

11. System Modelling using Case Studies

IT 3106– Object Oriented Analysis and Design

Level II - Semester 3

Overview

In this section students will

- Learn how to prepare Object Oriented Analysis and Design documents for a given problem using Unified Modeling Language

Intended Learning Outcomes

At the end of this lesson students will be able to

- Understand the processes of OOAD
- Prepare Object Oriented Analysis and Design documents for a given problem using Unified Modeling Language

List of sub topics

11.0 Prepare Object Oriented Analysis and Design documents for the Case Studies given in the VLE.

Ref 1: Alan Dennis, Barbara Haley, David Tegarden, Systems analysis design, An Object Oriented Approach with UML : an object oriented approach, 5th edition, John Wiley & Sons, 2015, ISBN 978-1-118-80467-4

Case Study 1 – Sarasavi Library

- Sarasavi is a popular library with a large collection of books. It has a collection of nearly 500 books. These books are available for loan as well as for reference by registered members, free of charge and there is also a category called “Registered visitors” who are permitted reference facilities only.
- The functions of the Sarasavi library can be categorised as below:

Loan Process, Return Process, Reservation process, Inquiry Process, Overdue Report Process, Book Registration Process and User Registration process.

Case Study 1 – Sarasavi Library Conti...

- **Loan Process:**

The borrower collects from the racks and brings the copies he wants to borrow to the counter. Librarian will check whether the borrower has overdue books. The borrower is not allowed to borrow any copies until the overdue books are returned. The maximum number of copies allowed to be held after being borrowed is 5 per user at any one time. When issuing a copy, the Librarian will check the status of each copy. The status of each copy indicates whether it is referenced or borrowable. A two-week loan period is allowed per borrowable copy. The Librarian can choose to accept or cancel the request for a loan. The borrower is then informed of the expected return date of each of copies held, if the loan is accepted. The Librarian keeps all the loan details.

Case Study 1 — Sarasavi Library Conti...

- **Return Process:**

The copy to be returned is brought to the counter. The Librarian accepts the return and checks the status of the copy. If the copy is already reserved, the librarian takes steps to inform the member who has reserved the copy.

- **Reservation Process:**

The member informs the Librarian about the books he wants to reserve. The Librarian accepts the reservation depending on the status of the copies. If the reservation is accepted, the Librarian keeps all the reservation details.

Case Study 1 — Sarasavi Library Conti...

- **Inquiry Process:**

The Librarian can also handle inquiries from the borrower about the availability of a book. A facility is also available for a borrower/registered visitor to check the availability of a book. The inquiries may be done by knowing the specific book accession number or knowing a part or whole of the title or author. If it is in the catalogue, Librarian will inform the borrower the status of the book. The status indicates whether the book is available, referenced or not, and in the case of availability of multiple copies, whether all/some/no copies are loaned out, or reserved.

- **Overdue Report Process:**

A report containing the following information is produced at the end of each week. Borrower code, name, address, sex, expected return date, accession number, book title and author/s.

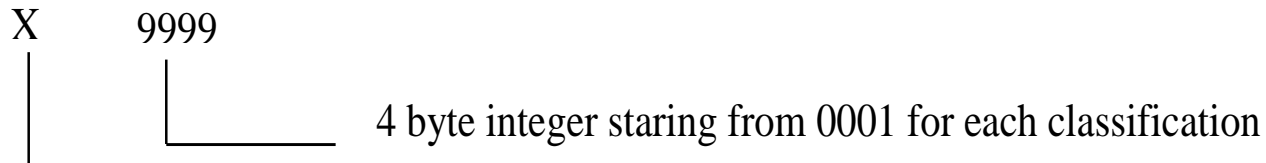
Case Study 1 – Sarasavi Library

Conti...

Book Registration Process:

The Librarian also registers new books into the library. This registration may also be an addition of a new copy. However, a maximum of 10 copies are allowed to be registered per book number. The Librarian records the classification, book title, publisher, whether the copy is reference or borrowable.

The book number comprises



classification
(1 byte classification)

The copy number in case of multiple copies has the same structure with an extra number appended at the end.

Case Study 1 – Sarasavi Library Conti...

- **User Registration Process:**

New borrowers may also be registered. The following is captured for the user registration.

User Number, Name, Sex, National identity card number and Address.

- **Management Reports:**

The following reports are needed for the management to support their decision-makings.

- A summary report of the total no of books borrowed, returned and reserved in each month.
- A bar chart to illustrate the above figures.
- Number of borrowings for each book in the library in the descending order of the number of borrowings.

Drawing a Use Case model

A Use Case model can be developed by following the steps below.

- Identify the Actors (role of users) of the system.
- identify all roles played by the users relevant to the system for each category of users, .
- Identify what the users required the system to be performed to achieve the goals.
- Create use cases for every goal.
- Draw the Use case model
- Identify use case to use case relationships

Identify the System Actors

- Anyone or anything that needs to interact with the system to exchange information.

Registered Member

Librarian

Registered Visitor

Payment Clerk

Management Staff

Use Cases

- Book Registration
- Member Registration
- Inquiry
- Reservation
- Lending
- Returning
- Pay Fine
- Generate Reports

What is a Use Case?

- It is a typical interaction between a user and a computer system.
- They are the primary elements in software development.
- They represent the functionality provided by the system. i.e. what capabilities will be provided to an actor by the system.

Identify the use cases that are responsibilities of each actor

Actors	Use Cases
Registered Member	Inquiry, Reservation
Librarian	Inquiry, Reservation, Book Registration, Member Registration, Generate Reports, Returning ,Lending
Registered Visitor	Inquiry
Payment Clerk	Pay Fine
Management Staff	Generate Reports

Note : Certain functionalities are assumed. They are not very clear from the Case Study.

Use Case Diagram

- Relationships

- Extend **<<extend>>**

- <<extend>> provides a way to insert new behaviour into an existing use case.
- The extension use case extends the functionality of the original use case.
- Shows optional behavior of a Use Case
- Depicted as an arrow headed line (either solid/dashed)
- Has an arrow drawn from the extension use case to the base use case.

