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Analysis, Design and Implementation

Topic 5:

Dynamic Analysis and Design

V1.0

Introduction

- In the last lecture we looked at building static models of the systems we are to build.
    - The class diagram focuses on how things fit together.
- Today, we are going to look at an aspect of the dynamic design.
    - How a system should respond to users and evolve over time.
- This involves two new diagram notations:
    - Sequence diagrams
    - Activity diagrams

Activity Diagrams

- Activity diagrams are known as ***workflow diagrams***.
- They are much like flow-charts, except more structured.
- Activity diagrams are used to describe the full process behind an internal process or a user request.
- They describe the logic of the operations that are shown on class diagrams.
- They are constructed of a number of notational elements.

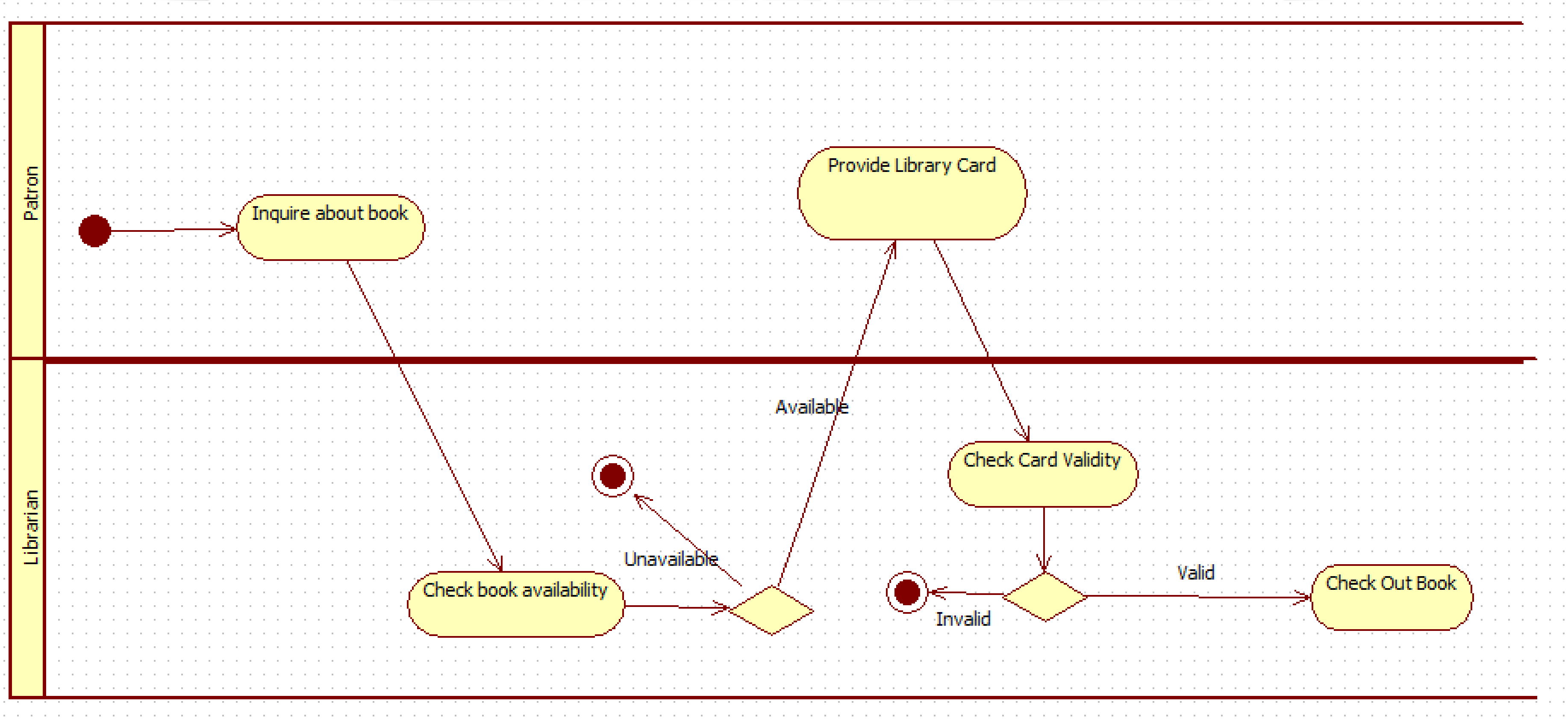
Notational Elements - 1

Element	Description
Swim Lane	Used to indicate which actors or objects are responsible for the action. They are indicated by a series of lines partitioning the diagram.
Initial Node	The starting point for the diagram. This is represented by a single filled circle.
Activity Final Node	The termination point for the activities. There may be several of these in a diagram. This is a filled circle surrounded by a border.
Flow	The flow represents the order in which activities are performed. Indicated by arrows.

