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# Agent-based University Library System

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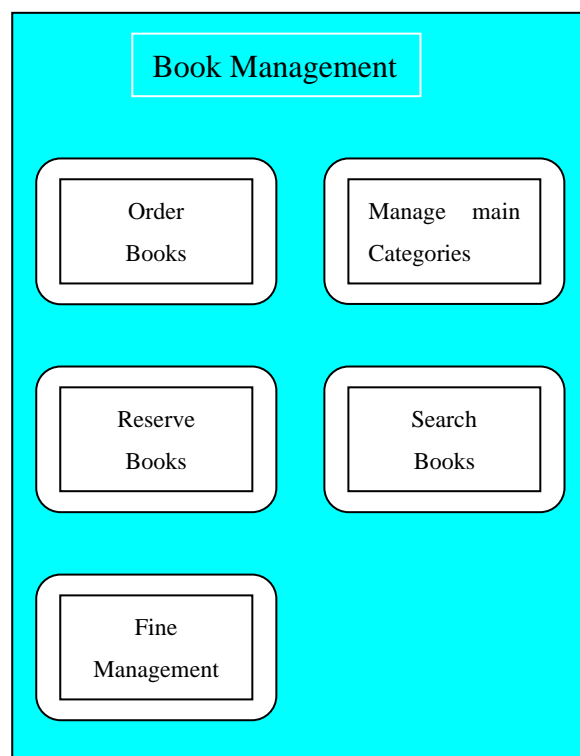
## **1. Introduction**

Agent-based University Library System is a multiagent system that allows:

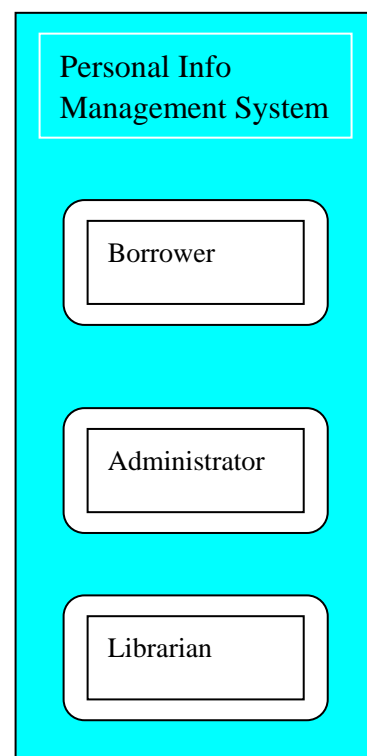
- Borrowers to manage their personal information, reserve for the books and report loss/damage of books.
- Book Administrator to maintain whole collection of books physically: Purchasing new books to fulfill the orders from professors, reporting the out-of-date/wearing books to General Book Manager, updating Master Category of Library, and preparing the books for picking up.
- Librarians to manage book lists including responding to requirements from Borrower, and report the loss/damaged to General Book Manager. We adopt the GAIA methodology to analyze and design system, and MSC to define the detailed design.

## 2. 0 System overall Specification

### 2.1 System general description



**Figure 1:** Booking Management System



**Figure 2:** Personal Info Management System

The top-level system description is shown in Figure. 1 and 2. The University Library System consists of two parts:

- Booking management System.
- Personal Management System

Booking Management System consists of following use cases:

**Order books:** professors or senior librarians (General Book Manager) can order new books for library via this system.

**Manage main categories:** the librarian can update the categories. For example, deleting the lost/wearing item from database, adding new coming books, and setting/modifying the lending policies for books, etc.

**Reserve books:** borrower can place hold on their favorite books, or make special booking with course id from instructors.

**Fine management:** borrower can pay fines for overdue books on-line by credit/debit card, or just cash to the human agent in the library.

**Search books:** borrower can search their books by providing title, author, or subjects of book not only in one library, but also in connected libraries.

## **2.2 Requirements**

### **2.2.1 Functions**

The borrowers should be allowed in Agent-based University Library System to:

- . register in system; be authenticated by ID or password.
- . manage their own information such as personal password, date of graduate which will be confirmed later by the system with relative server.
- . find the books information by keywords such as title, author, caller ID, section number, date of publication, and location where it is stacked.
- . place holds on the books which are available for them.
- . report loss/damaged and get value for paying for.
- . get approximate period time to wait for the held books and recommendations from the system.
- . pay fines/value of lost book by credit/debit card.

The Book Administrator should be allowed in Agent-based University Library System to:

- . be authenticated by system with their employee ID, password, and/or other relative information.
- . browse the Master Category of Library to find out the books should be added, and report wearing/out-of-date books to General Books Manager.
- . check the orders for buying book to supply library.

### **2.2.2 General Constraints**

1. The user interface should be simple, so all the staff of library and borrowers required no special training.
2. A maximum of 10000 concurrent users should be supported by the system.
3. System can be accessed remotely from outside of campus.
4. System response time would be no more than 15 seconds.

## **2.3 Assumptions**

- . The data resource of the qualified borrowers including student and all university

staff and interface should be ready to access.

. The database of categories of library and its interface should be available to access.

### **3.0 System Design Document**

#### **3.1 Agent-based Analysis**

The system is designed for the university library, so within our problem domain, the organization entities which actually are the organization roles in our system are Borrower, Book Administrator, and Librarian.

Roles:

1. Borrowers: The main role of borrower is to manage their own personal information through a interface agent, interact with Librarian to get their favorite books, and to interact with fine system to pay fines and value of the lost book.
2. Book Administrator: The main role of Administrator is maintaining the all collection books physically by interacting with Librarian and General Books Manager. He should figure out which books are old enough to take off shelves.
3. Librarian: The first role is to response to requirements from borrower. He should tick off the books that have already been lent out, and updates the related information of books he lent out, and reports the loss/damaged to General Books Manager and Fine System. The second role is to communicate with borrower by auto-email system to inform them to pick up their reserved books, urge borrower to return the overdue books.
4. Besides of physical roles, there is also a logical organizational entity, which play important role. They are Fine system and General Book Management System.

The Fine System collects all borrowers' fine information, or value of paying for lost books, and warns for delayed payment of fines. It also takes charge of doing transaction with certain bank.

The General Book Management System is the most important role, which should be able to manage whole collection of books. It has authority to establish the lending policies for every book, and make order for new books.

So, the roles in Agent-based University Library System are:

- . Borrower role
- . Book Administrator role
- . Librarian role
- . Fine System role
- . General Book Management System

#### **3.2 Role schema**

<b>Role schema: librarian</b>
-------------------------------

<p>Description:</p> <p>Response to borrowers' requirements: search, reserve, and report of loss; informs borrowers to pick up their reserved books, urges borrower to return the overdue books.</p>
<p>Protocols and Activities:</p> <p>RespondSearch, RespondHolding, RespondLossDamagedReport, InformBorrowerInfo</p>
<p>Permissions: RespondSearch</p> <p>Reads:</p> <p>MasterCategoryLibrary</p> <p>Generates</p> <p>InformationSentToBorrower</p> <p>Permissions: RespondHolding</p> <p>Reads:</p> <p>BookID BorrowerID</p> <p>Generates:</p> <p>InformationToBorrower InformationToBookAdministrator</p> <p>Permissions: RespondLossDamagedReport</p> <p>Reads:</p> <p>BookID BorrowerID</p> <p>Generates:</p> <p>InformationToBookAdministrator InformationToFineAgent</p> <p>Permissions: InformBorrowerInfo</p> <p>Reads</p> <p>MasterCategoryLibrary</p> <p>Generates:</p> <p>InfoSentBorrower</p>
<p>Responsibilities: RespondSearch</p> <p>Liveness:</p> <p>Reading whole category of Library</p> <p>Safety:</p> <p>Check to see if response list is empty</p> <p>Responsibilities: RespondHolding</p> <p>Liveness:</p> <p>Modify the status of held books</p> <p>Safety:</p> <p>Check for valid input data</p> <p>Responsibilities: RespondLossDamageReport</p> <p>Liveness:</p> <p>Modify the status of lost/damaged books</p>

Safety:	Check for the correctness of input data
Responsibilities:	InformBorrowerInfo
Liveness:	Generate email for borrowers
Safety:	Check for the if the ID of receiver is correct

**Role schema: Book Administrator**

Description:  
 Maintaining the all books should be adjusted physically; figuring out which books are old enough to take off shelves.