Extension Use Case



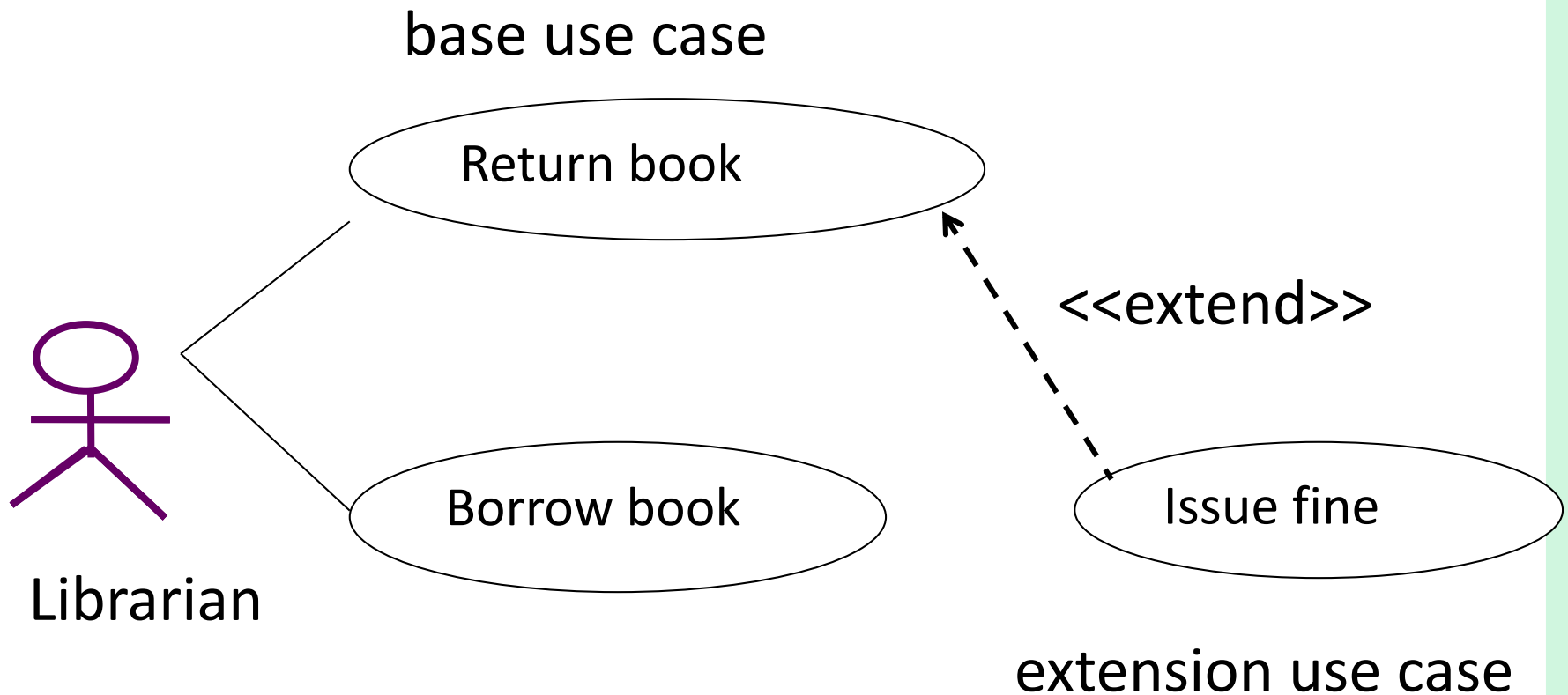
<<extend>>



Base Use Case

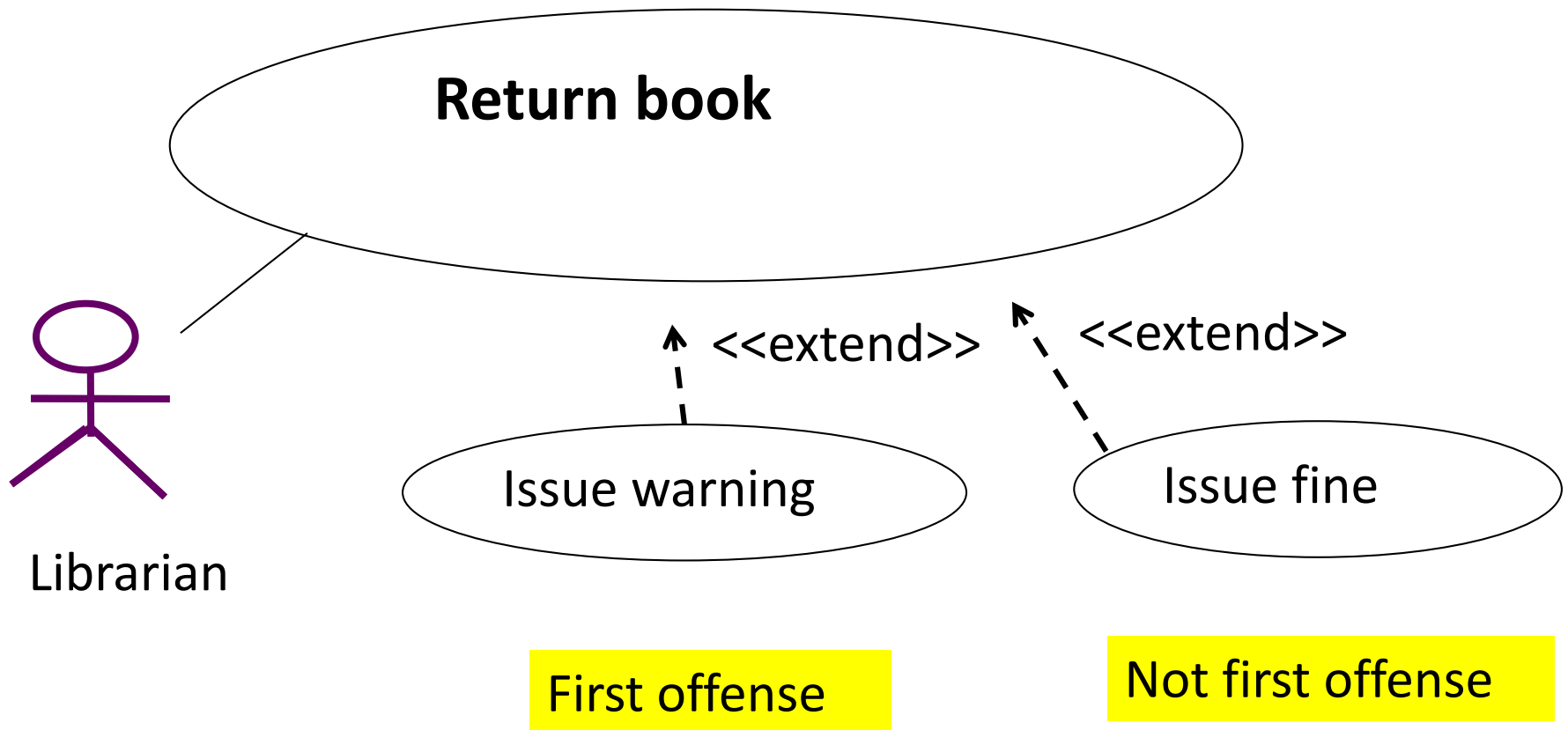


Use Case Diagram



Example of <<extend>> Relationship cont..

- Conditional extensions



Example of <<extend>> Relationship cont..

- a library system in which borrowers are given a warning the first time a book is returned over-due and are fined only subsequently.
- We can model this by adding a new extension use case, IssueWarning, and then placing conditions on the <<extend>> relationships. The conditions are Boolean expression evaluates to true.
- This is not mentioned in the Case Study

