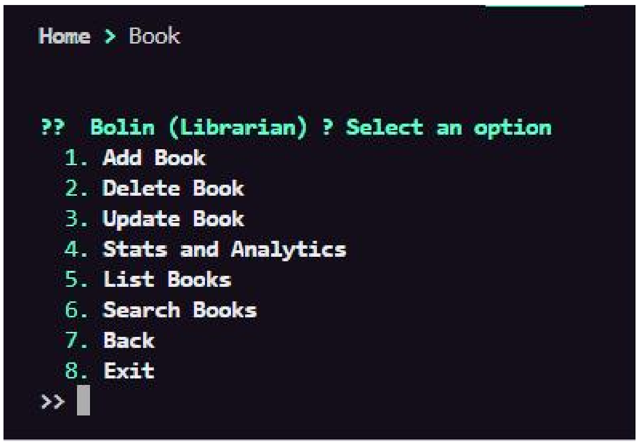
1. Book Catalog Management

The system supports adding, removing, and listing books. Each book record contains:

- **Title**, **Author**, **ISBN**
- **Category**, **Year**, **Publisher**
- **Shelf Location**, **Quantity in stock**

Books are internally stored using a **hash map**, allowing for efficient grouping and filtering. When a book with an existing ISBN is added, its quantity is incremented rather than duplicating the entry.

Non-interactive commands:
book add, book delete, book list, book update, book stats, book search



```
Home > Book


?? Bolin (Librarian) ? Select an option
  1. Add Book
  2. Delete Book
  3. Update Book
  4. Stats and Analytics
  5. List Books
  6. Search Books
  7. Back
  8. Exit
>>
```

---

2. Universal Search and Sort Engine

The system includes a **generic search and sort engine** implemented using Java's functional programming capabilities (Comparator<T>, Function<T,R>). These are used across multiple modules, including books, users, and borrowing records.

Search:

- Linear search is used for partial matching (e.g., searching by a keyword).
- Binary search is available for exact lookups in pre-sorted lists.
- Search is case-insensitive and field-agnostic (you can search by title, author, ID, etc., depending on the module).

Sort:

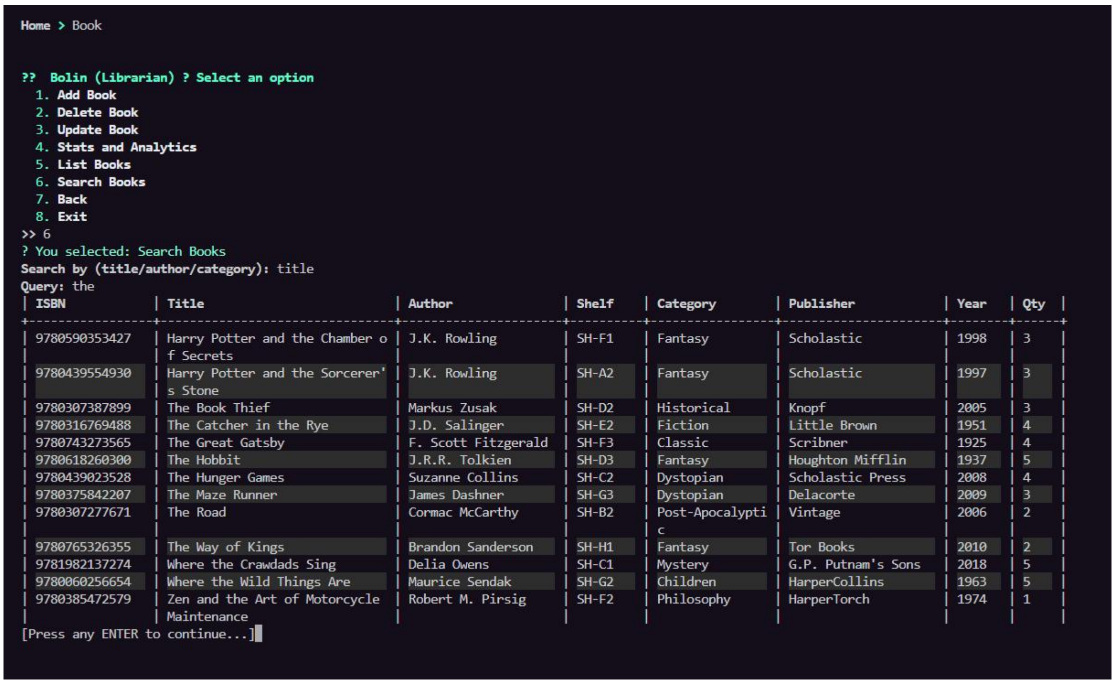
- The system uses a universal **merge sort** implementation to sort lists based on any comparator — such as sorting users by username, books by year, or fines in descending order.
- Sorting is customizable in ascending or descending order.

Search and sort utilities are found in the Searcher and Sorter classes and are reused across:

- BookService

- UserStore
- BorrowStore
- ReportHandler

Used in modules and sections:
Book search, top-borrowed books, top borrowers, fine rankings, report generation, etc.



```
Home > Book


??  Bolin (Librarian) ? Select an option
  1. Add Book
  2. Delete Book
  3. Update Book
  4. Stats and Analytics
  5. List Books
  6. Search Books
  7. Back
  8. Exit
>> 6
? You selected: Search Books
Search by (title/author/category): title
Query: the
| ISBN            | Title                          | Author               | Shelf    | Category        | Publisher            | Year   | Qty  |
+-----------------+--------------------------------+----------------------+----------+-----------------+----------------------+--------+------+
| 9780590353427   | Harry Potter and the Chamber o | J.K. Rowling         | SH-F1    | Fantasy         | Scholastic           | 1998   | 3    |
|                 | f Secrets                      |                      |          |                 |                      |        |      |
| 9780439554930   | Harry Potter and the Sorcerer' | J.K. Rowling         | SH-A2    | Fantasy         | Scholastic           | 1997   | 3    |
|                 | s Stone                        |                      |          |                 |                      |        |      |
| 9780307387899   | The Book Thief                 | Markus Zusak         | SH-D2    | Historical      | Knopf                | 2005   | 3    |
| 9780316769488   | The Catcher in the Rye         | J.D. Salinger        | SH-E2    | Fiction         | Little Brown         | 1951   | 4    |
| 9780743273565   | The Great Gatsby               | F. Scott Fitzgerald  | SH-F3    | Classic         | Scribner             | 1925   | 4    |
| 9780618260300   | The Hobbit                     | J.R.R. Tolkien       | SH-D3    | Fantasy         | Houghton Mifflin     | 1937   | 5    |
| 9780439023528   | The Hunger Games               | Suzanne Collins      | SH-C2    | Dystopian       | Scholastic Press     | 2008   | 4    |
| 9780375842207   | The Maze Runner                | James Dashner        | SH-G3    | Dystopian       | Delacorte            | 2009   | 3    |
| 9780307277671   | The Road                       | Cormac McCarthy      | SH-B2    | Post-Apocalypti | Vintage              | 2006   | 2    |
|                 |                                |                      |          | c               |                      |        |      |
| 9780765326355   | The Way of Kings               | Brandon Sanderson    | SH-H1    | Fantasy         | Tor Books            | 2010   | 2    |
| 9781982137274   | Where the Crawdads Sing        | Delia Owens          | SH-C1    | Mystery         | G.P. Putnam's Sons   | 2018   | 5    |
| 9780060256654   | Where the Wild Things Are      | Maurice Sendak       | SH-G2    | Children        | HarperCollins        | 1963   | 5    |
| 9780385472579   | Zen and the Art of Motorcycle  | Robert M. Pirsig     | SH-F2    | Philosophy      | HarperTorch          | 1974   | 1    |
|                 | Maintenance                    |                      |          |                 |                      |        |      |
[Press any ENTER to continue...]
```

3. Borrowing and Lending System

This feature tracks borrowing transactions from request to return. Each borrow record includes:

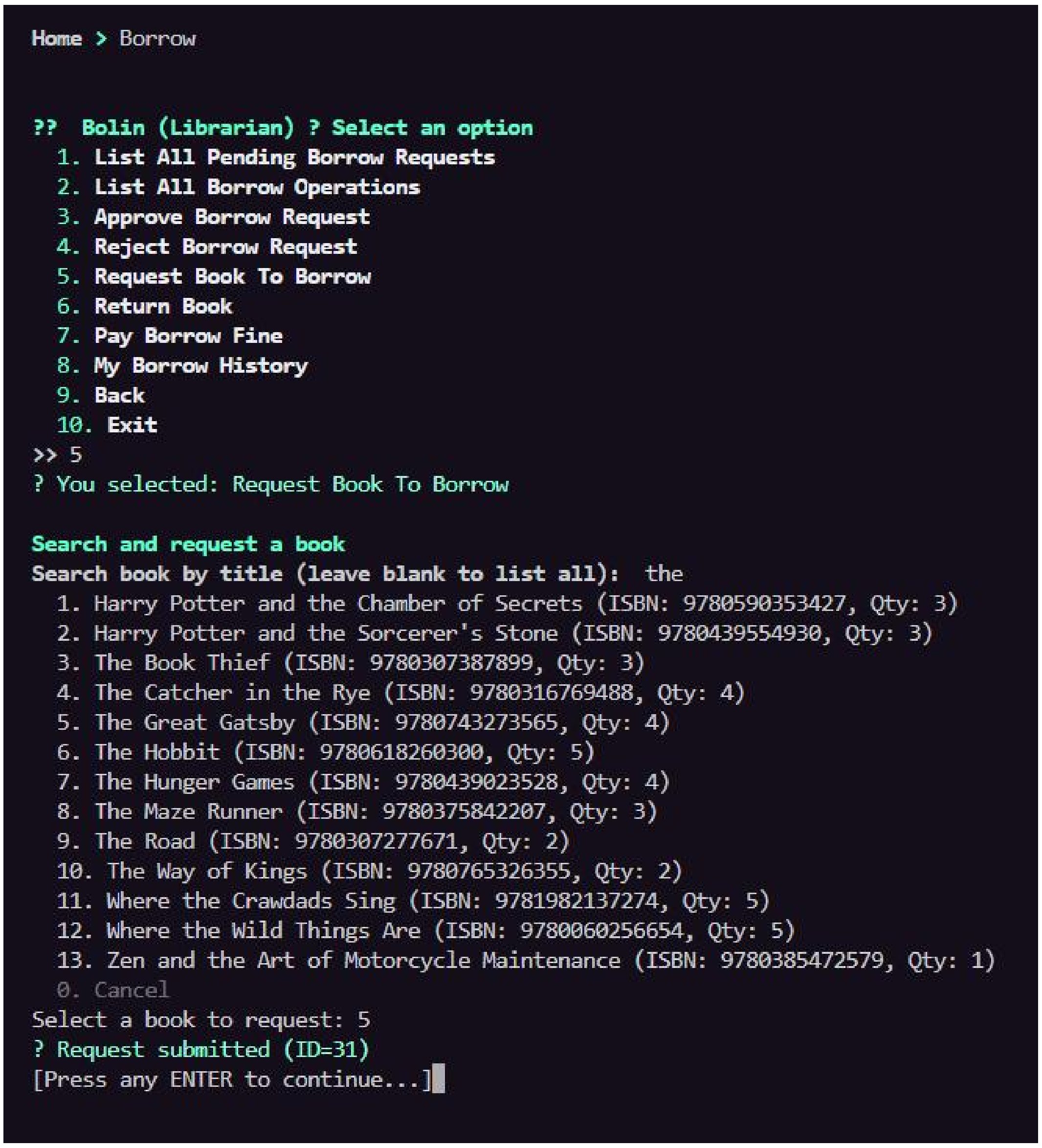
- **Book ISBN**
- **User ID**
- **Borrow Date**, **Return Date**
- **Status** (PENDING, APPROVED, RETURNED)

Borrow requests are approved only if:

- The book is in stock
- The user is active and has not exceeded the fine threshold

Stock is automatically deducted on approval and replenished upon return.