Protocols and Activities:  
 TakeOffBook, AddNewBook, PrepareForHolding

Permissions: TakeOffBook  
 Reads:  
     InformationFromLibrarian      //report of damaged books  
 Generates:  
     InformationToGeneral  
 Permissions: AddNewBook  
 Reads  
     InformationSentFromGeneral  
 Generates  
     AdjustedBookList  
 Permissions: PrepareForHolding  
 Reads:  
     MasterCategoryLibrary  
 Generates:  
     InformationToLibrarian

Responsibilities: DeleteBook  
 Liveness:  
     Updating Adjusted List of Books  
 Safety:  
     Check to see if books is adjusted  
 Responsibilities: AddNewBook  
 Liveness:  
     Updating Adjusted List Books  
 Safety:  
     Check to see if books is adjusted  
 Responsibilities: PrepareForHolding  
 Liveness:

<p>Read the MasterCategoryLibrary to get list of books for preparing to pick up.</p> <p>Safety:</p> <p>Check if the books are correct</p>
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<b>Role schema: Borrower</b>
<p>Description:</p> <p>Manage personal information, search, reserve books and report loss of books, and pay fines and value of the lost book.</p>
<p>Protocols and Activities:</p> <p>ManagePersonalInfo, SearchBook, ReserveBook, ReportLossNDamaged, PayFine</p>
<p>Permissions: ManagePersonalInfo</p> <p>Inputs:</p> <p>Relative personal information</p> <p>Generates:</p> <p>InformationToServer</p> <p>Permissions: SearchBook</p> <p>Inputs</p> <p>Book titles, Author, subjects</p> <p>Generates</p> <p>InformationToLibrarian</p> <p>Permissions: ReserveBook</p> <p>Inputs:</p> <p>Caller ID of book</p> <p>Generates:</p> <p>InformationToLibrarian</p> <p>Permissions: ReportLossNDamaged</p> <p>Inputs:</p> <p>Caller ID of book Borrower's ID</p> <p>Generates:</p> <p>InformationToLibrarian</p> <p>Permissions: PayFine</p> <p>Reads</p> <p>InfoFromFineAgent // for penalty</p> <p>Generates:</p> <p>PayorderToFineAgent</p>
<p>Responsibilities: ManagePersonalInfo</p> <p>Liveness:</p>

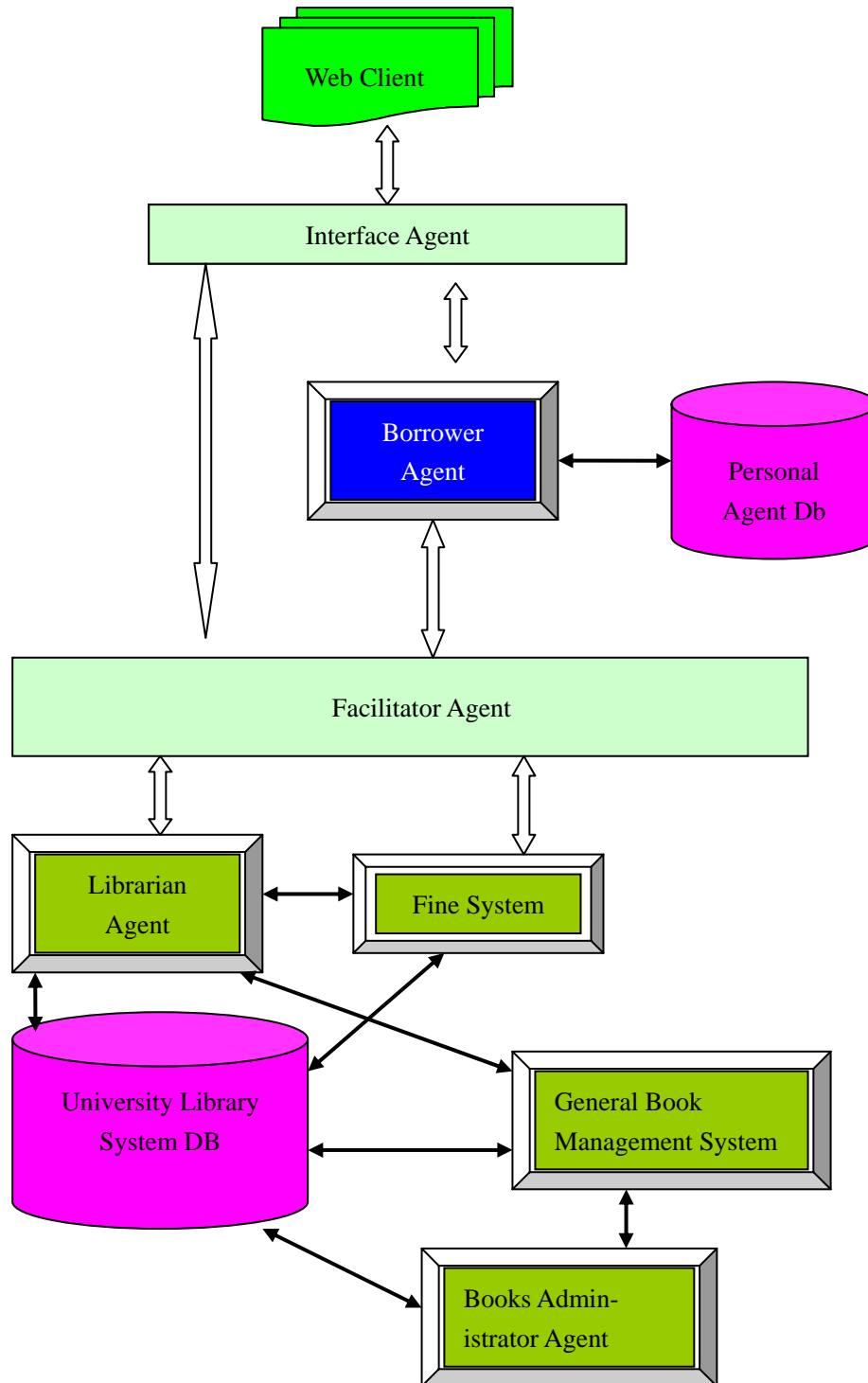
<p>Activate membership of Library</p> <p>Input/modify personal information</p> <p>Safety:</p> <p>Make sure of that personal information is correct</p> <p>Responsibilities: SearchBook</p> <p>Liveness:</p> <p>Able to search the favorite books by keywords or combination of it</p> <p>Safety:</p> <p>Check to see if keywords are suitable for searching.</p> <p>Responsibilities: ReserveBook</p> <p>Liveness:</p> <p>Borrower can place their holds on available books</p> <p>Safety:</p> <p>Make sure the borrower has a valid name, ID, and password</p> <p>Responsibilities: ReportLossNDDamaged</p> <p>Liveness:</p> <p>Borrower can report the loss of books</p> <p>Borrower can get evaluated value of lost book</p> <p>Safety:</p> <p>Make sure the borrower's ID and password are correct</p>
--

<b>Role schema: Fine System</b>
<p>Description:</p> <p>Inform borrower the value of lost/damaged books officially and extra penalty for overdue. Transfer penalty into accounts in banks.</p>
<p>Protocols and Activities:</p> <p>InformBorrower, TransferPenalty</p>
<p>Permissions: InformBorrower</p> <p>Inputs:</p> <p>Borrower's ID</p> <p>Amount of penalty</p> <p>Simple explanation</p> <p>Generates</p> <p>InformationSentToBorrower</p> <p>Permissions: TransferPenalty</p> <p>Reads:</p> <p>BorrowerID</p> <p>Account ID of borrower</p> <p>Amount of penalty</p> <p>Generates:</p>

<p>InformationToBank ReceiptToBorrower</p>
<p>Responsibilities: InformBorrower</p> <p>Liveness: Fine agent can send message to borrowers</p> <p>Safety: Make sure of that the message can be delivered correctly.</p> <p>Responsibilities: TransferPenalty</p> <p>Liveness: Fine agent can help borrowers to do transaction of paying fine</p> <p>Safety: Make sure of that the transaction be correctly finished</p>

<b>Role schema: General Book Management System</b>
<p>Description: Manage whole collection of books: order new books, delete damaged or out-of-date books. Set lending policies for every book, and other kind of media.</p>
<p>Protocols and Activities: ManageCategoryLibrary, OrderNewBooks</p>
<p>Permissions: ManageCategoryLibrary</p> <p>Reads: MasterCategoryLibrary</p> <p>Generates InformationSentToBookAdministrator</p> <p>Permissions: OrderNewBooks</p> <p>Reads: InformationFromLibrarian</p> <p>Generates: InformationToBookAdministrator</p>
<p>Responsibilities: ManageCategoryLibrary</p> <p>Liveness: Modify the MasterCategoryLibrarian Delete the damaged/lost items from ManageCategoryLibrary Put the policies for every item in ManageCategoryLibrary</p> <p>Safety: Make sure of that all operations are authorized and correct.</p> <p>Responsibilities: OrderNewBooks</p> <p>Liveness: Send the order for new books to Book Administrator</p> <p>Safety: Double check the list of new book is correct</p>

### 3.3 System Architecture



**Figure 3** System Architecture diagram for University Library System

As shown in figure 3, the system architecture consists of high level agents such as Personal agent, General book management agent, and fine agent. The inner agent can

communicate based on the coordination of facilitator agent. All the agents register the services they can provide in facilitator agent and it provide the agent directory services to all connected agent, so the requesting agent can obtain the location and services of target agents. Then requesting agent can send messages directly to the target agent.