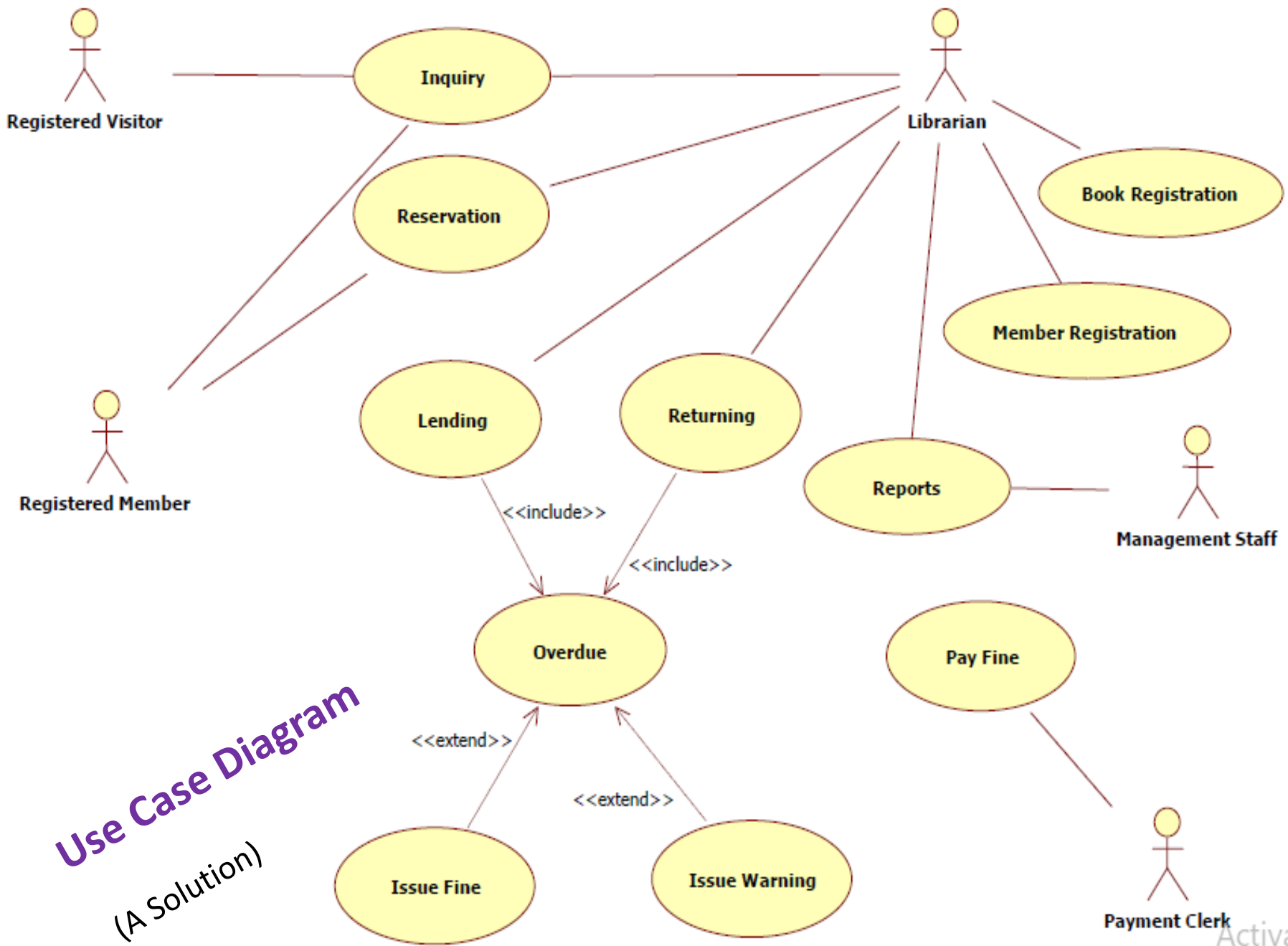
Use Case Diagram

- Relationships **<<include>>**

- Include

- The base use case explicitly incorporates the behavior of another use case.
 - The relationship between the abstract use case and use case that uses it.

Eg. CheckOverdue use case can be a <<include>> use case to both Lending and Returning. In both cases need to check overdue books.



Use Case Diagram
(A Solution)

Prepare Use Case Narratives for the Use Cases

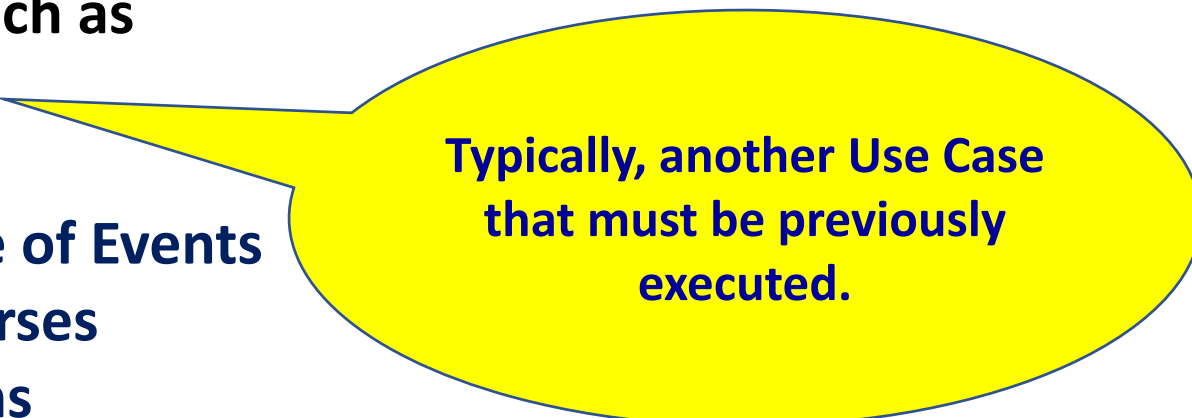
e.g. Expanded Version of a use-case narrative

More details such as

- Preconditions
- Trigger
- Typical Course of Events
- Alternate Courses
- Post conditions

etc. are included.

(for more information Refer pg258 of Ref 1)



Typically, another Use Case that must be previously executed.

Prepare Use Case Narratives for the Use Cases

e.g. Expanded Version of a use-case narrative

More details such as

- Preconditions
- Trigger
- Typical Course of Events
- Alternate Courses
- Post conditions

etc. are included.

(for more information Refer pg258 of Ref 1)



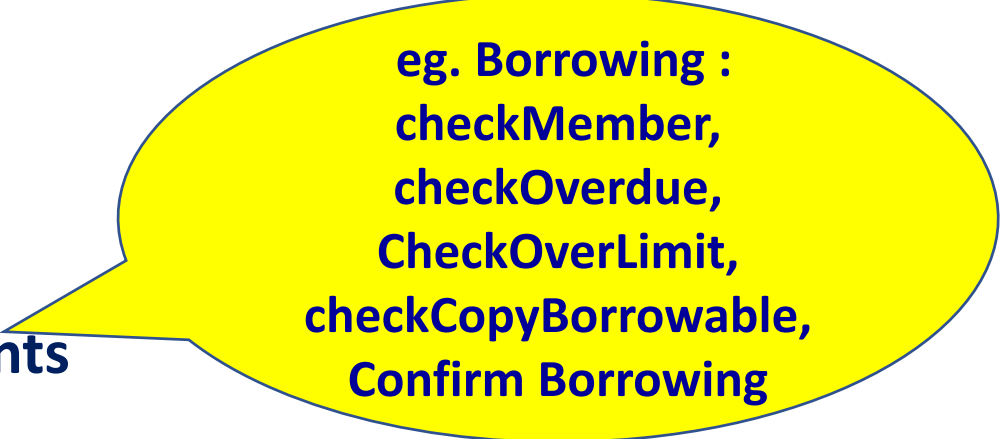
Time receiving a cheque.

Use-Case Modelling

e.g. Expanded Version of a use-case narrative

More details such as

- Preconditions
 - Trigger
 - Typical Course of Events
 - Alternate Courses
 - Post conditions
- etc. are included.



eg. Borrowing :
checkMember,
checkOverdue,
CheckOverLimit,
checkCopyBorrowable,
Confirm Borrowing

Use-Case Modelling

e.g. Expanded Version of a use-case narrative

More details such as

- Preconditions
- Trigger
- Typical Course of Events
- Alternate Courses
- Post conditions

etc. are included.



Errors, Confirm
Messages

Use-Case Modelling

e.g. Expanded Version of a use-case narrative

More details such as

- Preconditions
- Trigger
- Typical Course of Events
- Alternate Courses
- Post conditions

etc. are included.