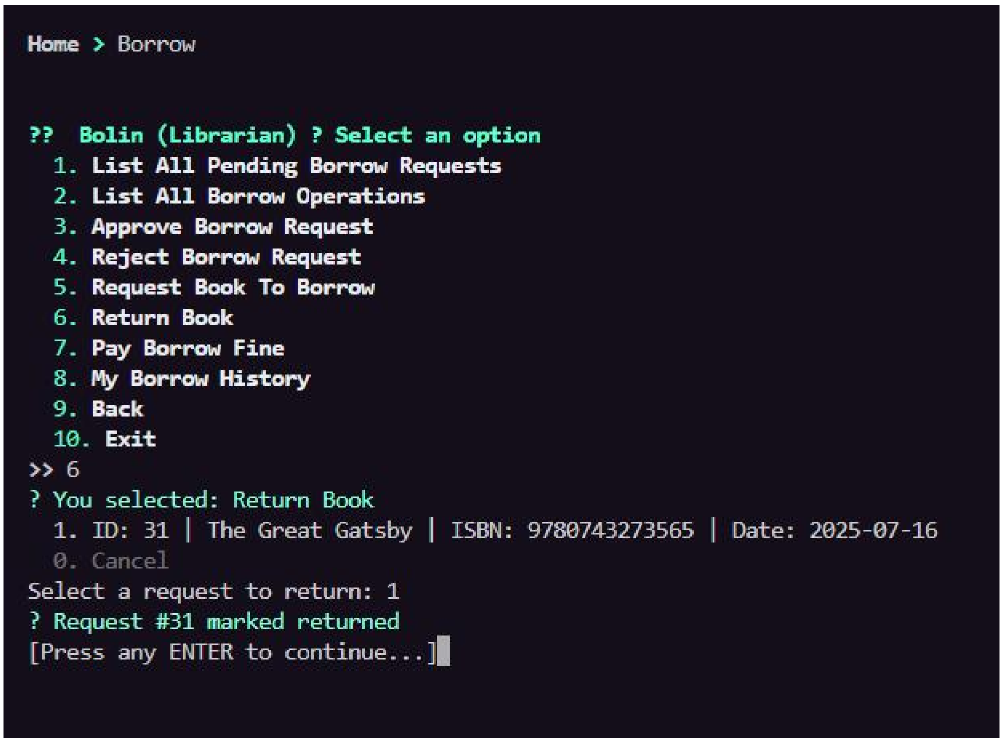
Non-interactive commands:
borrow request, borrow approve, borrow return, borrow list



```
Home > Borrow


?? Bolin (Librarian) ? Select an option
  1. List All Pending Borrow Requests
  2. List All Borrow Operations
  3. Approve Borrow Request
  4. Reject Borrow Request
  5. Request Book To Borrow
  6. Return Book
  7. Pay Borrow Fine
  8. My Borrow History
  9. Back
  10. Exit
>> 5
? You selected: Request Book To Borrow

Search and request a book
Search book by title (leave blank to list all):  the
  1. Harry Potter and the Chamber of Secrets (ISBN: 9780590353427, Qty: 3)
  2. Harry Potter and the Sorcerer's Stone (ISBN: 9780439554930, Qty: 3)
  3. The Book Thief (ISBN: 9780307387899, Qty: 3)
  4. The Catcher in the Rye (ISBN: 9780316769488, Qty: 4)
  5. The Great Gatsby (ISBN: 9780743273565, Qty: 4)
  6. The Hobbit (ISBN: 9780618260300, Qty: 5)
  7. The Hunger Games (ISBN: 9780439023528, Qty: 4)
  8. The Maze Runner (ISBN: 9780375842207, Qty: 3)
  9. The Road (ISBN: 9780307277671, Qty: 2)
  10. The Way of Kings (ISBN: 9780765326355, Qty: 2)
  11. Where the Crawdads Sing (ISBN: 9781982137274, Qty: 5)
  12. Where the Wild Things Are (ISBN: 9780060256654, Qty: 5)
  13. Zen and the Art of Motorcycle Maintenance (ISBN: 9780385472579, Qty: 1)
  0. Cancel
Select a book to request: 5
? Request submitted (ID=31)
[Press any ENTER to continue...]
```



```
Home > Borrow


??  Bolin (Librarian) ? Select an option
  1. List All Pending Borrow Requests
  2. List All Borrow Operations
  3. Approve Borrow Request
  4. Reject Borrow Request
  5. Request Book To Borrow
  6. Return Book
  7. Pay Borrow Fine
  8. My Borrow History
  9. Back
  10. Exit
>> 6
? You selected: Return Book
  1. ID: 31 | The Great Gatsby | ISBN: 9780743273565 | Date: 2025-07-16
  0. Cancel
Select a request to return: 1
? Request #31 marked returned
[Press any ENTER to continue...]
```

