Report Data Structures Project: KMUTT Book store system

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Problems Statement

The KMUTT Bookstore wants to develop a management system that efficiently handles its book inventory, customer purchases, and search functionality using core data structures. A linked list will be used to manage the dynamic stock of books, allowing staff to add, update, or remove book records easily. A queue structure will handle customer purchase and order requests in a first-in, first-out manner, processing them based on stock availability and managing backorders when necessary. To enable fast and efficient searching of books by title, a binary search tree (BST) will be implemented, linking each node to the corresponding book in the inventory. This system will ensure streamlined bookstore operations, quick book lookups, and organized handling of purchase activities.

System objective

1. Efficiently manage book inventory using a linked list for dynamic addition, update, and removal of books.
2. Process customer purchases and backorders in a first-in, first-out manner using a queue.
3. Enable fast and accurate book searches by title using a binary search tree (BST).
4. Ensure real-time updates and synchronization between the inventory, order system, and search function.
5. Improve overall operational efficiency, reduce manual workload, and enhance the customer experience at the KMUTT Bookstore.

Functionality

For administrator

1. Show Books - Displays all available books in the inventory with details such as title, author, price, and quantity.
2. Show Orders - Lists all current customer purchase or backorder requests waiting to be processed.
3. Show History Orders - Displays a log of completed orders, including customer details and book purchase information.
4. Show Log Stock Book - Shows a record of all stock changes (additions, removals, updates) for tracking inventory activity.
5. Show List Borrowed Books - Displays the list of books currently borrowed by customers, including due dates if applicable.
6. Show List Returned Books - Lists books that have been returned, including return dates and borrower details.
7. Search Book - Allows users to search for a book by title using a binary search tree for fast lookup.
8. Edit Stock Book - Enables staff to update book information such as price or quantity in the inventory.
9. Manage Coupons - Lets admins create, update, or disable discount coupons for customer purchases.
10. Manage Admins - Provides functionality to add, remove, or update administrator accounts and permissions.
11. Generate Report - Creates summary reports on sales, stock levels, borrowed/returned books, and coupon usage.
12. Manage Borrowed Books - Handles borrowing activities such as checking out books to customers, tracking due dates, and marking returns.

For customer

1. View Books (Include buy a book) - Displays all available books with details and allows customers to purchase books directly if they are in stock.
2. Search Books - Lets users search for books by title using a fast binary search tree (BST) structure and view their availability.
3. Pre-Order Book - Allows customers to place an order for books that are currently out of stock, adding them to a pre-order (backorder) queue.
4. Borrow Book - Enables users to borrow books from the bookstore (e.g., for academic purposes), recording borrow details and due dates.
5. Return Book - Processes the return of borrowed books, updates stock, and logs the return activity for tracking.
6. Process Order - Handles pending purchase and pre-order queues by checking stock and completing transactions in a first-come, first-served manner.

General functions
1. Allows users (customers or admins) to securely access the system by verifying their username and password, directing them to the appropriate dashboard based on their role.

Explanation of the chosen data structures

1. Linked List

Used For:

- Managing books in stock (Book structure)
- Handling items in the shopping cart (CartItem structure)

Why Chosen:

- Supports dynamic memory allocation, making it easy to add or remove books and cart items without resizing.
- A doubly linked list for books enables forward and backward traversal, helpful for editing or deleting entries.

Key Operations:

- Insertion: Add new books or cart items
- Traversal: Display books or cart contents
- Deletion: Remove books or cart items when needed

2. Queue

Used For:

- Managing purchase orders (OrderQueue)
- Managing borrow requests (BorrowQueue)
- Logging actions and order history (LogQueue, HistoryQueue)

Why Chosen:

- Follows First-In-First-Out (FIFO), ideal for processing actions in the order received.
- Simplifies sequential task handling, such as confirming orders or returning books.

Key Operations:

- Enqueue: Add new orders, borrow requests, or logs
- Dequeue: Process and remove the oldest entry
- Traversal: Display queue contents for admin review

3. Binary Search Tree (BST)

Used For:

- Organizing books for efficient search operations (TreeNode structure)

Why Chosen:

- Enables fast search, insert, and traversal based on book attributes (e.g., title, ID, category).
- Keeps books organized to support efficient queries.

Key Operations:

- Insertion: Add books while maintaining BST order
- Traversal: Use in-order traversal to display sorted books
- Search: Find books by title, author, or category

Solution with functionalities

The bookstore management system is built as a modular C program with distinct roles and features for Admins and Users. It integrates multiple data structures and file operations to simulate real-world bookstore operations such as inventory management, order processing, and book lending.

Solution Architecture

The system is composed of five major modules:

1. Login Module (login.c)
2. Admin Module (admin.c)
3. User Module (main.c)
4. Search Modules (search.c, searchadmin.c)
5. Data Storage Layer (CSV files)

Admin Functionalities

Handled in admin.c

Admins manage and monitor bookstore operations.

Functionality	Description
Show Books	Display all books in stock using a doubly linked list.
Show Orders	Display and process customer orders (queue-based).
Show History Orders	View all past confirmed orders from file.
Show Log Stock Book	Track stock-in/out activity using Log_Stockbook.csv.
Show Borrowed Books	List currently borrowed books from List_borrow_book.csv.
Show Returned Books	List all returned books from list_return.csv.
Search Book	Search by title, author, category, or price using searchadmin.exe.
Edit Stock Book	Add, edit, delete, or restock books.
Manage Coupons	Create, update, delete, and view available coupons.
Manage Admins	Add or remove other admin accounts.
Generate Report	Summarize key stats: total orders, sales, and revenue.
Manage Borrowed Books	View and manage borrow records.
Exit	Return to login module.