Notational Elements - 2

Element	Description
Fork	A fork indicates parallel processing – activities that can be undertaken at the same time. A fork is indicated by a thick bar where one flow enters and multiple flows leave.
Join	A join indicates the end of parallel processing, and is indicated by a thick bar where multiple flows enter and only one leaves.
Decision	A decision represents a choice that must be taken, and is represented as a diamond with a single flow entering and one or more flows leaving.
Activity	An activity is the baseline step in an activity diagram, and is represented by a rounded oval. An activity is any logically discreet action that must be taken throughout the course of the overall activity.

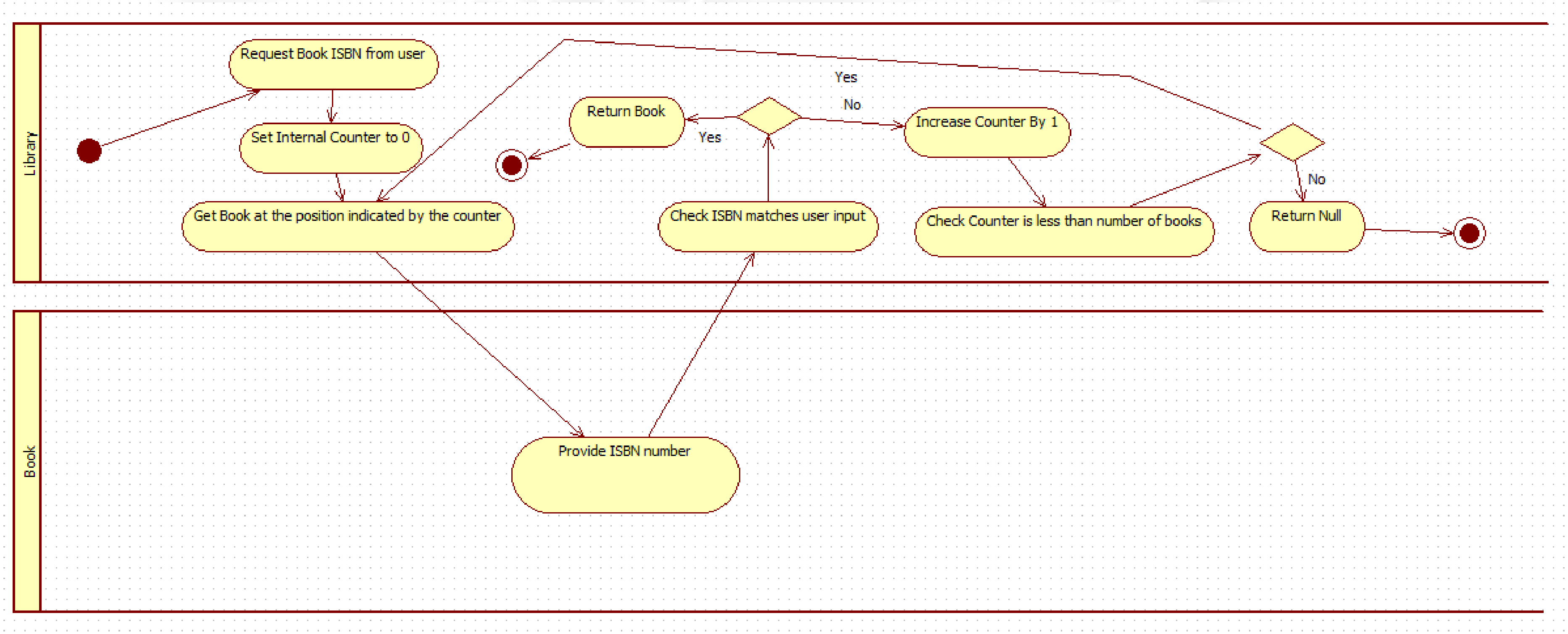
Activity Diagram



Activity Diagrams

- Activity diagrams are mostly used for two purposes:
  - Outlining the high level activity in a system (as with our example diagram)
  - Formally representing algorithms (each activity becomes a line of code)
- In the latter case, activity diagrams serve as a consistent notation for representing logical processes (like pseudocode, but graphical).

