Library Management System

UML Diagrams & OOP Python Project

Aitronix AI Course

OOP Assignment

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1. Project Overview

Project Name: Library Management System

Language: Python 3

Implementation: Multi-file project

The Library Management System is a console-based application that allows librarians and members to manage books, magazines, borrowing, returning, and purchasing operations. The system demonstrates all core OOP principles.

2. OOP Concepts Applied

Concept	How It's Applied
Abstraction	Abstract base classes: Item, Person, Transaction using abc.ABC and @abstractmethod
Encapsulation	Private/protected attributes with @property and setters in all model classes
Inheritance	Person → Member, Librarian | Item → Book, Magazine | Transaction → BorrowTransaction, PurchaseTransaction
Polymorphism	display_info() and process_transaction() overridden in each subclass
Association	Library associates with Member and Item objects
Aggregation	Library aggregates lists of Books and Magazines
Composition	BorrowTransaction is composed within the Library lifecycle

3. Project Structure

The project is organized into the following modules:

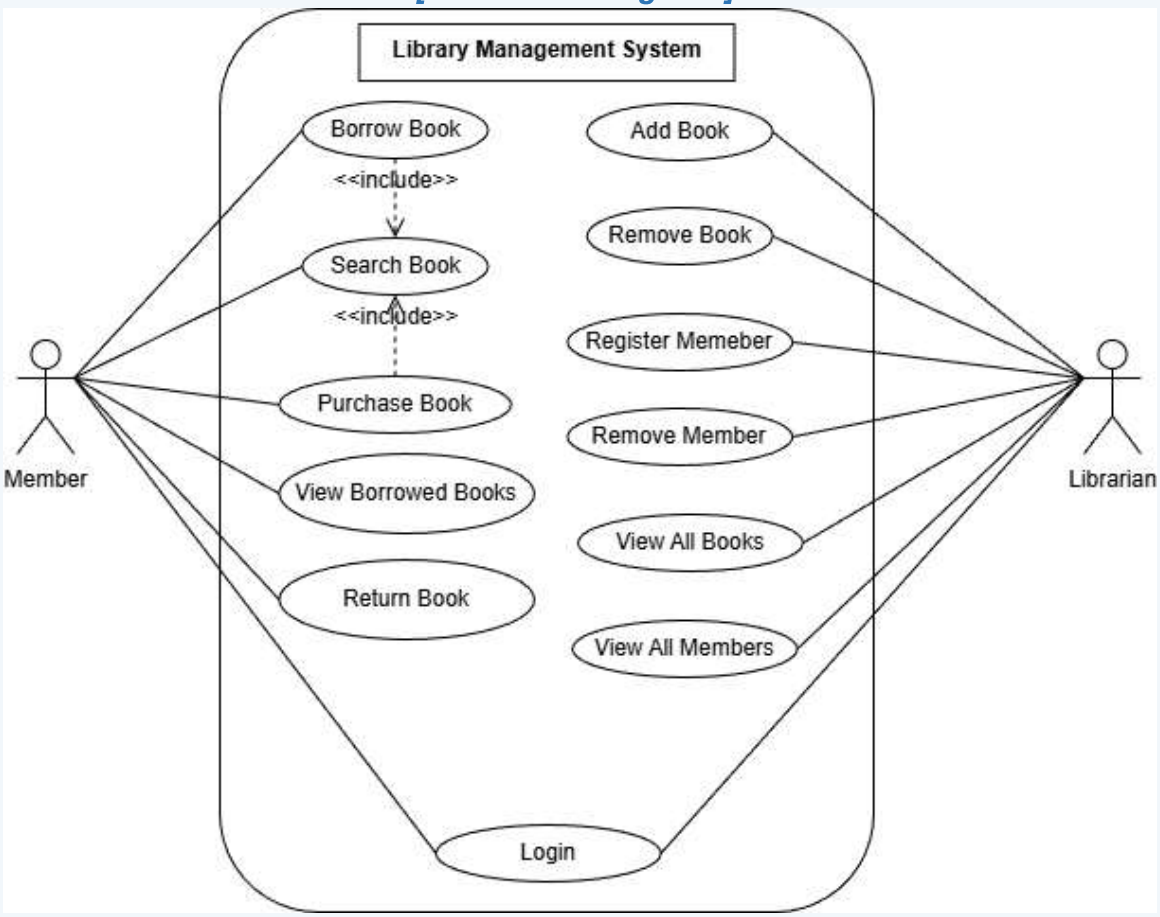
- models/item.py — Abstract base class: Item
- models/book.py — Book(Item)
- models/magazine.py — Magazine(Item)
- models/person.py — Abstract base class: Person
- models/member.py — Member(Person)
- models/librarian.py — Librarian(Person)
- models/transaction.py — Abstract base class: Transaction
- models/borrow_transaction.py — BorrowTransaction(Transaction)
- models/purchase_transaction.py — PurchaseTransaction(Transaction)
- library.py — Core Library class
- main.py — Entry point