User Functionalities

Handled in main.c

Users interact with the system for browsing and purchasing.

Functionality	Description
View Books	Display all available books and allow users to add to cart.
Search Books	Search for books using search.exe by title, author, category, or price.
Pre-Order Book	Reserve a book that is currently out of stock.
Borrow Book	Borrow books and temporarily reduce stock.
Return Book	Return borrowed books and update stock.
Process Order	Finalize purchases and generate order records.
Exit	Return to login screen.

Search Functionalities

Handled in searchadmin.c and search.c

Functionality	Description
Search by Title	Look up books by their title.
Search by Author	Find books written by a specific author.

Functionality	Description
Search by Category	Filter books by genre or classification.
Search by Price	Find books within a specified price range.
Return to Menu	Exit the search module and return to admin/user interface.

Login Functionalities

Handled in login.c

Functionality	Description
Login	Authenticate users and admins and redirect accordingly.
Create Account	Register a new user account.
Show Books (Guest)	Allow unauthenticated users to view available books.
Exit	Terminate the program.

Persistent Storage (CSV Files)

File Name	Purpose
Book_Stock.csv	Stores all book inventory details.
Orderlist.csv	Tracks pending user orders.
History_Order.csv	Stores all completed orders.
List_borrow_book.csv	Stores currently borrowed books.
list_return.csv	Stores returned book records.
Log_Stockbook.csv	Tracks stock change logs.
coupon.csv	Stores coupon details.
admin_login.csv	Stores admin credentials.
user_login.csv	Stores user credentials.

Code Walkthrough

1. login.c

- **Purpose**: Handles user and admin authentication and account creation.

   Key Functions:

   - **createAccount()**: Allows users to create accounts after ensuring the username is unique.
   - **login()**: Authenticates users and admins, redirecting them to the appropriate module (admin.exe or main.exe).
   - **showBooks()**: Displays all books in stock for unauthenticated users.

- **main()**: Provides a menu for login, account creation, viewing books, and exiting.

2. main.c

- **Purpose**: Implements user-side functionalities.

Key Features:

- **View Books**: Displays books in stock and allows users to add them to the cart.
- **Search Books**: Calls search.exe to search for books by category, title, author, or price range.
- **Pre-Order Book**: Allows users to pre-order books from incoming stock.
- **Borrow/Return Books**: Enables users to borrow and return books, updating stock accordingly.
- **Process Orders**: Processes pending orders for users.
- **Cart Operations**: Allows users to add, view, edit, and checkout items in their cart.

3. admin.c

- **Purpose**: Implements admin-side functionalities.

Key Features:

- **Book Management**: View, edit, delete, add stock, or add new books.
- **Order Management**: View and confirm pending orders, and view order history.
- **Log Management**: View stock transaction logs.
- **Coupon Management**: Add, edit, delete, or view coupons.
- **Borrowed Books Management**: View, edit, or delete borrowed book records.
- **Admin Account Management**: Add, edit, or delete admin accounts.
- **Generate Reports**: Summarize total orders, books sold, and revenue.

4. search.c

- **Purpose**: Implements user-side search functionality.

Key Features:

- **Search by Category/Title/Author**: Searches for books in the stock using a binary search tree (BST).
- **Search by Price Range**: Finds books within a specified price range and allows sorting by price.
- **Tree Operations**: Efficiently manages books using a BST for fast searching.

5. searchadmin.c

- **Purpose**: Implements admin-side search functionality.

Key Features:

- Similar to search.c, but tailored for admin use.
- May include additional options for editing or deleting books directly from search results.

6. File-Based Storage

Data Files:

- Book_Stock.csv: Stores book details.

- **Orderlist.csv**: Stores pending orders.
- **History_Order.csv**: Stores confirmed orders.
- **Log_Stockbook.csv**: Stores stock transaction logs.
- **List_borrow_book.csv**: Stores borrowed book records.
- **list_return.csv**: Stores returned book records.
- **Coupon.csv**: Stores coupon codes and discounts.
- **Admin_Password.csv**: Stores admin credentials.
- **Account.csv**: Stores user credentials.

Flow of the System

1. **Login Module (login.c)**:

   - Users and admins log in or create accounts.
   - Redirects to the appropriate module (main.exe for users, admin.exe for admins).

2. **User Module (main.c)**:

   - Users can view books, search, manage orders, borrow/return books, and checkout.

3. **Admin Module (admin.c)**:

   - Admins can manage books, orders, logs, coupons, borrowed books, and generate reports.

4. **Search Modules (search.c and** searchadmin.c**)**:

   - Provides search functionality for books using a binary search tree.

Key Features

- **Account Management**: Create and authenticate user/admin accounts.
- **Book Management**: View, edit, delete, and add books.
- **Order Management**: Process and confirm orders.
- **Search Functionality**: Search books by category, title, author, or price range.
- **Reports**: Generate summaries of bookstore performance.
- **Error Handling**: Validates inputs and handles file-related errors.

Time Complexity Analysis

Summary of time complexities	
Functionality	Time complexity
Insert into BST	O(h)
Search in BST	O(n)
In-order Traversal of BST	O(n)
Sort Linked List (Price Results)	O(k²)
Load Books into BST	O(n * h)
Load Books into Linked List	O(n)
Display Books	O(n)
Add to Cart	O(n)
Checkout	O(c * n)
Borrow/Return Book	O(n)
Create Account	O(a + u)
Login	O(a + u)
Generate Report	O(h + l)

Team Member Responsibilities

Name	Responsibilities
Mr. Bannasorn Thongkorn	- Make a main.c page - Bug fixer
Mr. Supapanya Yathip	- Make a admin.c page - System designer
Mr. Kirakit Kingkaew	- Make a login.c page and search system - QA(Tester)