Finding a Book


Library
Request Book ISBN from user
Set Internal Counter to 0
Get Book at the position indicated by the counter
Return Book
Yes
Yes
No
Increase Counter By 1
Check ISBN matches user input
Check Counter is less than number of books
No
Return Null
Book
Provide ISBN number

Creating an Activity Diagram

- Creating an activity diagram is much like writing computer code.
  - There is no ‘right’ way, but plenty of wrong ways.
- Activity diagrams represent the flow of communication through a system.
  - It is important that each use case in your use case diagram has an activity diagram representation.
- Activity diagrams can be profitably developed in two parts.

Creating an Activity Diagram

- Analysis
  - Understand what the current system is doing
  - Understand the flow of communication for each distinct use case in the current system.
- Design
  - Improve the existing system
    - Improve efficiency
    - Remove bottlenecks
    - Remove redundancies
  - Diagram your improved workflows.

Understanding the System

- As with constructing a class diagram, the important thing is to understand your brief.
- Diagramming the workflow of a process will ensure that you understand each of the steps.
  - Having someone else try to follow your diagram will ensure that you haven't left anything out.
- The NLA processing that you may have done to outline the class diagram will assist in developing your activity diagrams.

Understanding the System

- Your NLA will reveal:
  - Behaviours
  - Classes
- Your use case diagrams will reveal:
  - Processes
  - Actors
- The development of one diagram should be informing the development of others.
  - UML is an integrated system for developing diagrams.

Developing an Activity Diagram

- A useful first step is to outline a process in structured English or pseudo-code.
- You do not need all of the detail to begin with.
  - As with class diagrams, we can continually refine these as we go along.
- Once you have a structured description of the process, construct the diagram from that description.
- Granularity can be difficult here.
  - It's often tricky to pick the right level of detail for individual pseudo-code statements.

Developing an Activity Diagram

- The process for constructing your description is as follows:
  - Identify the process to be documented.
  - Limit the scope of the process only to the relevant aspects.
  - Methodically document each step of the process:
    - When a decision is called for, precisely enumerate all options.
    - When a repetition is called for, precisely enumerate the termination condition.
    - When an activity is called for, break it down until each box represents one distinct step of the system.

Implementation - 1

- Activity diagrams lend themselves easily to code.
  - It is simply a case of translating activities into code statements.
- Activity diagrams are focused at the level of the method.
  - They don’t show big picture detail of how things interact.
- Consider the example activity diagram that looks to see if a book is currently available - we can convert that easily into an suitable OO language.

Implementation - 2

- As with any of these diagrams, they represent a high level, language independent view.
  - We need to make calls on implementation as we go along.
- Our activity diagrams don’t explicitly mention loops, so we need to decide for ourselves how to implement the looping behaviour.
  - (We’ll do ours with a for loop)
- We begin by writing the logic out in full, and then condense.

Implementation – Rough

```
Book findBook (String isbn) {
        int counter;
        Book tmp;
        String currentIsbn;

        counter = 0;

        tmp = allBooks.get(counter);

        currentIsbn = tmp.getISBN();

        if (currentIsbn.equals(isbn)) {
                return tmp;
        }

        counter += 1;

        if (counter < allBooks.size()) {
                // Loop back to line 8
        }

        return null;
}
```

Implementation - Refined

```
Book findBook (String isbn) {
       int counter;
       Book tmp;
       String currentIsbn;

       counter = 0;

       for (counter = 0; counter < allBooks.size(); counter += 1) {
              tmp = allBooks.get(counter);

              currentIsbn = tmp.getISBN();

              if (currentIsbn.equals(isbn)) {
                     return tmp;
              }
       }
       return null;
}
```

Implementation - 3

- Implementation at this level of abstraction is often, at least in part, an all or nothing affair.
    - We can’t implement the findBook method until we implement the getISBN method.
- We develop such programs from the fundamentals upwards:
    - Accessor methods are implemented first
    - Those methods that rely only on accessor methods are implemented next
    - Those methods that rely on other methods are done last.