Client does communicate with the agents only through the interface agent. All the core agents (borrower, book administrator, and librarian) would be valid through the personal agent. The personal agent can access domain specific service via other available agents. For example, the borrower agent can access the “view of fine” service via librarian agent. The core agents interact with Master Category of Library database to get required information. The personal agent isolates its own knowledge management database with other data source to offer personalized service to clients.

### **3.3.1 Agent Description**

The system consists of core agents Borrower agent, Librarian agent, and Fine Agent and high-level agents General Book Management agent, Personal agent.

- **Personal Agent**

Personal agent can support different roles according to the login profile. It also allows the user to maintain their individual working environment and preferences. Besides, it also can offer different services for different roles.

- **Librarian Agent**

Librarian agent provide basic core services such as searching books, interacting with General Book Management Agent to maintain the all collection books, interacting with the Fine Agent to deal with the penalty event, and some service for class order.

- **General Book Management Agent**

General Book Management Agent handles the whole list of books in the library. When Librarian order a batch of new books for class, the agent should send this order to Book Administrator to buy it; when got the report of damaged books from Book Administrator, it has to adjust the index of Master Category of Library database.

- **Fine Agent**

This agent is responsible for informing borrower amount of penalty, and provides a channel to help them transfer money into accepting account by credit /debit card.

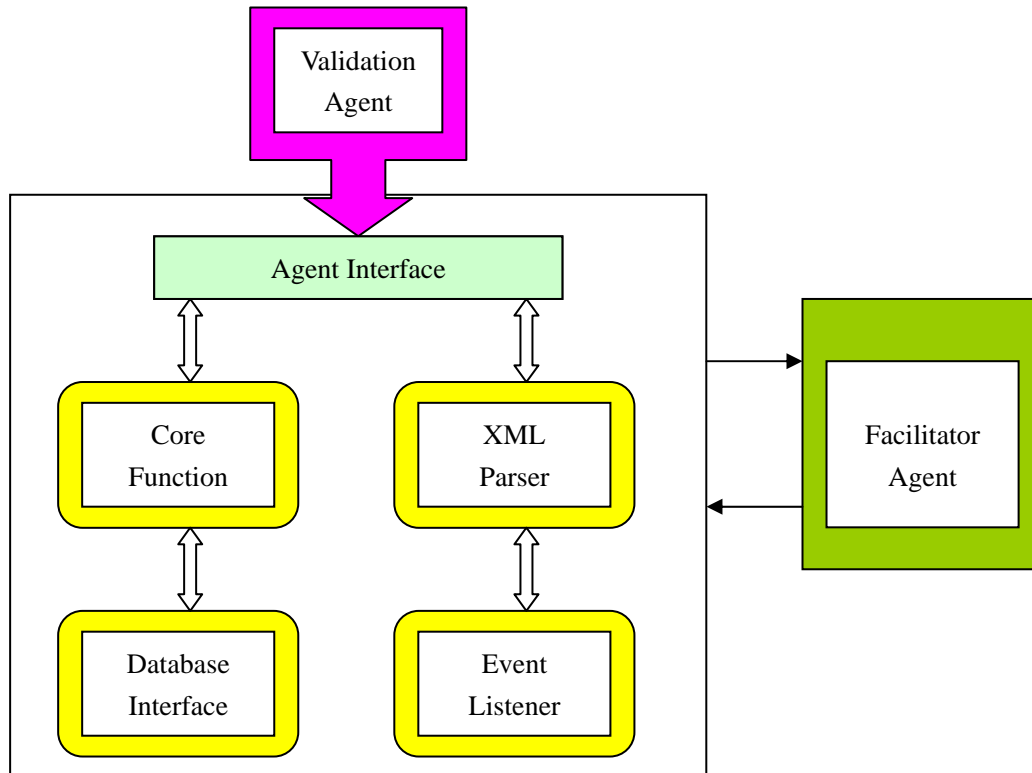
- **Borrower Agent**

Under roles of borrower agent, user can do register in library system, activate their membership, and require services from other agent.

- **Facilitator Agent**

It provides directory service for all the agents. All the agents have to login on the facilitator agent before they can work.

### **3.3.2 Generic agent structure**



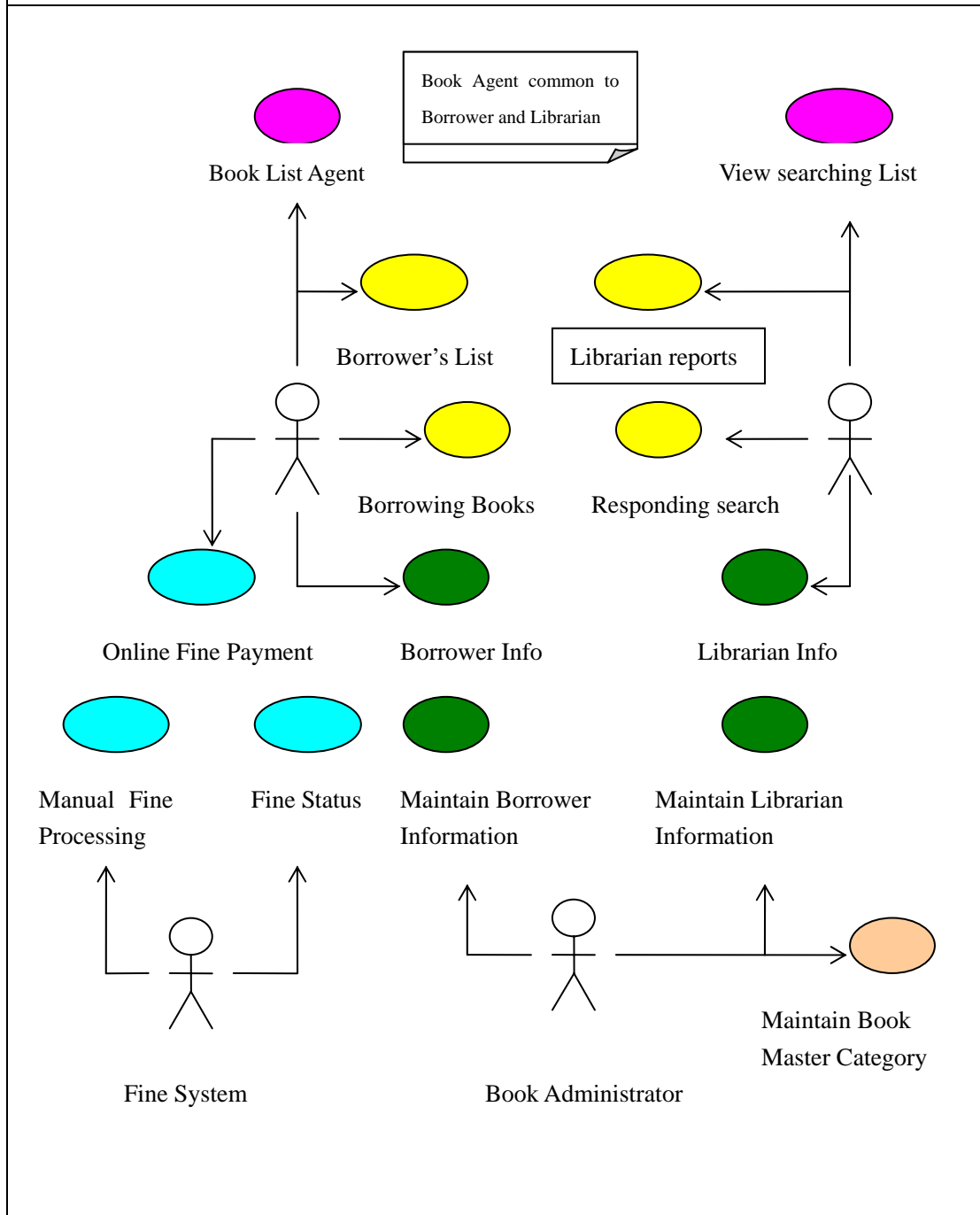
**Figure 4:** Internal architecture of an Agent