(for more information Refer pg259 of Ref 3)



Receipt Delivered to the
Customer

Identify the Objects






How to Identify Objects

- Go through the Case Study
- Pick out the nouns.
- Filter list of nouns to identify the objects

Identify the object interactions for each scenario (eg. Object interactions for Lending scenario)





A Library System: Lending Scenario – Identify Objects

Objects

- Librarian enters the borrower id.
- System checks whether borrower id exist.  **Member**
- Check for Overdue Books.  **Member , BorrowedCopy**
- Check Over limit  **Member, BorrowedCopy**
- Enter copy id  **Copy, Book**
- Check Copy Borrowable
- Librarian Confirm Borrowing  **BorrowedCopy**
- Update Borrowed Copy details

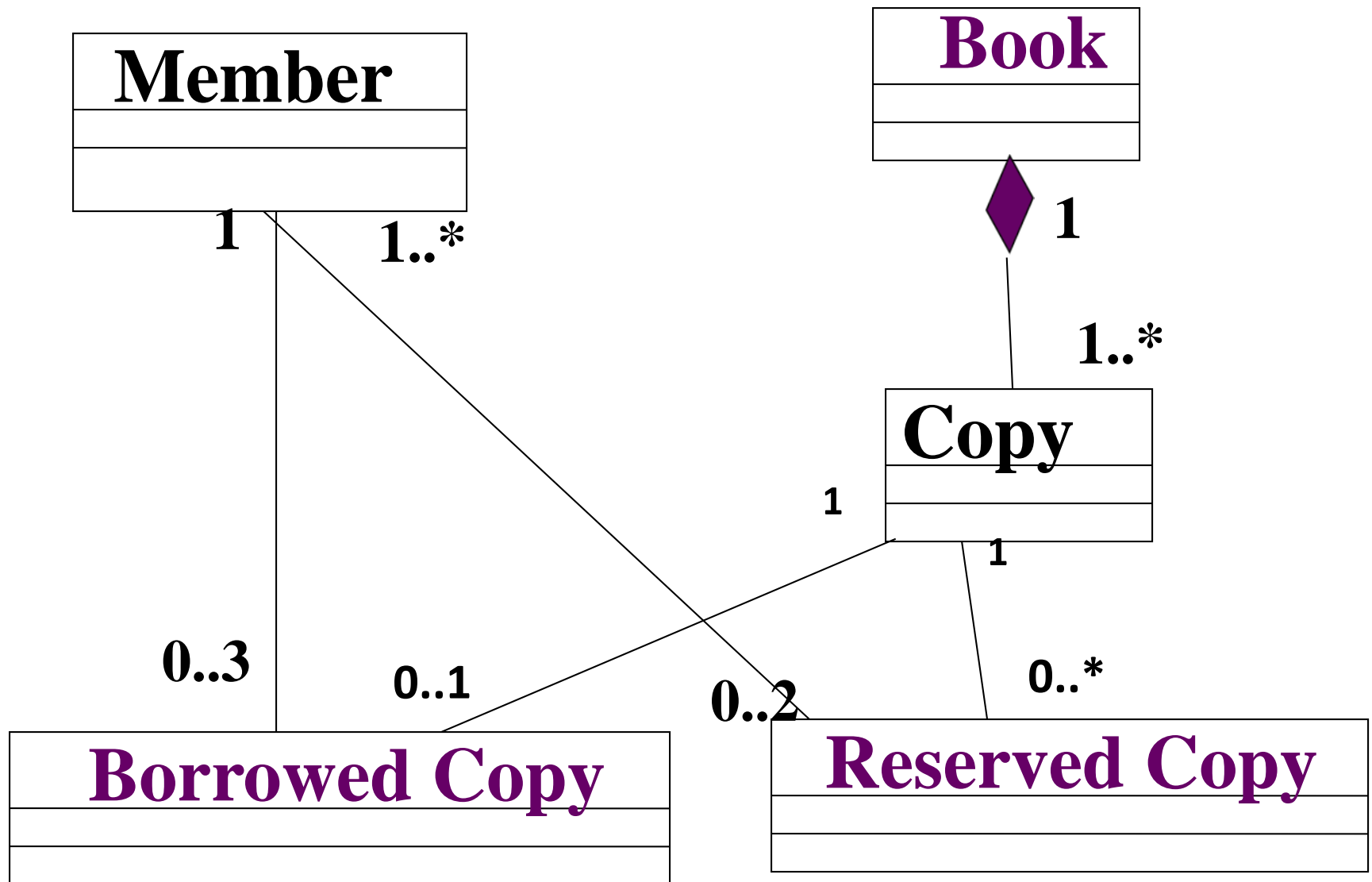
A Library System: Reservation Scenario-Identify Objects

Objects

- Librarian/Member enters the borrower id.
- System checks whether borrower id exist.  **Member**
- Check for Overdue Books.  **Member , BorrowedCopy**
- Enter Book id
- Check Book has Borrowable Copies  **Copy, Book**
- Librarian Confirm Reservation
- Update Reserved Copy details  **ReservedCopy**

Library System – Typical Classes

- Member
- Book
- Copy
- BorrowedCopy
- ReservedCopy



Class Diagram for the library system

How to draw a sequence Diagram

- Identify a set of objects that will participate in the general collaboration (or use case scenario)
- You should know the primary actor(s) who activates the use case
- Consider the first point of the scenario (or if you get it from the first point of the flow of event of a use case)
- Consider what the system need to be done in order to response to the actor, when the actor send the message to the system
- What the system need to be handled before the return message response back from the system?
- E.g. A customer inserted an ATM card to the machine, the system will display "input pin number" in the normal scenario,
- Guess, what will be handled inside the ADM by a set of objects at the "back" of the system? Something like, read and verify the ATM card (card reader), read the card information of the card holder (by the bank) and ask for the pin, or, return "invalid card type, insert another card", and etc.
- By this way, you will identify the candidate objects and operations of the target application for that particular scenario and you can also use these information as a basis to derive the class diagram incrementally.
- Repeat each of the point of the scenario (or flow of event) and until you complete all the points in the scenario.
- One can ignore the return messages if he likes.

Drawing the sequence diagram for Lending (borrowing) Scenario

Eg. Borrowing Scenario Flow of Events section of the Use Case narrative

Main Flow

Librarian enters the borrower id.

System checks whether borrower id exist.

 If not exist (E-1) end use case.

Else **Process**

Check for Overdue Books.

 If yes (E-2) end use case

Check Over limit (E-3)

 If yes (E-3) end use case

Use Case Narratives cont..

Enter copy id

Check Borrow able (E-4)

 If No (E-4) end use case

Librarian Confirm Borrowing (C-5)