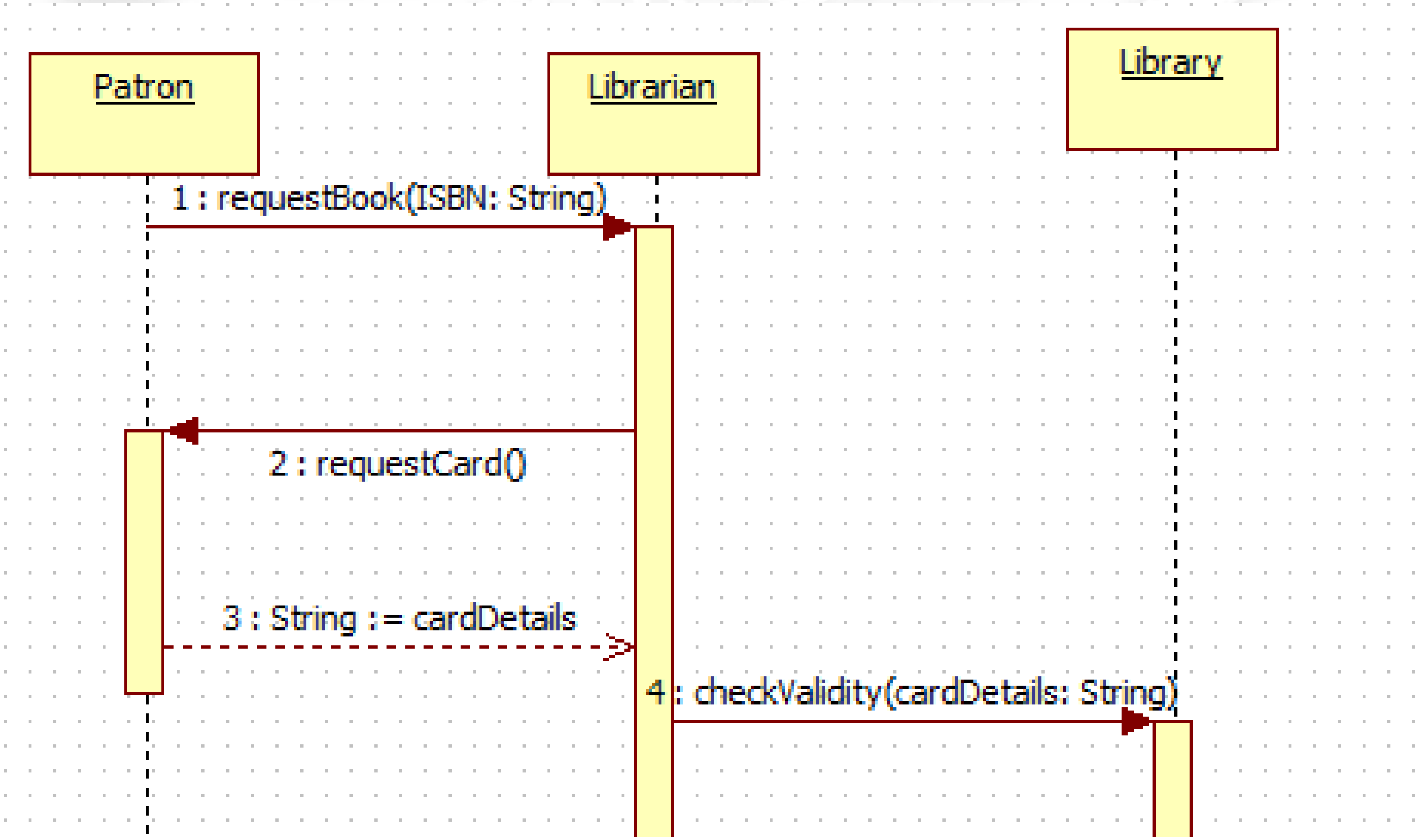
Sequence Diagrams

- The next diagram notation we will discuss is that of the sequence diagram.
  - This shows the order in which methods are invoked in a system.
  - It shows the scope, or lifetime, of objects.
- Sequence diagrams are useful for developers to see the big picture of how things interact.
  - It views the operation at a higher level of abstraction than an activity diagram.

Sequence Diagram Notation

- Sequence diagrams consist of a number of ***lifelines***.
  - These are boxes that represent the roles and lifetimes of objects involved in an interaction.
- Each of these life-lines will produce ***messages***.
  - These are labelled arrows that show the name of methods invoked and their parameters.
- Return messages are drawn with the type of the parameter, and a dotted arrow.