Agent architecture consists of following components

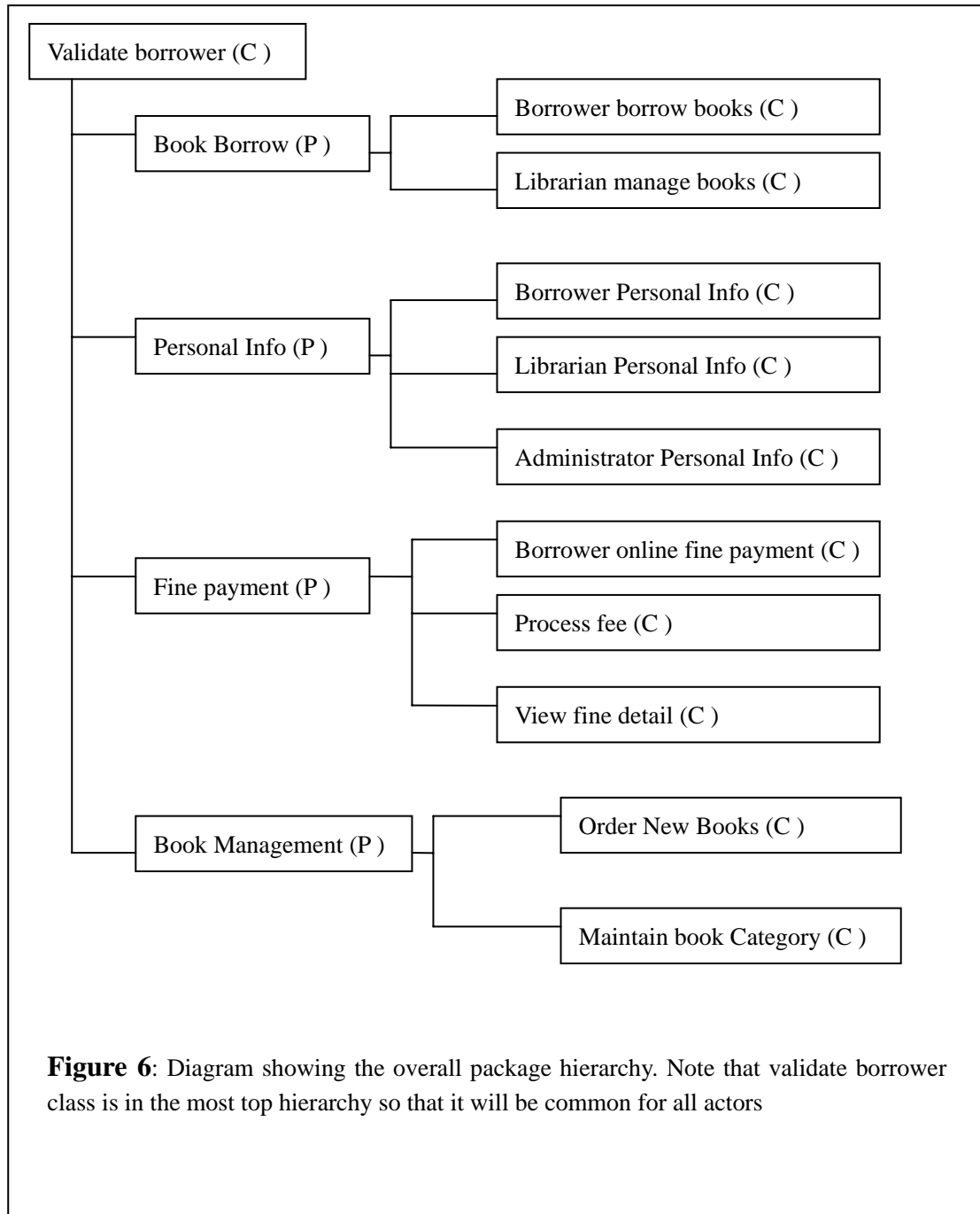
- . Agent Interface  
The Agent services are exposed only to inside of system to provide a way to access the core agents.
- . Database Interface  
Database interface provide basic database access function to the agent.
- . Event Listener  
Event listener seems like a daemon on webserver, which listens to incoming events, triggers, and establishes asynchronous information processing.
- . Core Functions  
Core functions provide all functionalities of core agent. The parameters transformed by XML parser is processed in this part, and the output back to the XML parser, which transforms it and sends back to agent interface.
- . Validation Agent  
Validation agent filters the authorized requests out of the input stream of requests. It protects the system from any illegal access.

#### **4.0 Overall design architecture diagram (in Use case view)**

**Figure 5** : This diagram gives the overall architecture of University Library System: It shows the services rendered to Borrower, Librarian, Administrator and the Fine Receiver

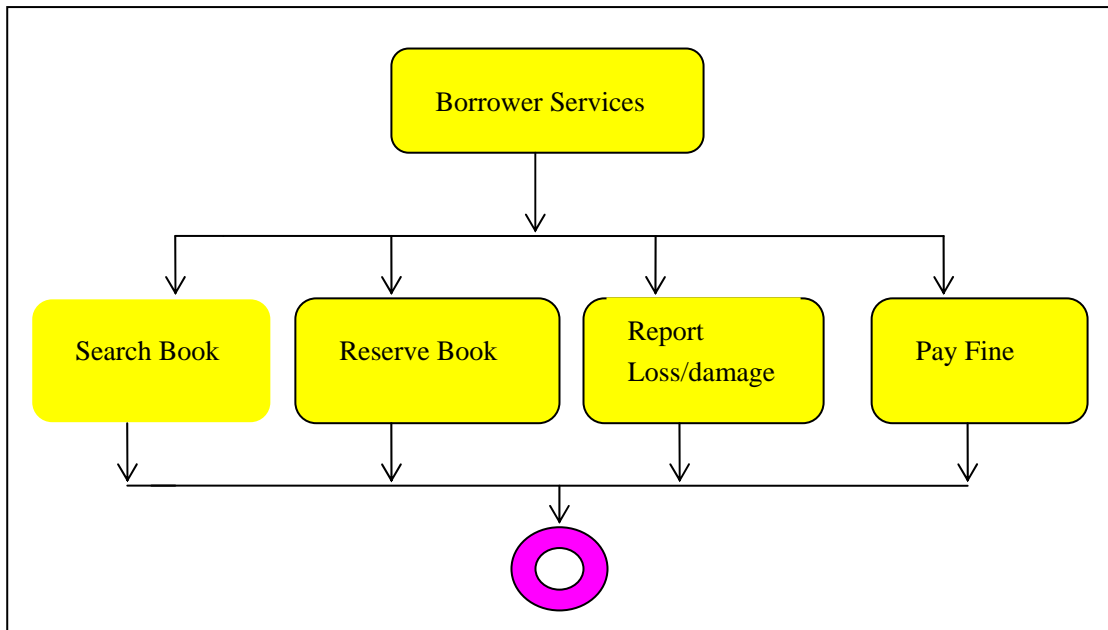


## 5.0 Package Hierarchy



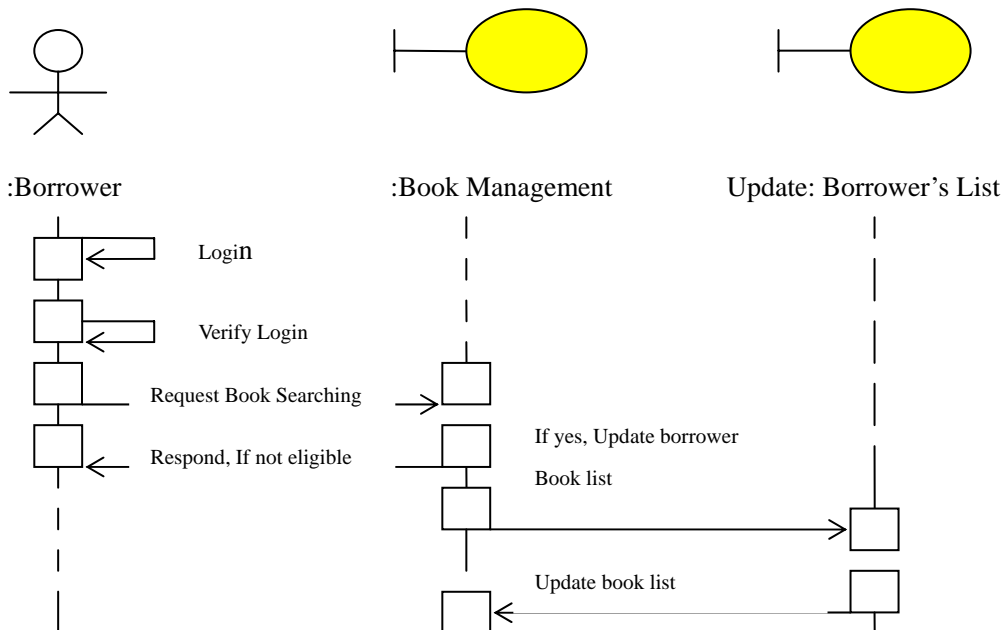
## 5.1 Detailed design (activity diagram, sequence diagrams based on Actors)