Update Borrowed Copy details

Alternate Flows

E-1 : Borrower id exist

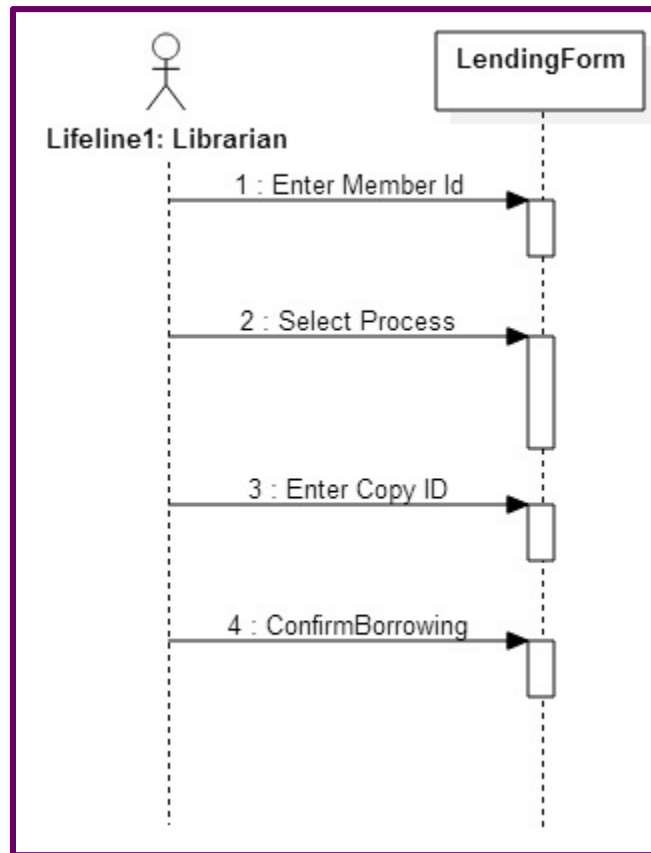
E-2 : There are overdue books

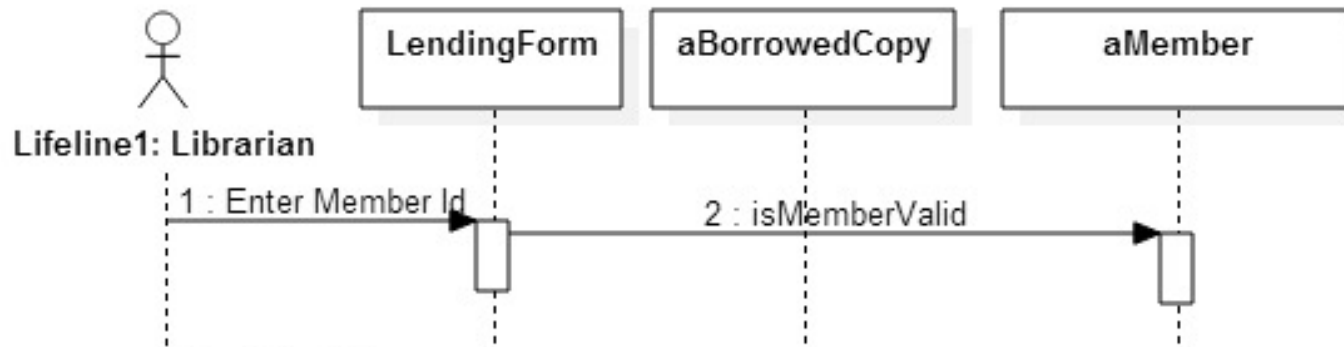
E-3 : Borrower has already borrowed 5 books (max)