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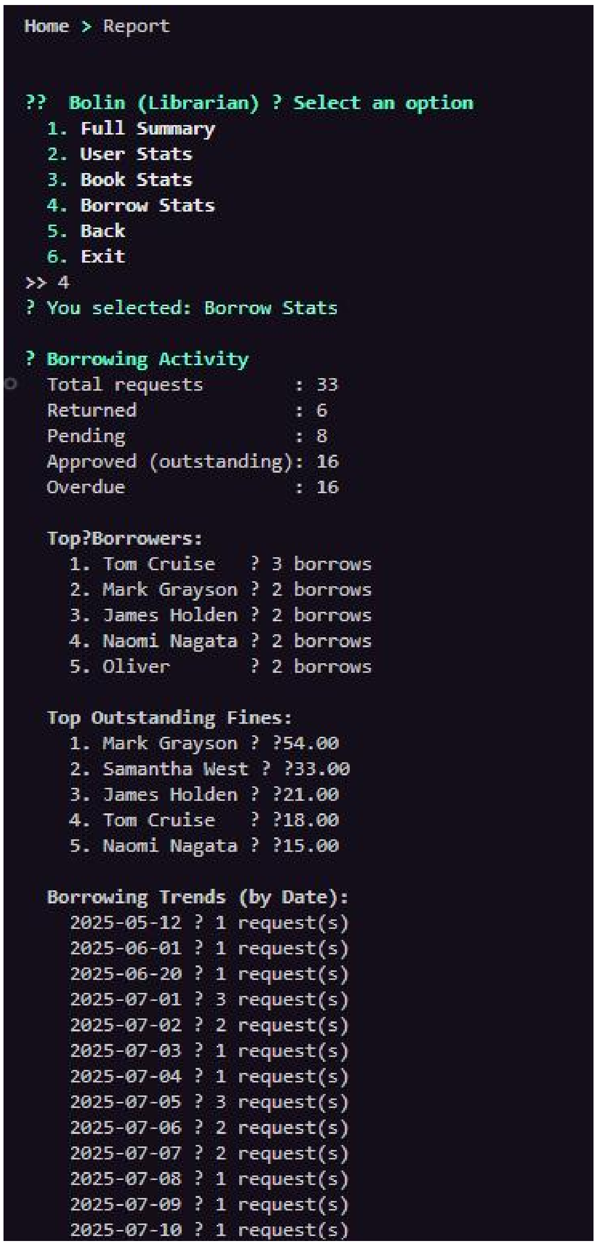
4. Overdue Detection and Fine System

The system uses **date-based logic** to determine overdue books. Once a book surpasses the **loan period**, the system calculates a fine using the configured **fine-per-day** value.

- Overdue fines are stored per user and updated on each run.
- Borrowers exceeding the **block threshold** are prevented from making new requests.
- Admins can reduce fines or reset approve dates to help borrowers.



```
Home > Report

??  Bolin (Librarian) ? Select an option
  1. Full Summary
  2. User Stats
  3. Book Stats
  4. Borrow Stats
  5. Back
  6. Exit
>> 4
? You selected: Borrow Stats

? Borrowing Activity
  Total requests        : 33
  Returned              : 6
  Pending               : 8
  Approved (outstanding): 16
  Overdue               : 16

  Top?Borrowers:
    1. Tom Cruise    ? 3 borrows
    2. Mark Grayson  ? 2 borrows
    3. James Holden  ? 2 borrows
    4. Naomi Nagata  ? 2 borrows
    5. Oliver        ? 2 borrows

  Top Outstanding Fines:
    1. Mark Grayson ? ?54.00
    2. Samantha West ? ?33.00
    3. James Holden ? ?21.00
    4. Tom Cruise   ? ?18.00
    5. Naomi Nagata ? ?15.00

  Borrowing Trends (by Date):
    2025-05-12 ? 1 request(s)
    2025-06-01 ? 1 request(s)
    2025-06-20 ? 1 request(s)
    2025-07-01 ? 3 request(s)
    2025-07-02 ? 2 request(s)
    2025-07-03 ? 1 request(s)
    2025-07-04 ? 1 request(s)
    2025-07-05 ? 3 request(s)
    2025-07-06 ? 2 request(s)
    2025-07-07 ? 2 request(s)
    2025-07-08 ? 1 request(s)
    2025-07-09 ? 1 request(s)
    2025-07-10 ? 1 request(s)
```

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5. User Management

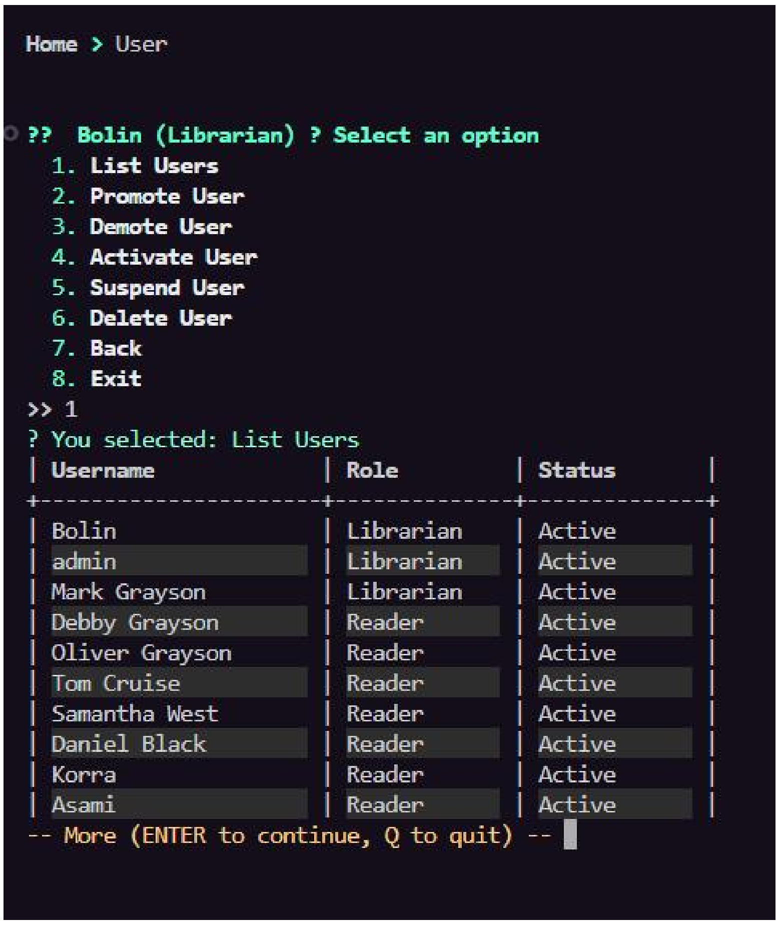
Admins can manage user accounts with features to:

- deactivate/activate accounts
- Promote to librarian or demote to reader

All operations are persisted to file and include validation checks to avoid duplicates.