### Borrower Service:



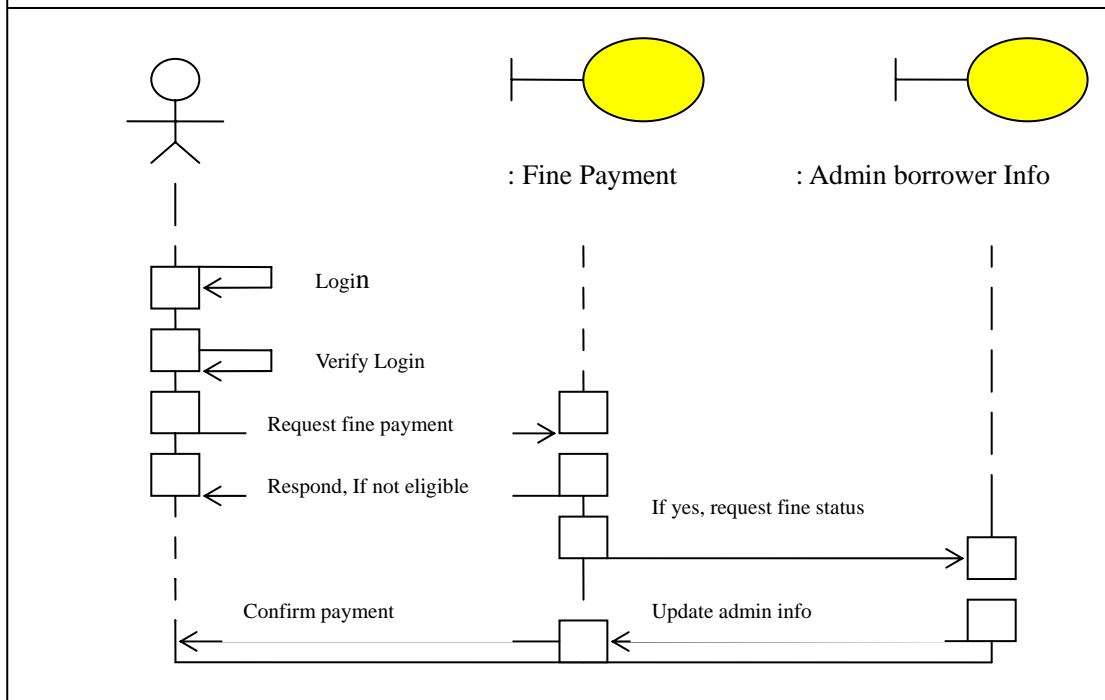
## I. Search Books

**Figure 8:** This use case begins when the borrower input his/her personal info. The system verifies the information. If the info is valid then, the system prompts the borrower to select the desired activity: Search by book titles, Search by Author and Search by Subjects



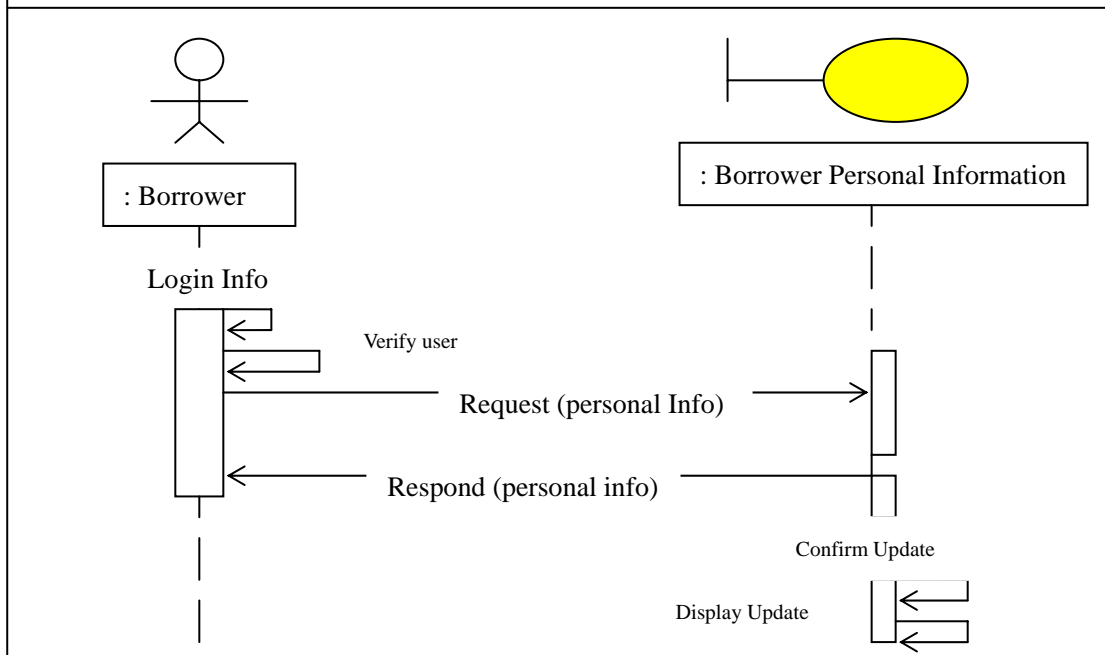
## II. Fine Payment:

**Figure 9:** This use case begins when the borrower input his/her personal info. The system verifies the information. If the info is valid, the borrower can pay fine online.



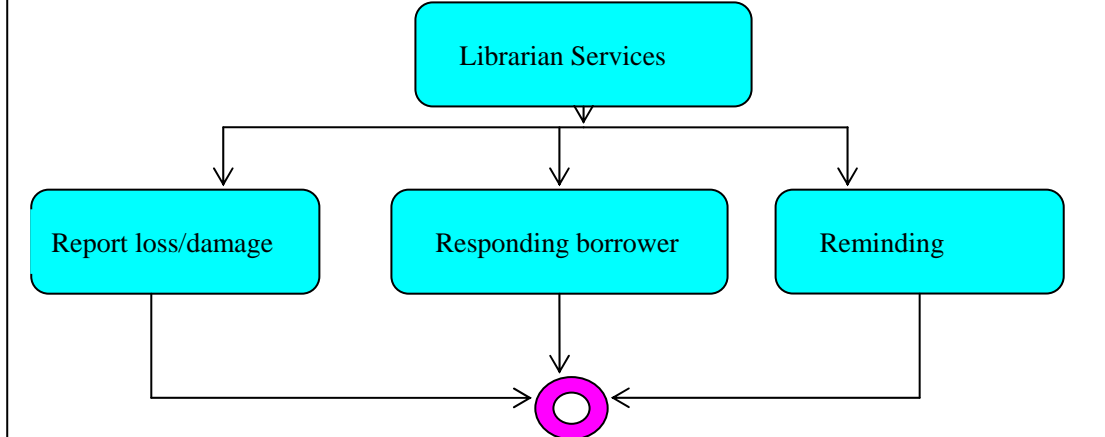
### III. Borrower Personal Info

**Figure 10:** This use case begins when the borrow log onto the system for updating his/her personal information.



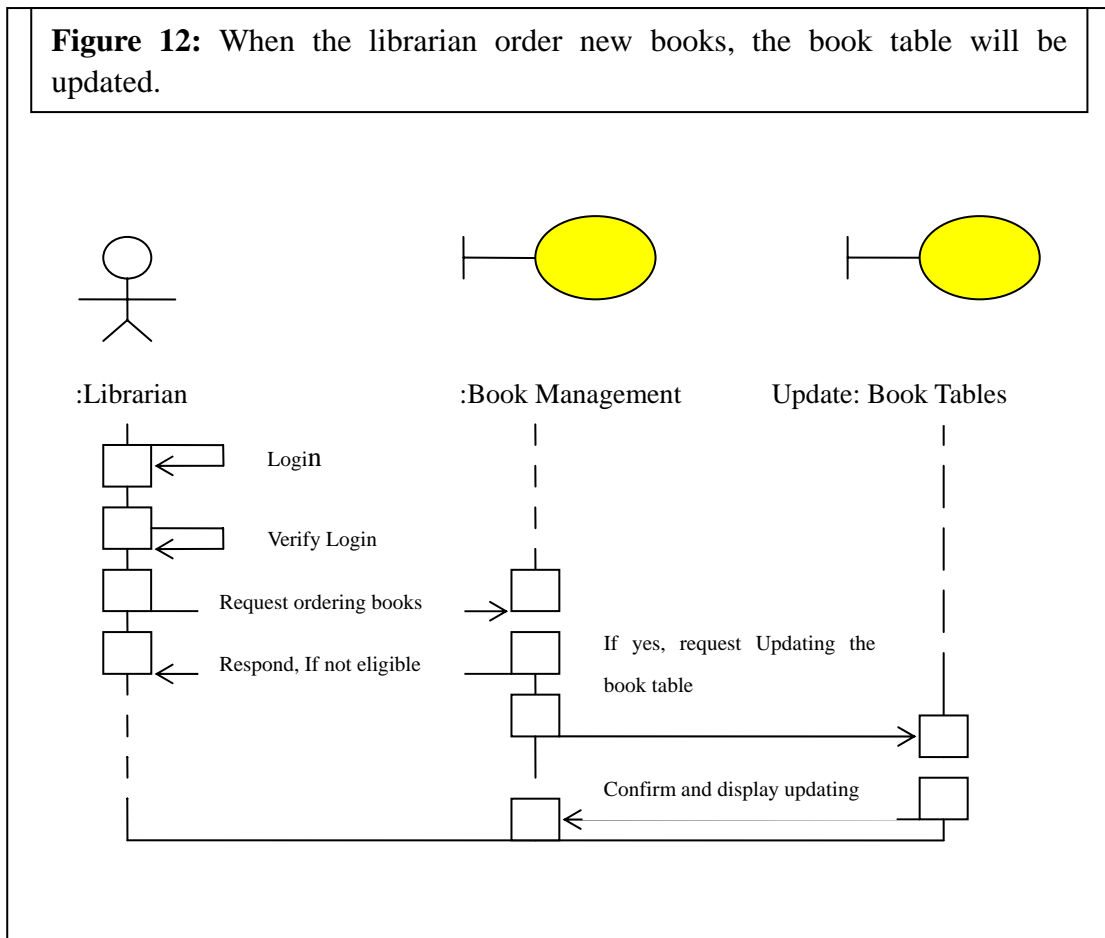
### Librarian Services:

**Figure 11:** This diagram shows services rendered to librarian at high level. After librarian login, he/she can order new book, respond the borrower's search and remind borrower.