E-4 : Copy is not borrowable

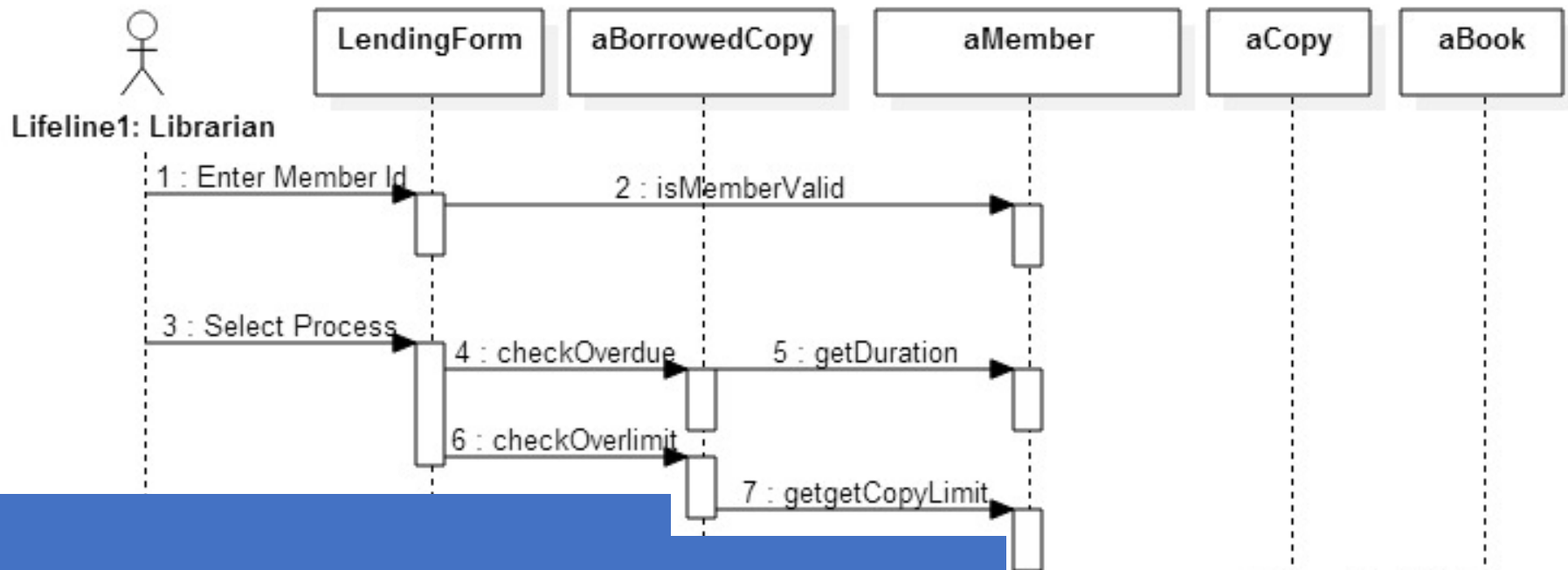
C-1 : Confirm borrowing Message box

Top level Sequence Diagram for Borrowing Scenario

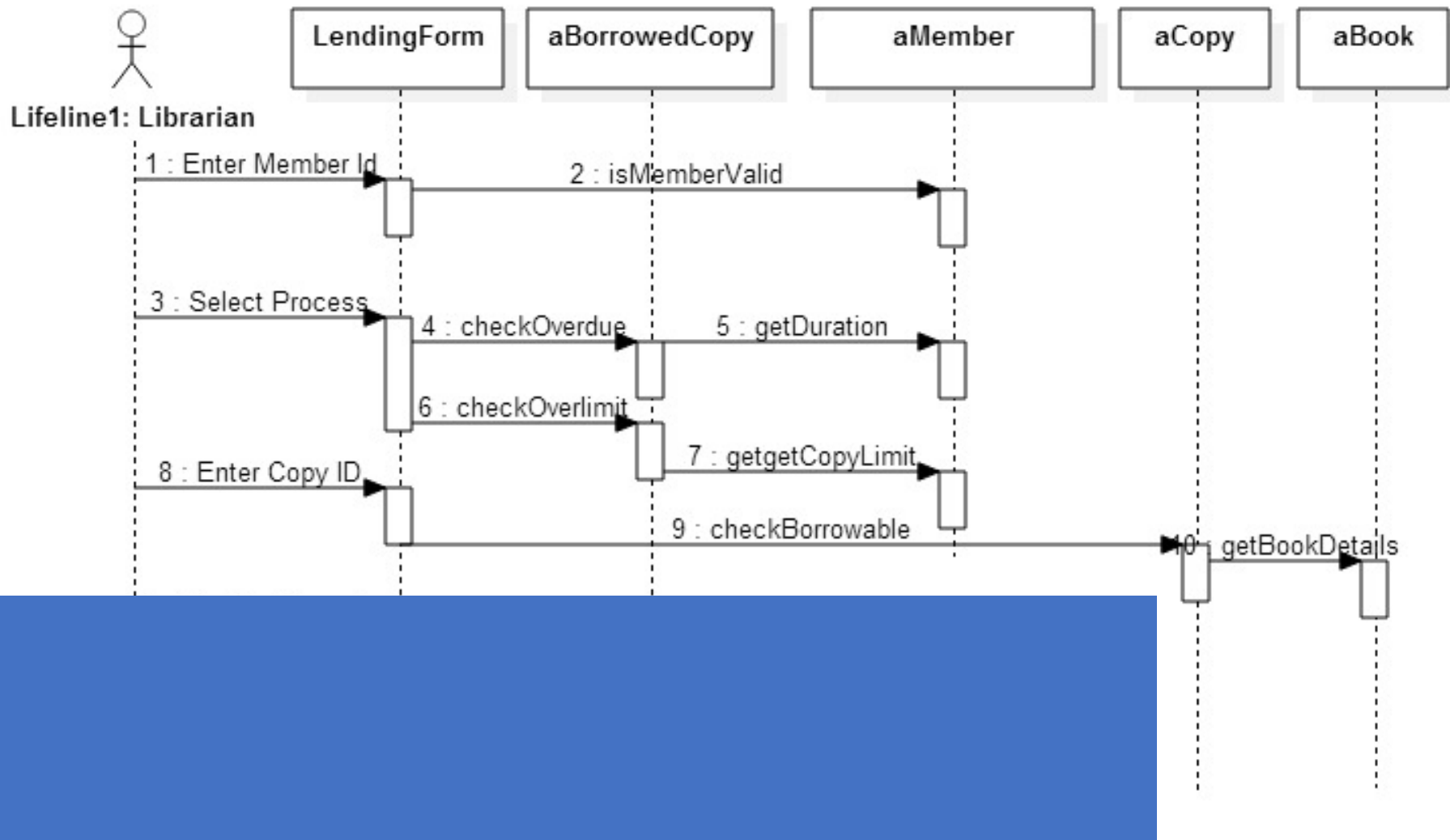




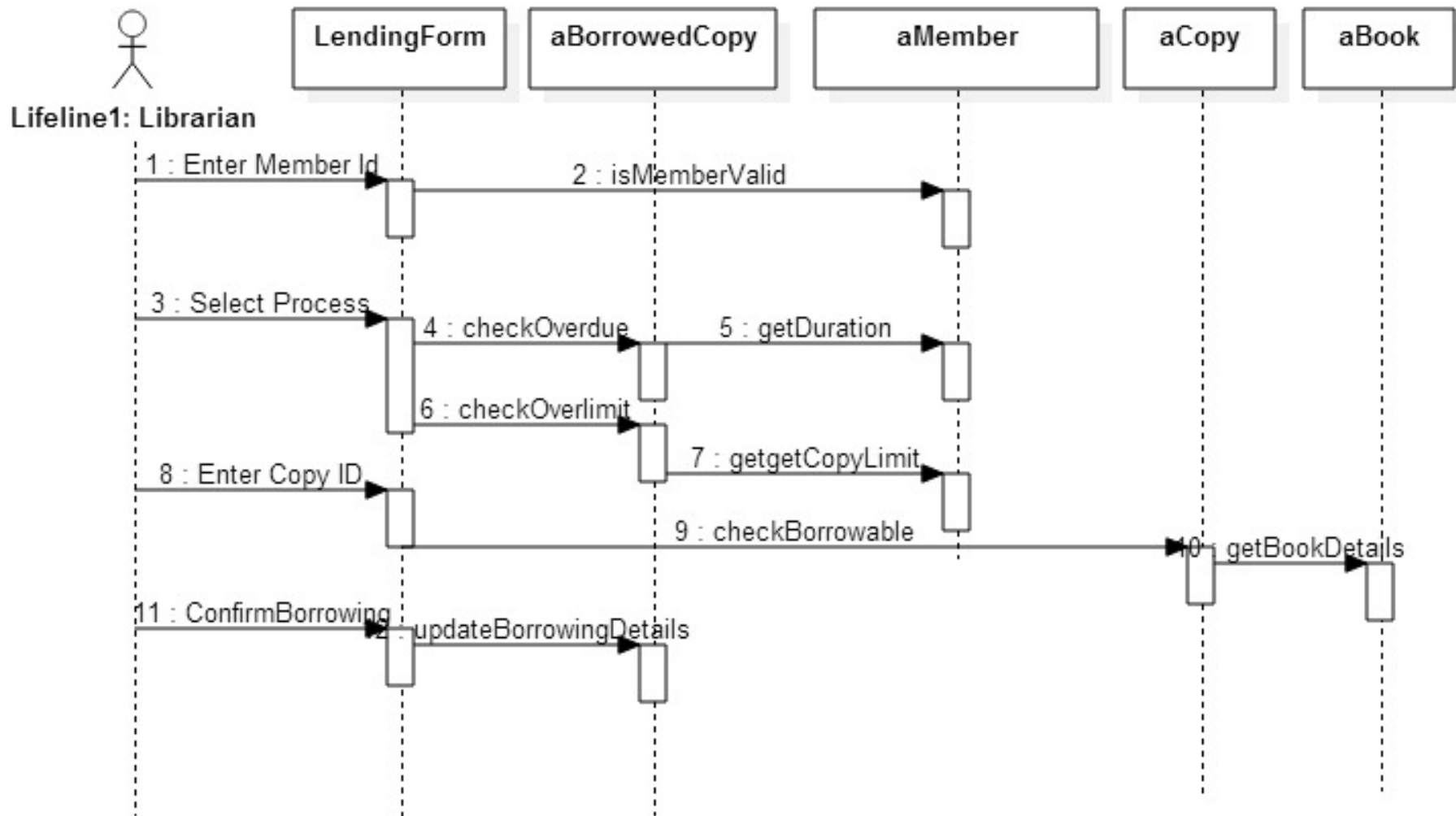
Borrowing Sequence Diagram with objects and messages (first User interaction)



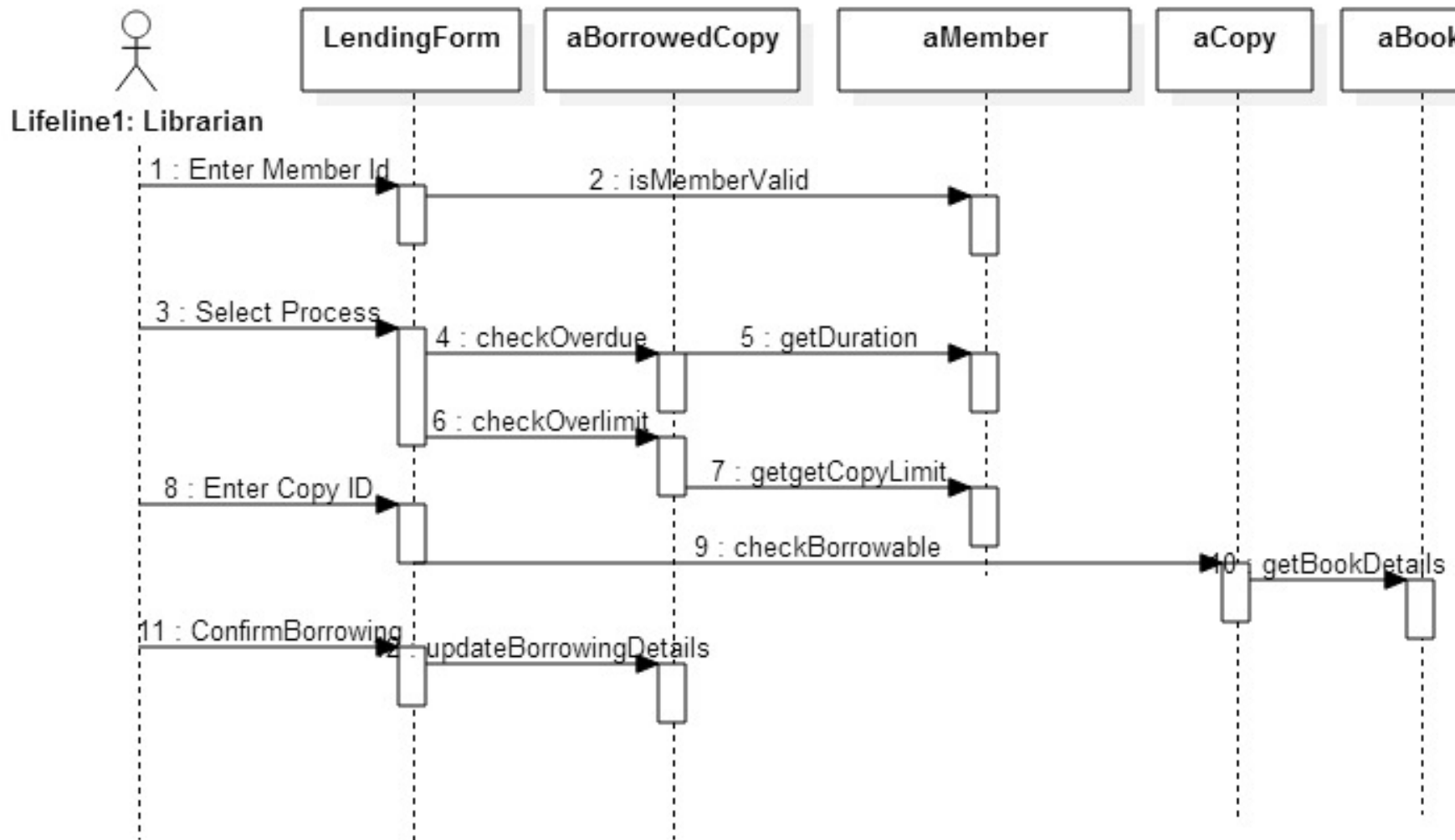
Borrowing Sequence Diagram with objects and messages (2nd User interaction)