Non-interactive commands:
user list, user delete, user deactivate, user promote, user demote, user activate

Interactive path:
Home > User



```
Home > User

?? Bolin (Librarian) ? Select an option
  1. List Users
  2. Promote User
  3. Demote User
  4. Activate User
  5. Suspend User
  6. Delete User
  7. Back
  8. Exit
>> 1
? You selected: List Users
| Username             | Role          | Status        |
+----------------------+---------------+---------------+
| Bolin                | Librarian     | Active        |
| admin                | Librarian     | Active        |
| Mark Grayson         | Librarian     | Active        |
| Debby Grayson        | Reader        | Active        |
| Oliver Grayson       | Reader        | Active        |
| Tom Cruise           | Reader        | Active        |
| Samantha West        | Reader        | Active        |
| Daniel Black         | Reader        | Active        |
| Korra                | Reader        | Active        |
| Asami                | Reader        | Active        |
-- More (ENTER to continue, Q to quit) --
```

---

6. Reports and Analytics

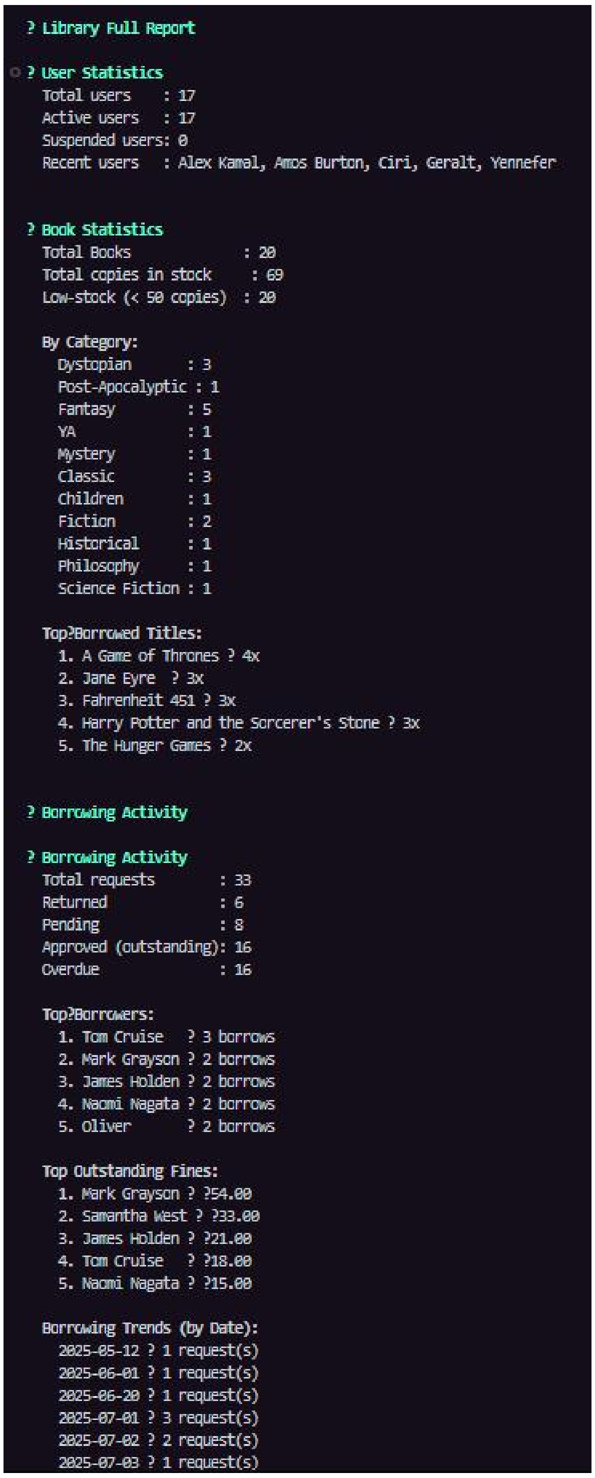
The system supports rich reporting features powered by in-memory statistics and sorted data structures. It includes:

1. **Top Borrowed Books** (ranked by frequency)
2. **Top Borrowers** (users with the most requests)
3. **Users with Highest Fines Paid**
4. **Inventory Breakdown** (by category, total stock, low stock)
5. **Borrowing Activity** (approved, pending, returned, overdue)

Reports are generated via static methods in the ReportHandler class, and sorting is handled with the universal sort logic.