4. UML Diagrams

4.1 Use Case Diagram

The Use Case Diagram shows the two main actors (Member and Librarian) and their interactions with the Library Management System.

[Use Case Diagram]

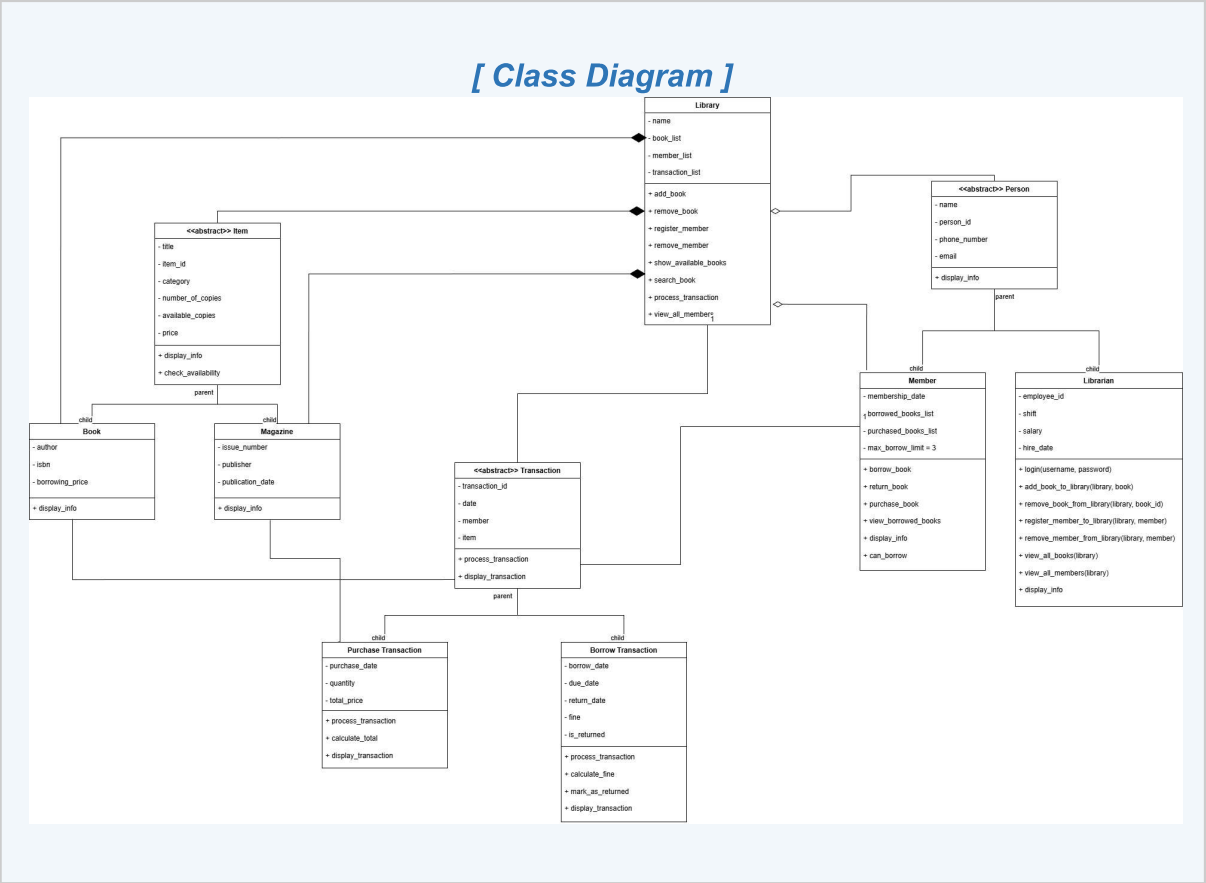


Key use cases:

- Member: Borrow Book, Return Book, Purchase Book, Search Book, View Borrowed Books
- Librarian: Add Book, Remove Book, Register Member, Remove Member, View All Books, View All Members, Login
- Shared: Login

4.2 Class Diagram

The Class Diagram shows all classes, their attributes, methods, and relationships including Inheritance, Aggregation, Composition, and Association.



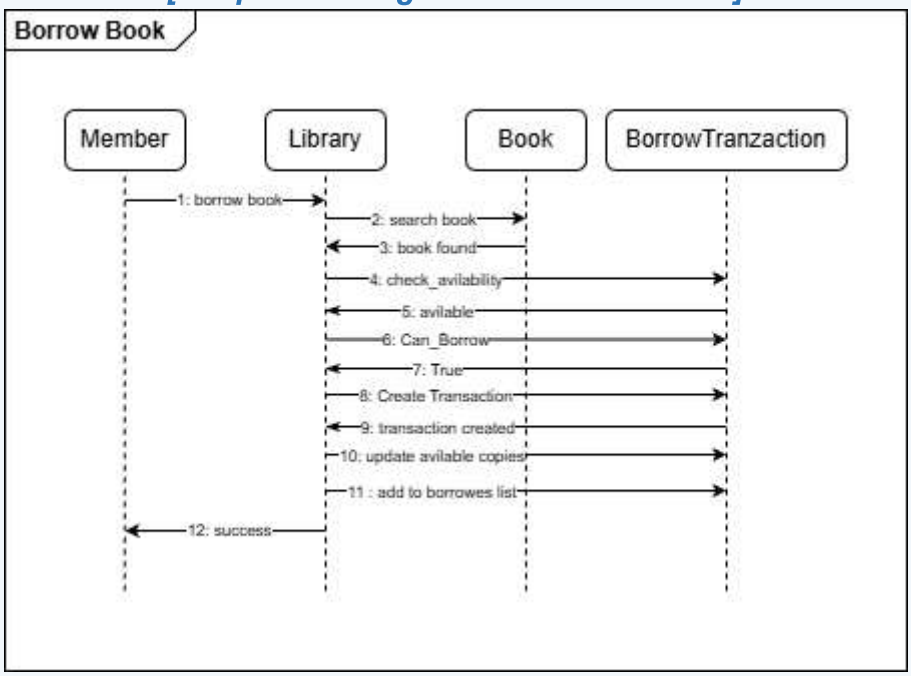
Main relationships:

- Inheritance: Person → Member, Librarian | Item → Book, Magazine | Transaction → BorrowTransaction, PurchaseTransaction
- Composition: Library ◆→ book_list, member_list, transaction_list
- Association: BorrowTransaction → Member, BorrowTransaction → Item

4.3 Sequence Diagram — Borrow Book

The Sequence Diagram shows the step-by-step interaction between objects when a member borrows a book.

[Sequence Diagram — Borrow Book]