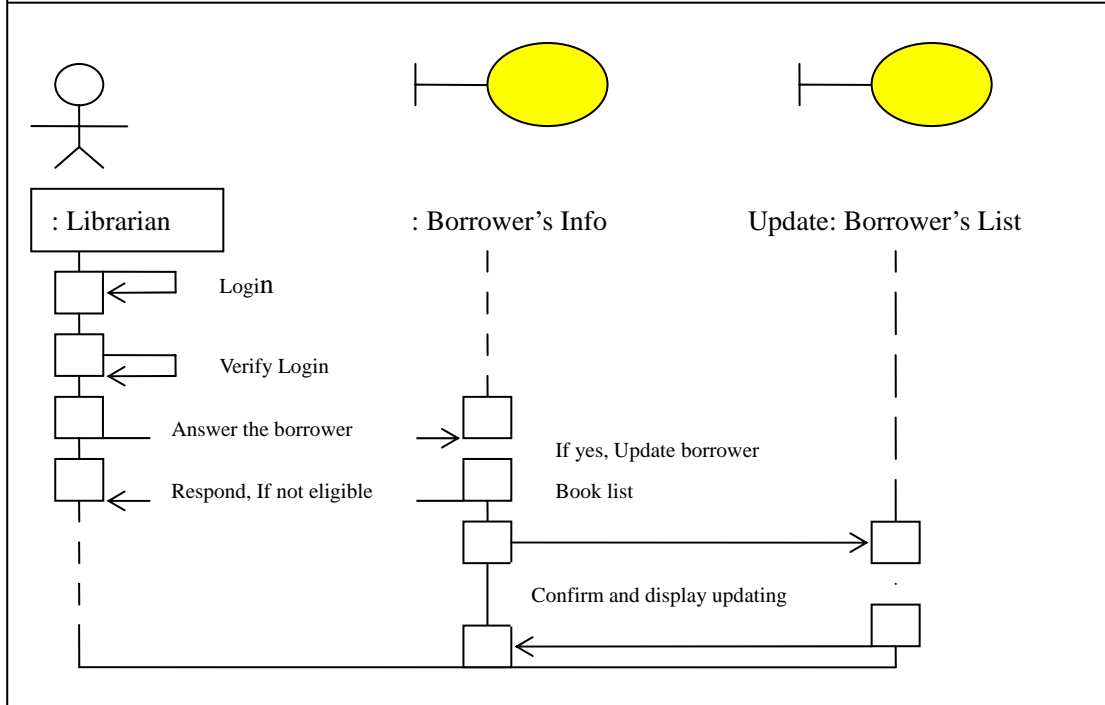
### I. Order New Books

**Figure 12:** When the librarian order new books, the book table will be updated.



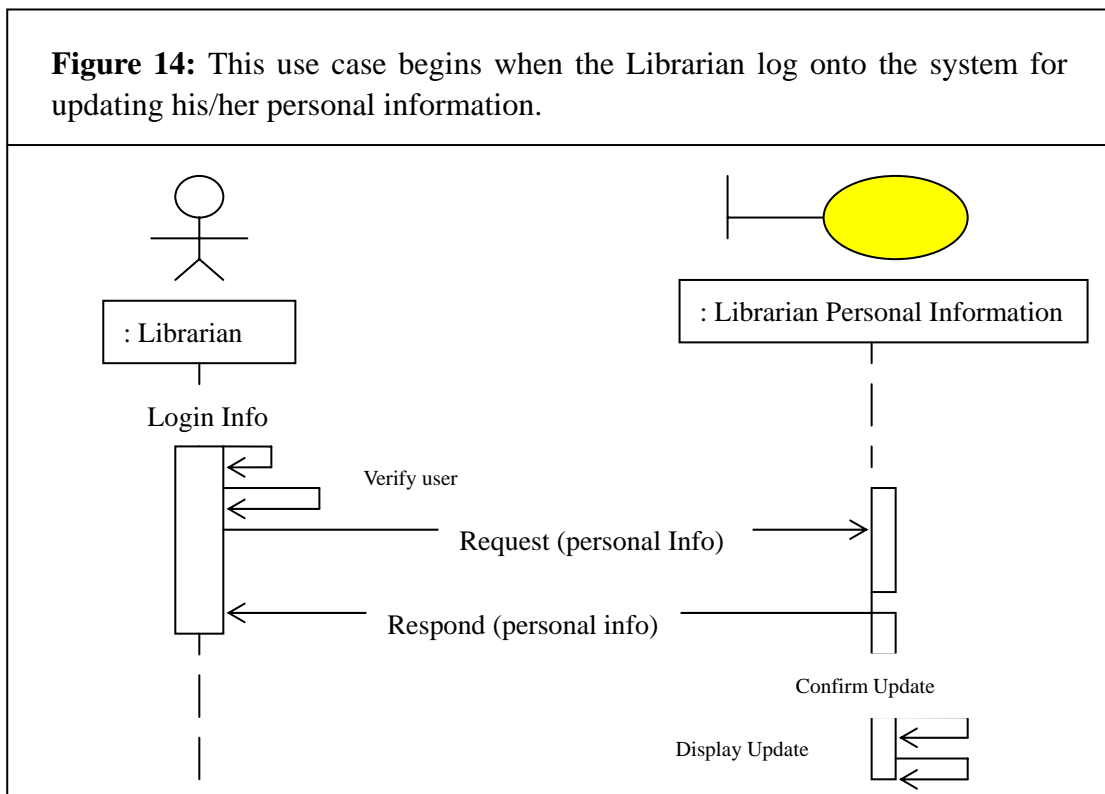
### II. Responding Borrower's Search

**Figure 13:** When the librarian login, he/she can responds the borrower's requirement and remind the borrower.



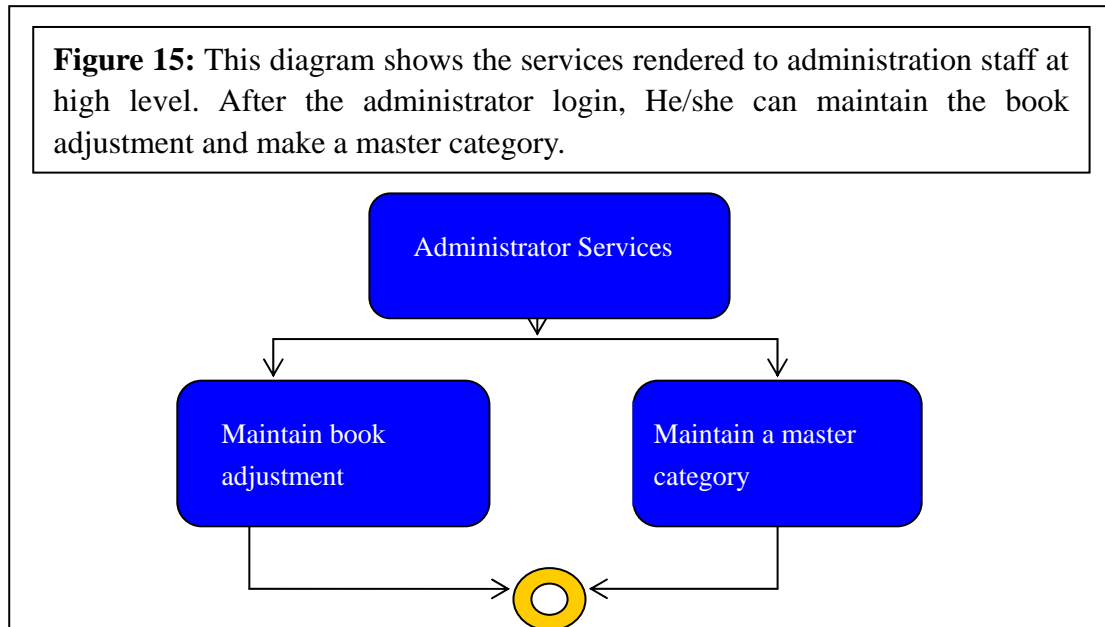
### III. Librarian Personal Info

**Figure 14:** This use case begins when the Librarian log onto the system for updating his/her personal information.



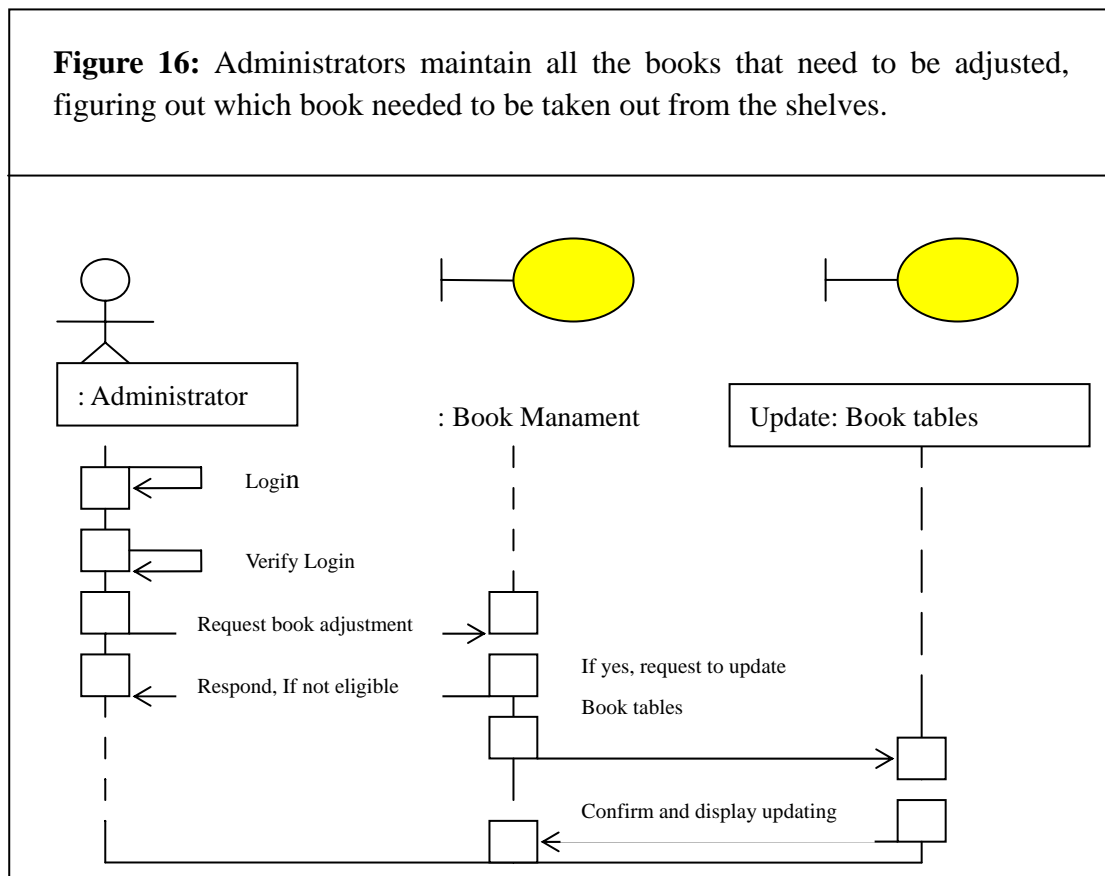