Non-interactive commands:
report view, report books, report users, report borrows

Interactive path:
Home > Report - (Full Summary, Users, Books, Borrows)


```
? Library Full Report

? User Statistics
  Total users    : 17
  Active users   : 17
  Suspended users: 0
  Recent users   : Alex Kamal, Amos Burton, Ciri, Geralt, Yennefer


? Book Statistics
  Total Books             : 20
  Total copies in stock    : 69
  Low-stock (< 50 copies)  : 20

  By Category:
    Dystopian       : 3
    Post-Apocalyptic : 1
    Fantasy         : 5
    YA              : 1
    Mystery         : 1
    Classic         : 3
    Children        : 1
    Fiction         : 2
    Historical      : 1
    Philosophy      : 1
    Science Fiction : 1

  Top?Borrowed Titles:
    1. A Game of Thrones ? 4x
    2. Jane Eyre  ? 3x
    3. Fahrenheit 451 ? 3x
    4. Harry Potter and the Sorcerer's Stone ? 3x
    5. The Hunger Games ? 2x


? Borrowing Activity

? Borrowing Activity
  Total requests        : 33
  Returned              : 6
  Pending               : 8
  Approved (outstanding): 16
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    5. Naomi Nagata ? ?15.00

  Borrowing Trends (by Date):
    2025-05-12 ? 1 request(s)
    2025-06-01 ? 1 request(s)
    2025-06-20 ? 1 request(s)
    2025-07-01 ? 3 request(s)
    2025-07-02 ? 2 request(s)
    2025-07-03 ? 1 request(s)
```

---

7. System Configuration

The borrowing behavior is configurable via a settings file (settings.txt). The admin can update:

loanPeriod — how many days a book may be borrowed

finePerDay — fine charged per day overdue

blockThreshold — max fine before suspension

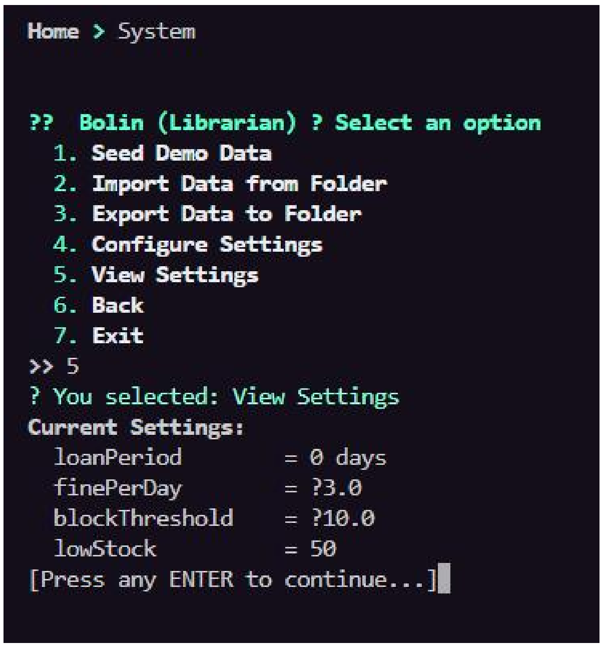
lowStock — stock level below which books are flagged

The config is loaded on startup and persisted on update.

Non-interactive commands:

system config set <loanPeriod | finePerDay | blockThreshold | lowStock> <value>

Interactive path:
Home > System - (Configure Settings)



```
Home > System


??  Bolin (Librarian) ? Select an option
  1. Seed Demo Data
  2. Import Data from Folder
  3. Export Data to Folder
  4. Configure Settings
  5. View Settings
  6. Back
  7. Exit
>> 5
? You selected: View Settings
Current Settings:
  loanPeriod        = 0 days
  finePerDay        = ?3.0
  blockThreshold    = ?10.0
  lowStock          = 50
[Press any ENTER to continue...]
```

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8. Data Persistence, Import, Export, and Seeding

All data is stored in plain text format within a resources/ folder. The app supports:

Automatic saving on every update

Data reload on startup

Export: Dump current state to a folder (excluding session)

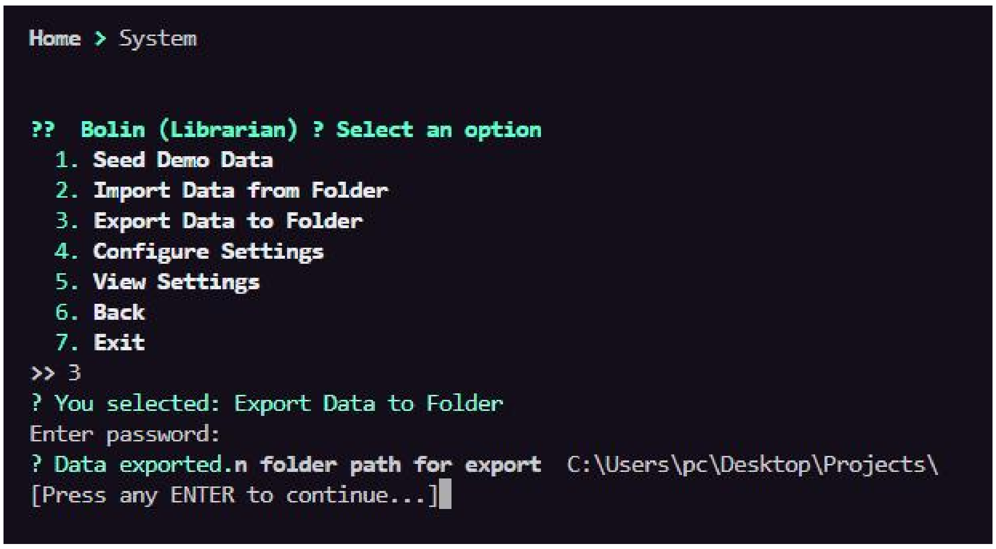
Import: Load from folder (overwrites current data)

Seed: Developer-only feature that populates demo data (only enabled in dev mode)

Session files are excluded from import/export to avoid credential leakage.

Non-interactive commands:
system export --file <path>, system import --file <path>, system seed

Interactive path:
Home > System - (Export Data to Folder, Import Data from Folder, Seed Demo Data)



```
Home > System


??  Bolin (Librarian) ? Select an option
  1. Seed Demo Data
  2. Import Data from Folder
  3. Export Data to Folder
  4. Configure Settings
  5. View Settings
  6. Back
  7. Exit
>> 3
? You selected: Export Data to Folder
Enter password:
? Data exported.n folder path for export  C:\Users\pc\Desktop\Projects\
[Press any ENTER to continue...]
```

3. Data Structures Used

This system was intentionally built without external databases or GUI libraries. All data structures were implemented using core Java features, with emphasis on correct application of standard DSA techniques.