Borrowing Sequence Diagram with objects and messages (3rd User interaction)



Borrowing Sequence Diagram with objects and messages (4th User interaction)



Borrowing Sequence Diagram

After mapping **objects** to classes and **messages** to methods

Other sequence diagrams can be drawn similarly

Case Study 2

Hotel Reservation System

A Hotel consisting of 100 rooms needs to computerize their manual Hotel Reservation System. The systems analyst who was assigned to this project has visited the Hotel and he has gathered the following information about the system. The following text describes his findings.

The 100 rooms available are categorized into different room types and each room type has different rates. The number of rooms in different types and the corresponding rates are as follows:

Room Type	Room No. from/to	Rate/Night
Single	1 to 60	Rs. 1000
Double	61 to 89	Rs. 1800
Suite	90 to 100	Rs. 5000

Case Study 2

Hotel Reservation System cont...

A Customer can reserve a room by calling the hotel receptionist. The receptionist will answer customer's queries regarding the room types, room rates, modes of payments available and any discounts the customer is entitled to etc. The receptionist will then take the following particulars from the customer, if customer wishes to proceed with the reservation.

Customer's name, Contact address, Country, Sex,
Type of accommodation, the period of stay, expected check in date.

Subsequently the receptionist will check the room availability. If a room is available, the customer is informed about the room availability. If customer accepts the reservation, a room number is allocated at the same time. The customer is also informed if a room is not available.

Case Study 2

Hotel Reservation System cont...

A customer can cancel the reservation at any time. It can be done by calling or by sending a fax. The receptionist is also responsible for handling the cancellations.

When the customer checks-in at the hotel on the reserved date, the receptionist will obtain the customers desired mode of payment. The customer may be entitled to a discount based on the payment mode selected.

The different payment modes and their discounts are as follows:

Payment Modes		Discount
Cash	-	No discount
Traveler's Cheque	-	2% eg. AMEX, Cooks etc.
Credit Card	-	3% eg. Diners, Master etc.
Company	-	Depend upon the company, Eg. NEC 12%, IBM 10% etc.

Case Study 2

Hotel Reservation System cont...

The Customer can check-out from the hotel at any time by informing the receptionist. The receptionist will immediately inform the billing Clerk to handle the billing. The details about the Payments such as discounts given, company name, kind of traveler's cheques used, and credit card details etc. are preserved for any future reference.

If the customer needs to extend the stay, he/she may do so by informing the receptionist. Receptionist will check the room availability and extension is accepted if rooms are available.

System Actors

- Receptionist
- Billing Clerk
- ~~Customer~~

According to the Case Study Customer is not a System Actor

Use Cases

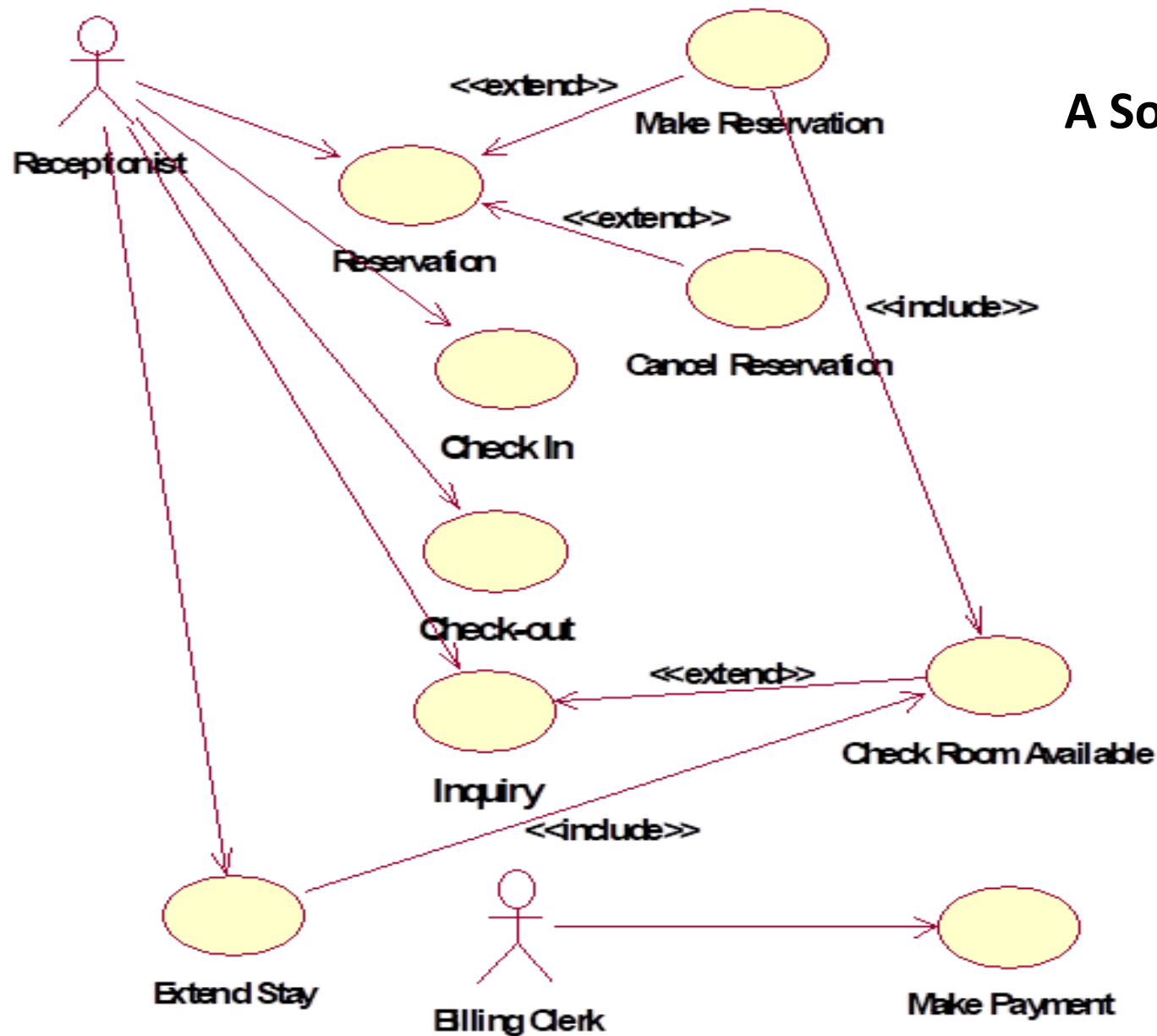
- Receptionist

Make Reservation, Cancel Reservation, Check-In, Check-out, Inquiry, Extended stay

- Billing Clerk

Make Payment

A Solution



Identifying the Classes

- Let's Look at the Nouns .
- The initial list of nouns must be filtered because, it could contain nouns that are
 - outside the problem domain.
 - language expressions.
 - redundant.
 - attributes.