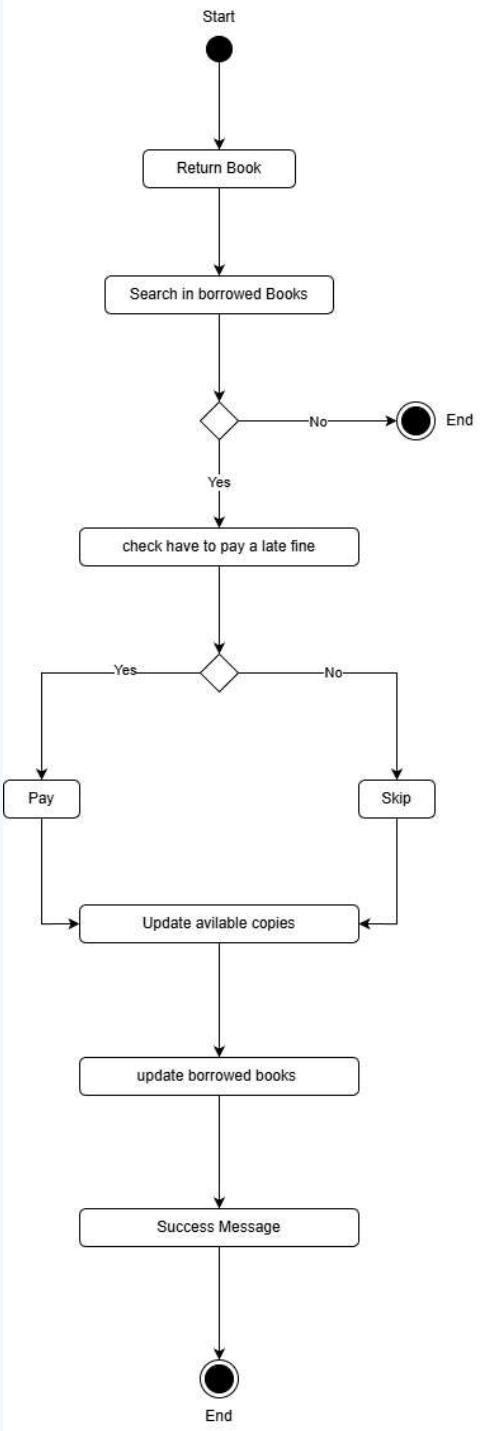
Steps:

- 1. Member sends borrow_book request to Library
- 2. Library searches for the book
- 3. Library checks availability and borrow limit
- 4. Library creates BorrowTransaction
- 5. Library updates available copies and member's borrowed list
- 6. Success message returned to Member

4.4 Activity Diagram — Return Book

The Activity Diagram shows the flow of actions when a member returns a book, including fine calculation.

[Activity Diagram — Return Book]



Flow:

- Start → Return Book request
- Search in borrowed books → if not found → End
- If found → Check if late fine applies
- If late → Pay fine | If on time → Skip
- Update available copies → Update borrowed books list
- Show success message → End

