28.11.2024
122200058

CMPE.261

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Library Project **(**Digital Library Management System)

The goal of this project is to create a Digital Library Management System using C++. This system is designed to handle a collection of books and users, offering features such as adding, searching, borrowing, and displaying books, along with user account management. This project highlights the implementation of object-oriented programming (OOP) principles, including encapsulation, inheritance, polymorphism, and efficient dynamic memory management.

Class and Function

1. LibraryBook

This class represents individual books in the library.

- **Attributes:**
- title: The title of the book.
- author: The author of the book.
- ISBN: A unique identifier for the book.
- isAvailable: Indicates whether the book is available.
- numberOfBooks: A static variable that tracks the total number of books.
- **Methods:**
- **Constructor and Destructor:** Manages the lifecycle of a book object and updates the static count of books.
- **Getter and Setter Methods:** Provides access and modification functionality for the attributes.
- **displayInfo():** Displays the book's deta

2. LibraryUser (Abstract Base Class)

Defines the generic attributes and behaviors of a library user.

- **Attributes:**
- name: The user's name.
- id: A unique ID for the user.
- **Methods:**
- **Constructor:** Initializes user attributes.
- **displayInfo():** A pure virtual function to be overridden in derived classes.

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3. Librarian (Derived from LibraryUser)

This class represents a librarian with additional functionalities.

- **Attributes:** Inherits all attributes from LibraryUser.
- **Methods:**
- **addBook():** Adds a new book to the library system.
- **removeBook():** Removes a book from the library system based on its ISBN.
- **displayInfo():** Displays librarian details.

4. LibrarySystem

Manages the library's books and users.

- **Attributes:**
- books: A vector of pointers to LibraryBook objects.
- users: A vector of pointers to LibraryUser objects.
- **Methods:**
- **addUser():** Adds a new user to the system.
- **removeUser():** Removes a user by ID.
- **addBook():** Adds a new book to the library.
- **removeBook():** Removes a book by ISBN.
- **displayAllBooks():** Displays all books and the total count.
- **displayUsersInfo():** Displays all user information.

5. Main Function

The main() function demonstrates the usage of the library system with the following steps:

1. Create a LibrarySystem object.
2. Add a Member and a Librarian.
3. Add two books to the system.
4. Borrow and return books using the Member.
5. Display all books and users in the system.

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Design Approach

Dynamic Memory Management:
Dynamic memory allocation was utilized for creating objects like LibraryBook, Member, and Librarian. This approach provides flexibility and optimizes memory usage during runtime.

Polymorphism:
Polymorphism is implemented by employing base class pointers (LibraryUser*) to manage derived class objects such as Member and Librarian seamlessly.

Error Handling:
Basic error handling mechanisms were integrated to manage scenarios like attempting to remove users or books that do not exist in the system, ensuring the program remains robust and user-friendly.

Challenges Faced and Resolutions

Challenge: Ensuring proper memory management for dynamically allocated objects. **Solution**: Incorporated the use of delete statements to clean up all dynamically allocated objects, effectively preventing memory leaks.

Challenge: Developing a recursive search mechanism.
Solution: Designed and implemented a recursive function within the LibrarySystem class to enable efficient and advanced book search functionality.

Sample Outputs

The **Example Output** provided illustrates the expected behavior of the **Digital Library Management System** after performing various actions such as borrowing and returning books, as well as displaying information about books and users in the system.

Explanation of the Output:

1. **Total number of books: 2**
    - This line outputs the total number of books currently available in the library system. In this case, there are two books: *1984* and *To Kill a Mockingbird*.
2. **Dear, 101, '1984' -> Borrow the book**
    - This line indicates that the member with ID 101 (John Doe) is borrowing the book titled *1984*. The output shows the user ID and the book title to confirm the borrowing action.
3. **Dear, 101, '1984' -> Return the book**
    - This line shows that the same member (John Doe, ID 101) is returning the book *1984* back to the library system.

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4. **Displaying all books:**
    - The system then proceeds to display the list of books available in the library.
    - **- Title: 1984, Author: George Orwell, ISBN: 9780451524935, Available: Yes**
        - The first book listed is *1984* by George Orwell, with the ISBN 9780451524935, and its availability status is shown as "Yes", meaning the book is available.
    - **- Title: To Kill a Mockingbird, Author: Harper Lee, ISBN: 9780060935467, Available: Yes**
        - The second book listed is *To Kill a Mockingbird* by Harper Lee, with ISBN 9780060935467, and it is also available.
5. **Number of all books: 2**
    - This line again displays the total number of books in the system, confirming that there are 2 books in total.
6. **Displaying all users:**
    - The system then shows the details of all users currently registered in the system.
    - **- Member: John Doe, ID: 101**
        - This output shows that John Doe is a member of the library with ID 101.
    - **- Librarian: Sarah Smith, ID: 102**
        - This output shows that Sarah Smith is a librarian with ID 102.

Summary of Actions in the Code:

- The librarian adds two books to the system: *1984* and *To Kill a Mockingbird*.
- A member (John Doe) borrows and then returns *1984*.
- The program displays all available books in the system and the registered users.