## Administrator Services

**Figure 15:** This diagram shows the services rendered to administration staff at high level. After the administrator login, He/she can maintain the book adjustment and make a master category.



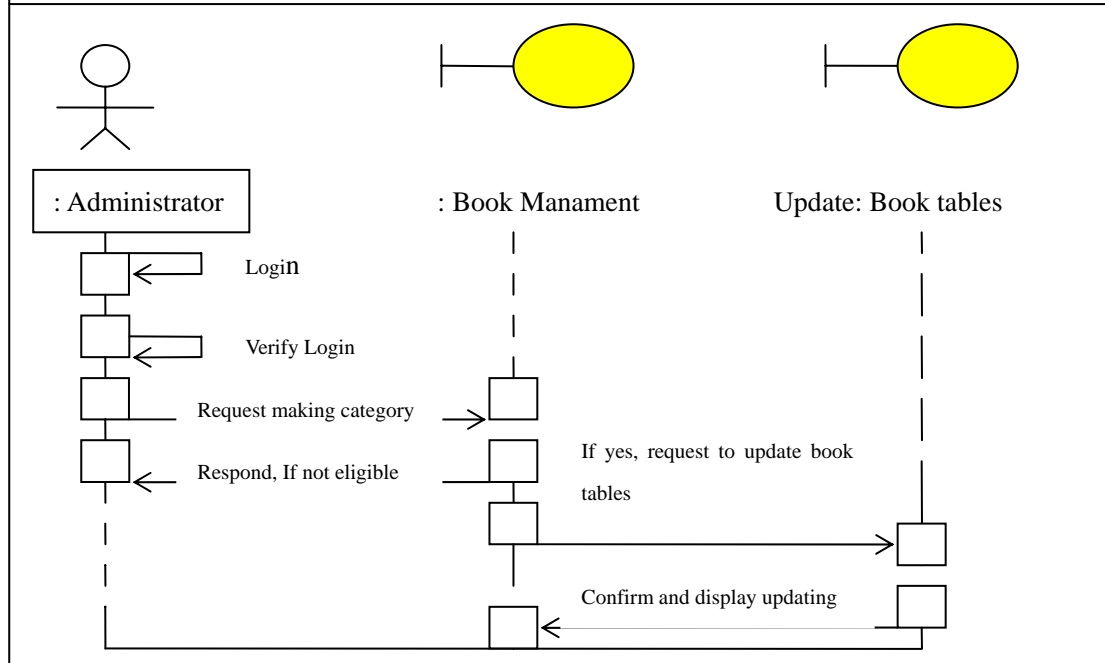
### I. Maintain Book Management

**Figure 16:** Administrators maintain all the books that need to be adjusted, figuring out which book needed to be taken out from the shelves.



