**Design Analysis and algorithms**



**Complex Computing Problem**

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### Library Management System Report

#### Introduction

The Library Management System (LMS) is a comprehensive tool designed to facilitate the management of books and clients within a library. This system provides functionalities for both clients and administrators, ensuring a seamless borrowing and returning process while maintaining an organized inventory of books. The key features include client registration, book management, and administrative tasks, which collectively enhance the library's operational efficiency.

#### Data Structures Used

The LMS employs various data structures to efficiently handle its operations:

1. **Classes**:
   * **Client**: Stores client information such as ID, username, first name, father's name, and password.
   * **Book**: Manages book details including title, book ID, and borrowed status.
   * **Administrator**: Holds administrator credentials for login purposes.
2. **Containers**:
   * **unordered\_map**: Used to store clients with their IDs as keys for fast retrieval.
   * **vector**: Maintains a list of books to facilitate operations such as adding and deleting books.
3. **Binary Search Trees**:
   * **BorrowedBookNode**: A node structure for maintaining a binary search tree of borrowed books.
   * **BookNode**: A node structure for maintaining a binary search tree of available books.

#### Program Workflow

The LMS consists of various modules, each handling specific aspects of library management. Here's a detailed explanation of how the program works:

1. **Client Registration**:
   * Clients can create a new profile by providing their ID, username, first name, father's name, and password.
   * The Client class is instantiated with the provided information, and the new client is added to the clients unordered\_map.
2. **Book Management**:
   * **Add Book**: Administrators can add new books by entering the book title and unique ID. The book is added to the books vector and also inserted into a binary search tree (booksRoot) for efficient management.
   * **Delete Book**: Administrators can remove books by searching for the title. If found, the book is removed from the books vector.
   * **View Books**: Both clients and administrators can view a list of all available books, showing the title, book ID, and borrowed status.
3. **Borrowing Books**:
   * **Search**: Clients can search for books by title or ID number to check availability.
   * **Borrow**: If a book is available, the client can borrow it. The book's status is updated to borrowed, and it is added to the borrowed books binary search tree (borrowedBooksRoot).
   * **Return**: When a client returns a book, the book's status is updated to available, and it is removed from the borrowed books tree.
4. **Client Management**:
   * **Add Client**: Administrators can add new clients by collecting required information and creating a new Client object.
   * **Delete Client**: Administrators can remove client profiles by searching for the client's ID.
   * **View Clients**: Administrators can view all registered clients, displaying their ID and username.
5. **Administrator Login**:
   * Administrators log in using a unique username and password. The system validates the credentials to grant access to administrative functions.
6. **Administrator Tasks**:
   * Administrators can add or delete books, manage clients, and view all books and clients.
   * The system provides an administrator menu with various options to perform these tasks.

### Conclusion

The Library Management System efficiently handles the library's operations, from client registration to book management and borrowing processes. By leveraging appropriate data structures, the system ensures fast and organized management, providing a user-friendly experience for both clients and administrators. This detailed report covers the essential aspects and functionalities of the system, illustrating how each component contributes to its overall effectiveness.