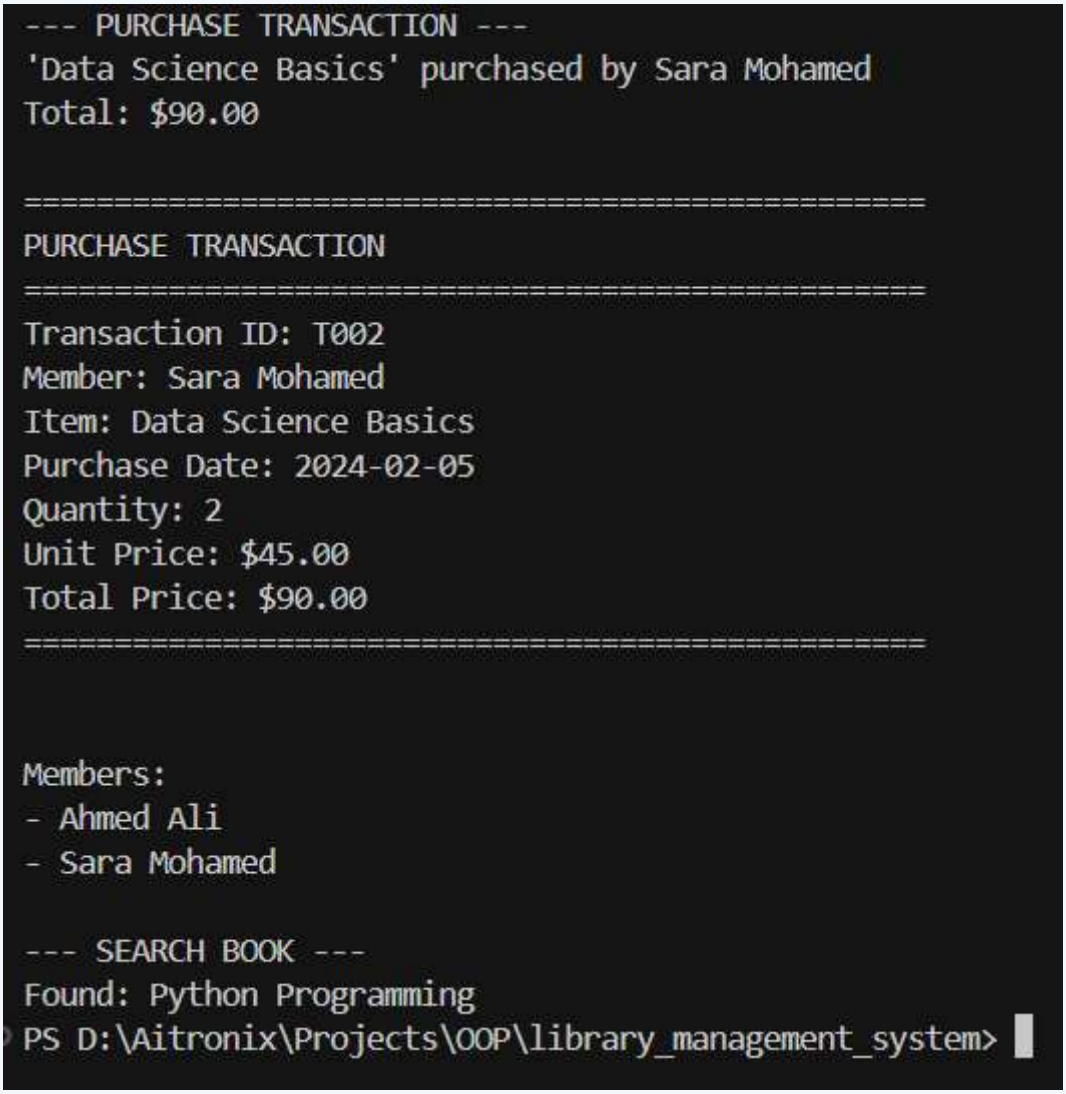
5. Program Output (Console Screenshot)

The following screenshot shows the program running successfully in the console.

[Console Output Screenshot]

```
Book Information:
        Title: Python Programming
        ID: B001
        Author: John Doe
        ISBN: 978-1234567890
        Category: Programming
        Price: $50.00
        Borrowing Price: $5.00
        Total Copies: 10
        Available Copies: 10



Available Books:
- Python Programming (10 available)
- Data Science Basics (5 available)
- Tech Monthly (20 available)

--- BORROW TRANSACTION ---
'Python Programming' borrowed by Ahmed Ali

==================================================
BORROW TRANSACTION

==================================================
Transaction ID: T001
Member: Ahmed Ali
Item: Python Programming
Borrow Date: 2024-02-01
Due Date: 2024-02-15
Status: Not Returned Yet
==================================================



Available Books:
- Python Programming (9 available)
- Data Science Basics (5 available)
- Tech Monthly (20 available)
```

```
Available Books:
- Python Programming (9 available)
- Data Science Basics (5 available)
- Tech Monthly (20 available)

--- RETURN BOOK ---
Book returned on time.

==================================================
BORROW TRANSACTION

==================================================
Transaction ID: T001
Member: Ahmed Ali
Item: Python Programming
Borrow Date: 2024-02-01
Due Date: 2024-02-15
Return Date: 2024-02-10
Fine: $0.00
==================================================


--- PURCHASE TRANSACTION ---
'Data Science Basics' purchased by Sara Mohamed
Total: $90.00

==================================================
PURCHASE TRANSACTION
==================================================
Transaction ID: T002
Member: Sara Mohamed
Item: Data Science Basics
Purchase Date: 2024-02-05
Quantity: 2
Unit Price: $45.00
Total Price: $90.00
==================================================
```



6. GitHub Repository

Repository: https://github.com/fahmy56/Aitronix-AI-Course-Projects

Branch: main

Project Folder: OOP-Library-Management/

Repository includes:

- Full Python source code (multi-file)
- README.md with project documentation
- .gitignore
- Clear commit history