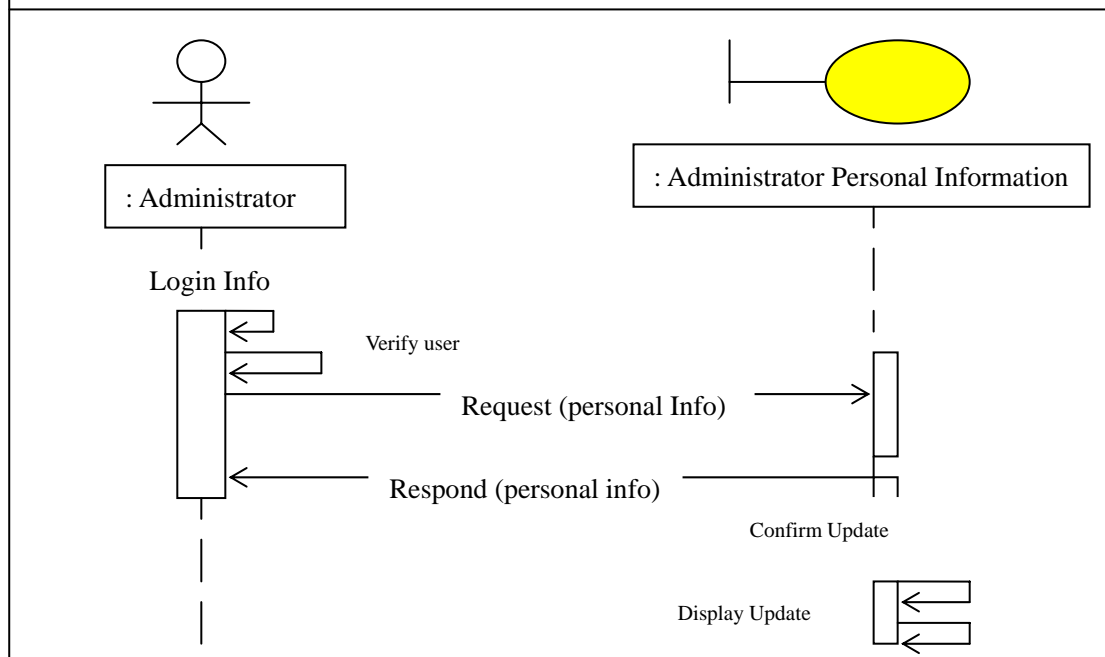
## II. Maintain Master Category

**Figure 17:** Administrators make a master category for all the books. And update it according to the book status.



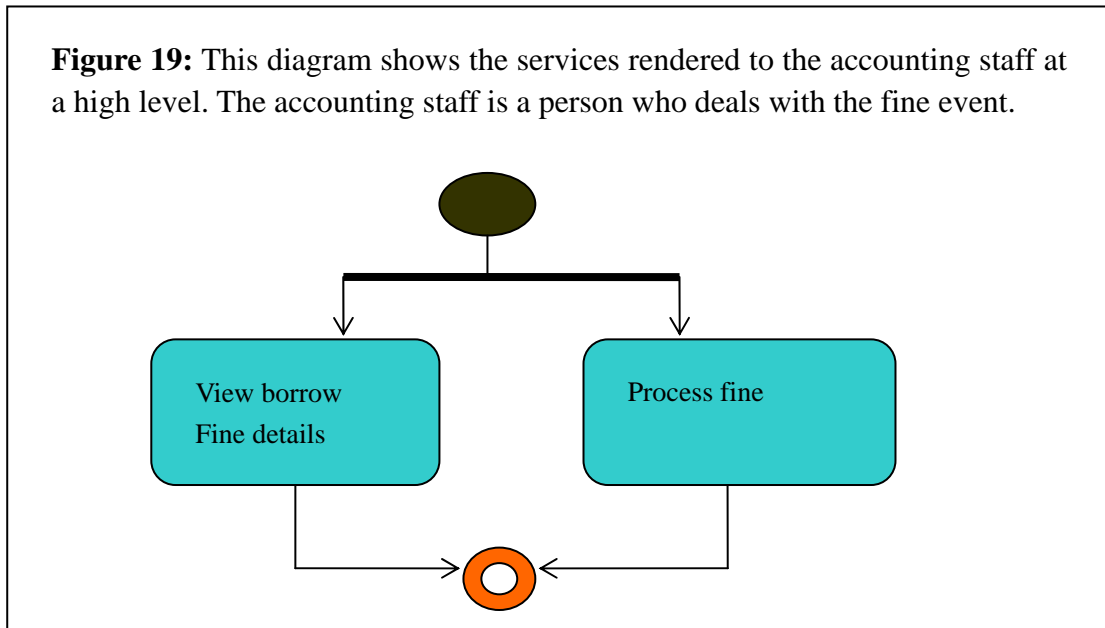
## III. Administrator Personal Info

**Figure 18:** This use case begins when the borrow log onto the system for updating his/her personal information.



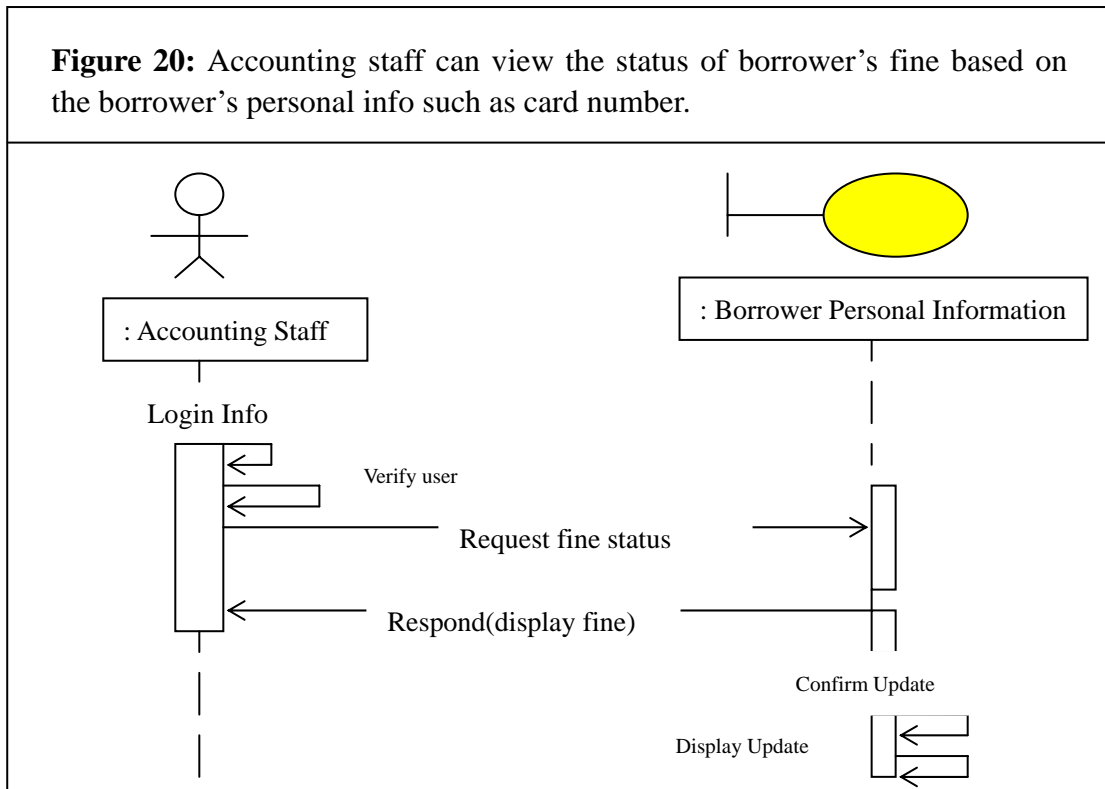
## Accounting Staff Services

**Figure 19:** This diagram shows the services rendered to the accounting staff at a high level. The accounting staff is a person who deals with the fine event.

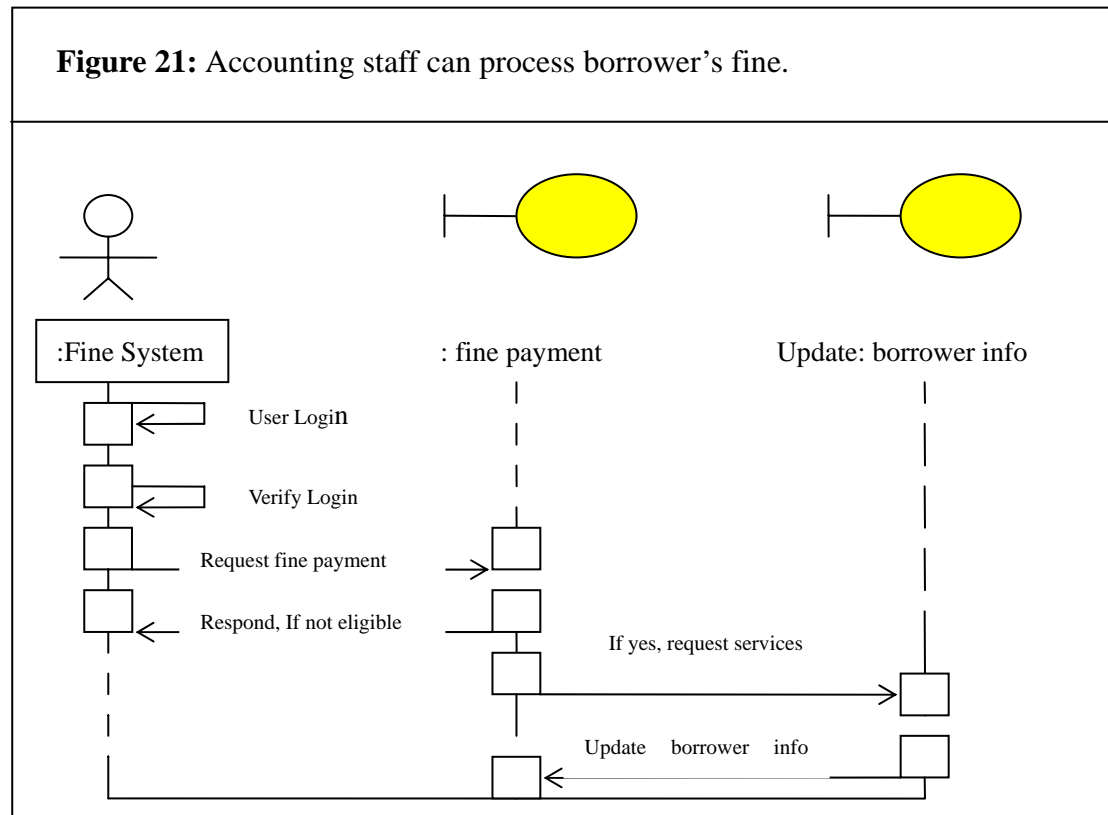


### I. View Borrower Fine Status

**Figure 20:** Accounting staff can view the status of borrower's fine based on the borrower's personal info such as card number.



## II. Process borrower fine.



## 6.0 Conclusion

In this project we focused on analysis and design of multiagent library system of a university. It covers main operations on the circulation desk and back services. Three basic core agents (Librarian, Borrower, and Books Administrator) and two higher-level agents (General Book Manager, Fine) were abstracted to form a frame of the Library System. We have used role-based model to analyze and dig out the interaction between agents. In detailed design phase, we adopted MSC to describe the interchange of information among the agents.

The final goal of the project is to develop an intelligent agent-based system to replace today's popular library management system that students and faculty will not stand in lines-up to get their books. The big improvements in this project are introduction of Fine Agent and Borrower Agent. It would be innovation to present module.

## 7.0 Reference:

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