Case Study 2

Hotel Reservation System

A Hotel consisting of 100 rooms needs to computerize their manual Hotel Reservation System. The systems analyst who was assigned to this project has visited the Hotel and he has gathered the following information about the system. The following text describes his findings.

The 100 rooms available are categorized into different room types and each room type has different rates. The number of rooms in different types and the corresponding rates are as follows:

Room Type	Room No. from/to	Rate/Night
Single	1 to 60	Rs. 1000
Double	61 to 89	Rs. 1800
Suite	90 to 100	Rs. 5000

Case Study 2

Hotel Reservation System cont...

A Customer can reserve a room by calling the hotel receptionist. The receptionist will answer customer's queries regarding the room types, room rates, modes of payments available and any discounts the customer is entitled to etc. The receptionist will then take the following particulars from the customer, if customer wishes to proceed with the reservation.

Customer's name, Contact address, Country, Sex,
Type of accommodation, the period of stay, expected check in date.

Subsequently the receptionist will check the room availability. If a room is available, the customer is informed about the room availability. If customer accepts the reservation, a room number is allocated at the same time. The customer is also informed if a room is not available.

Case Study 2

Hotel Reservation System cont...

A customer can cancel the reservation at any time. It can be done by calling or by sending a fax. The receptionist is also responsible for handling the cancellations.

When the customer checks-in at the hotel on the reserved date, the receptionist will obtain the customers desired mode of payment. The customer may be entitled to a discount based on the payment mode selected.

The different payment modes and their discounts are as follows:

Payment Modes		Discount
Cash	-	No discount
Traveler's Cheque	-	2% eg. AMEX, Cooks etc.
Credit Card	-	3% eg. Diners, Master etc.
Company	-	Depend upon the company, Eg. NEC 12%, IBM 10% etc.

Case Study 2

Hotel Reservation System cont...

The Customer can check-out from the hotel at any time by informing the receptionist. The receptionist will immediately inform the billing Clerk to handle the billing. The details about the Payments such as discounts given, company name, kind of traveler's cheques used, and credit card details etc. are preserved for any future reference.

If the customer needs to extend the stay he/she may do so by informing the receptionist. Receptionist will check the room availability and extension is accepted if rooms are available.

List of Nouns

Hotel, Room,
Room type, Rate, Room No,
Single, Double Suite,
Customer,
Receptionist, Payment,
Discount, Customer's name,
Contact address, Country,
Sex,

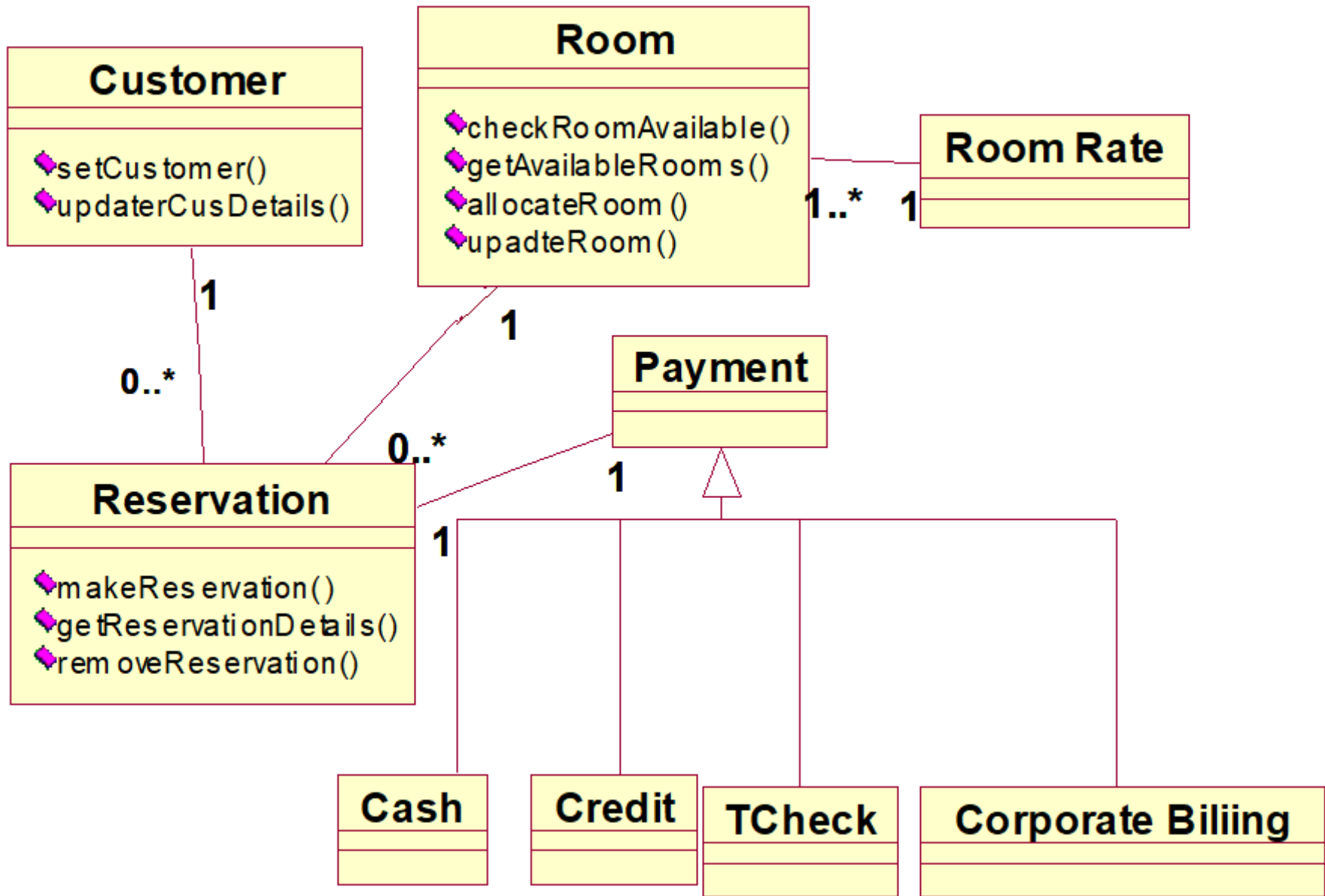
Type of
accommodation, the
period of stay, expected
check in date.

Reservation

Reserved date, Cash,
Trav. Cheque, Credit
Card, Company,
Billing Clerk

Potential Classes

- Room
- Customer
- Payment : Cash, CreditCard, Company, Trav. Cheques
- Reservation
- Room Rate



Draw the sequence diagrams

- Prepare Use case narratives for each use case
- Draw sequence diagrams(Refer Case Study 1 Solution)
- You may refer the Lecture slides to draw the other UML diagrams.

Summary

A Use Case model can be developed by following the steps below.

- Identify the Actors (role of users) of the system.
- For each category of users, identify all roles played by the users relevant to the system.
- Identify what the users required the system to be performed to achieve these goals.
- Create use cases for every goal.
- Draw the Use case model
- Identify use case to use case relationships

Summary cont..

A Class model can be drawn using the following steps

- Go through the Case Study
- Pick out the nouns.
- Filter list of nouns to identify the objects
- Prepare use case narratives for each use case
- Identify the objects need to interact during the scenario using the flow of events.
- Complete the class model.

Sequence diagrams can be drawn using the following steps

- Identify a set of objects that will participate in the general collaboration (or use case scenario)

Summary cont..

A Sequence diagram can be drawn using the following steps

- Identify a set of objects that will participate in the general collaboration (or use case scenario)
- You should also identify the primary actor(s) who activates the use case
- Consider what the system need to be done in order to response to the actor, when the actor send the message to the system
- Most Analyst ignore the return messages in sequence diagrams.
- Subsequently you can identify the candidate objects and operations of the target application for that particular scenario