Arrays and ArrayLists

Where Used: Book list, Borrow record list, user data, logs, menu options.

Why: Fast indexed access and ease of iteration. Suitable for operations like looping through all books, users, or borrow records.

Benefits: Simple to use, efficient for read-heavy scenarios.

Trade-offs: Linear search time unless sorted

HashMap (Dictionaries/Maps)

Where Used:

- Storing books.
- Counting borrow frequency per user or book.
- Mapping usernames to fine totals or borrow history.

Why: Allows fast O(1) lookup by key (e.g., isbn → book, username → count).

Benefits: Excellent for fast access, grouping, and counting tasks.

Trade-offs: Unordered; not suited for operations needing sorted order.

Stack (Breadcrumb Navigation)

Where Used:

Used internally in ConsoleUI to track menu history.

Benefits: Allows showing a breadcrumb like Home > System > Settings as the user navigates.

Why: Stack is ideal for last-in, first-out navigation history.

File Storage (CSV Files as Persistent Store)

Where Used:

All long-term storage: books.csv, users.csv, borrows.csv, settings.txt

Why: Offline-first requirement; no external database allowed.

Benefits: Human-readable, portable, editable.

Trade-offs: No indexing or concurrent access control like in DBs; all file operations are manual.

Priority Queue (Min-Heap / Max-Heap)

Where Used:

Overdue Monitoring: A min-heap based on borrow date tracks the most overdue books.

```
PriorityQueue<BorrowRecord> pq = new PriorityQueue<>(Comparator.comparing(r
-> r.getDecisionDate()));
```

Fines Ranking: A max-heap ranks users by their total fines.

```
PriorityQueue<Map.Entry<String, Double>> pq = new PriorityQueue<>((a,b) ->
Double.compare(b.getValue(), a.getValue()));
```

Why: Efficient way to get the most overdue book or highest fine payer in O(log n) time.

Benefits: Great for top-k queries and urgent prioritization.

Trade-offs: Not suited for full scans or range queries.

These choices were made based on the problem's offline, low-resource constraints, while still respecting good DSA principles for data organization, performance, and reusability.

4. Algorithms Used

This system features a few carefully selected algorithms, implemented manually as part of the course requirement. The main categories are:

Binary Search

Where Used:

Searching for a book or borrow record by ID or ISBN in a pre-sorted list.

Why: Reduces search time from O(n) to O(log n) in sorted lists.

Implementation:

A generic `Searcher.binarySearch(List<T>, T target, Comparator<T>)` was created to allow reuse across different object types.

Trade-offs:

- Requires pre-sorted data.
- Less flexible than linear search in unsorted lists.

Merge Sort

Where Used:

- Sorting books by title, year, or other fields.
- Sorting user or borrow statistics for reporting (e.g., most borrowed books, top borrowers).

Why: Stable, efficient O(n log n) sorting algorithm well-suited to large datasets.

Implementation:

A generic `Sorter.mergeSort(List<T>, Comparator<T>)` was written to allow sorting of any type.

Trade-offs:

- Uses extra space for intermediate sublists (recursive strategy).
- Not optimal for small or nearly-sorted lists compared to insertion sort.

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5. Conclusion

The **Ebenezer Library Book Lending System** meets the core project objectives:

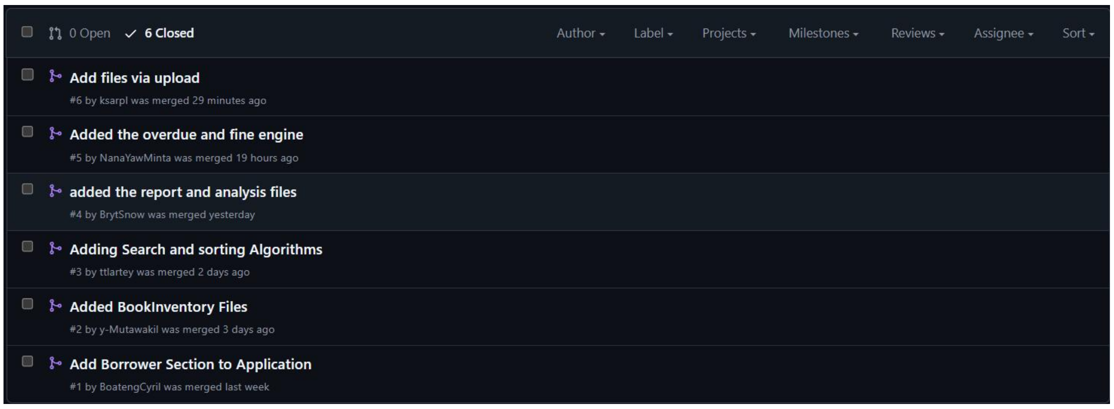
- It's fully offline and file-based.
- It replaces the library's outdated manual tracking with an efficient, user-friendly console system.
- It includes core features like book cataloging, borrow tracking, fine handling, and statistical reporting — all built with relevant data structures and algorithms as per the course requirements.

We adopted a modular design with reusable utilities (e.g., search/sort), and designed the system to be extendable for future GUI or network features if needed.

This project solidified our understanding of data structures like hash maps, arrays, and priority queues, as well as the practical implementation of algorithms like binary search and merge sort in real-world scenarios.

6. Group Member Contributions

Name	ID	Activities Done	Contribution %	Attendance (X/5)
Mensah Lartey Isaiah Nii Larte	11222100	Core backend, file storage, settings, borrow logic, CLI	20%	5/5
Anti Bright Gyeadu	11340436	Report & Analysis Generator	12%	5/5
Adjei-Gyebi Minta Okatakyie	11040586	Borrow Over Due and Fine logic	18%	4/5
Kofi Sarpei Lartey	11333137	Lending & Return System	10%	3/5
Boateng Cyril Konadu	11124483	Borrower Registry	12%	4/5
Yussif Mutawakil	11252675	Book Inventory & Catalog	13%	5/5
Thomas Tetteh Lartey	11223578	Search and Sort Logic	15%	4/5



Add files via upload
#6 by ksarpl was merged 29 minutes ago

Added the overdue and fine engine
#5 by NanaYawMinta was merged 19 hours ago

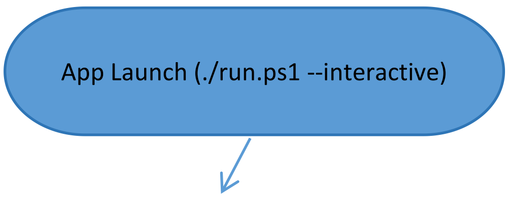
added the report and analysis files
#4 by BrytSnow was merged yesterday

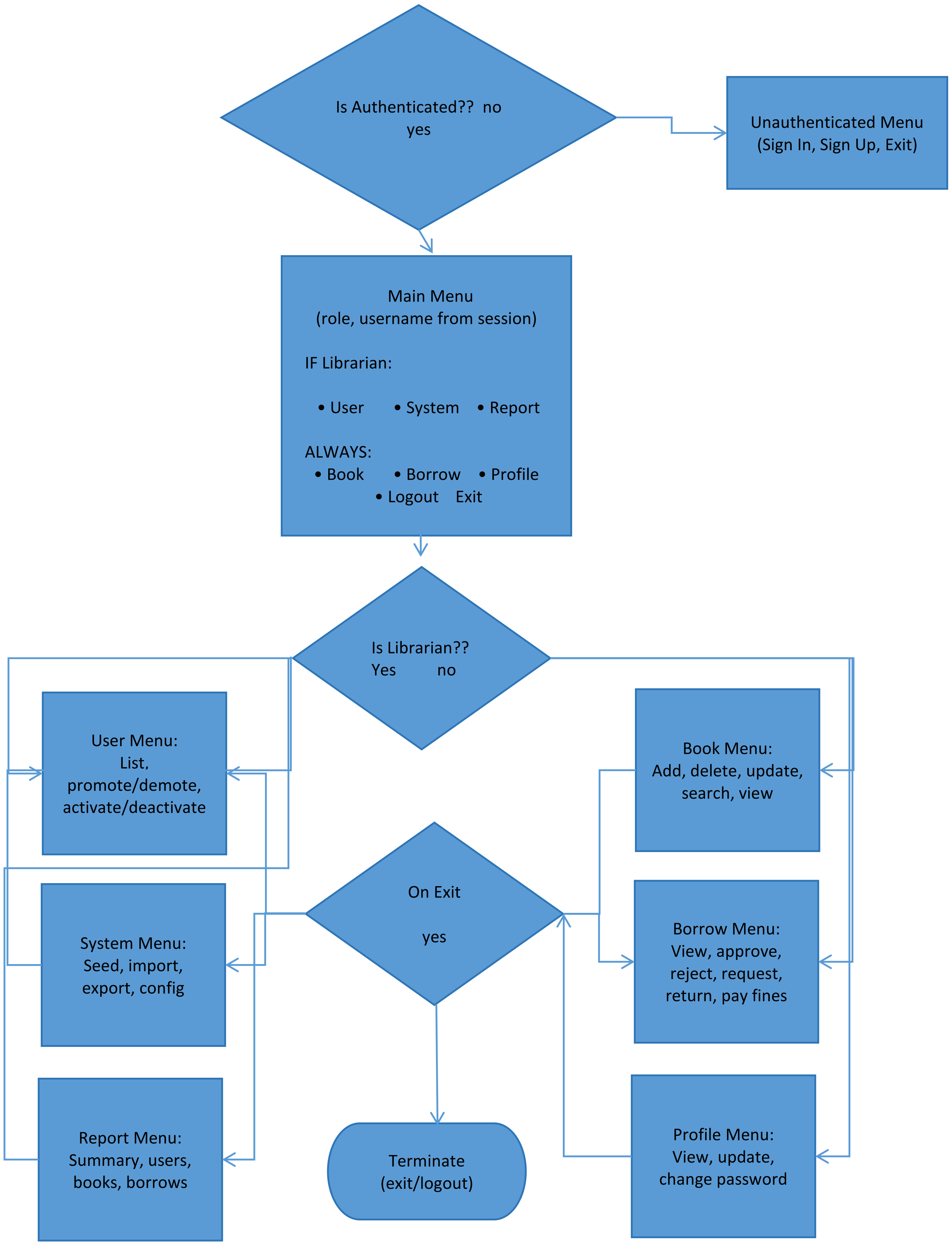
Adding Search and sorting Algorithms
#3 by ttlartey was merged 2 days ago

Added BookInventory Files
#2 by y-Mutawakil was merged 3 days ago

Add Borrower Section to Application
#1 by BoatengCyril was merged last week

Flow Diagram




Is Authenticated?? no
yes
Unauthenticated Menu
(Sign In, Sign Up, Exit)
Main Menu
(role, username from session)
IF Librarian:
• User • System • Report
ALWAYS:
• Book • Borrow • Profile
• Logout Exit
Is Librarian??
Yes no
User Menu:
List,
promote/demote,
activate/deactivate
System Menu:
Seed, import,
export, config
Report Menu:
Summary, users,
books, borrows
On Exit
yes
Terminate
(exit/logout)
Book Menu:
Add, delete, update,
search, view
Borrow Menu:
View, approve,
reject, request,
return, pay fines
Profile Menu:
View, update,
change password