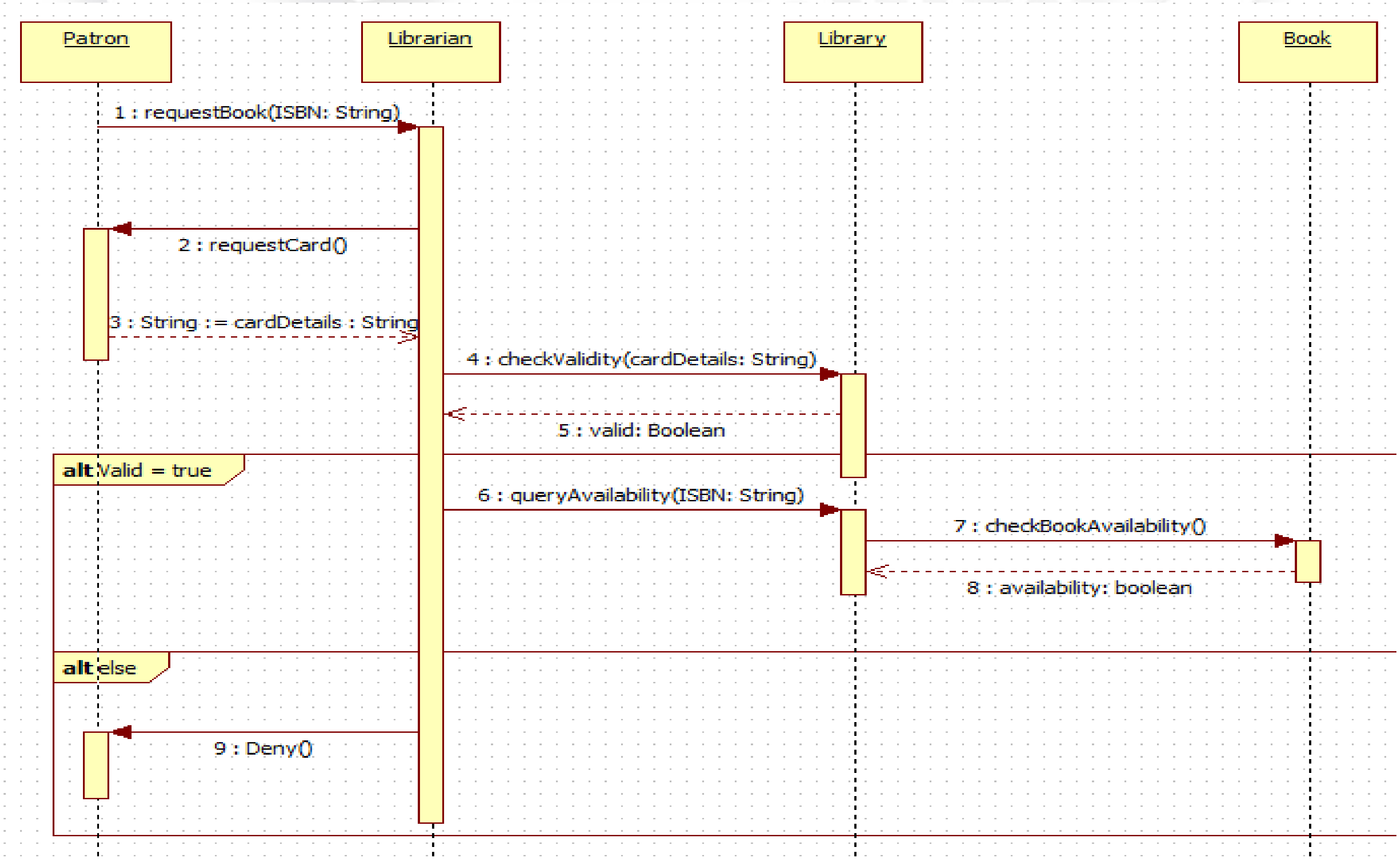
Sequence Diagram


Patron
Librarian
Library
1 : requestBook(ISBN: String)
2 : requestCard()
3 : String := cardDetails
4 : checkValidity(cardDetails: String)

Guards and Alternates - 1

- The flow of logic through a sequence diagram is often dependent on the state of returned values.
  - Card validity
  - Book availability
- We represent these in a sequence diagram through the use of a ***frame***.
  - This allows us to provide if/else strutures in our diagrams.
  - We place a ***guard*** condition on the frame which determines whether a frame should be executed.

Guards and Alternates - 2


Patron
Librarian
Library
Book
1 : requestBook(ISBN: String)
2 : requestCard()
3 : String := cardDetails : String
4 : checkValidity(cardDetails: String)
5 : valid: Boolean
alt Valid = true
6 : queryAvailability(ISBN: String)
7 : checkBookAvailability()
8 : availability: boolean
alt else
9 : Deny()

Objects and Classes

- In a sequence diagram, the boxes at the top of a lifeline represent objects, not classes.

- As such, they should properly be named and typed.
    - Names are of secondary importance unless we can be sure of a particular context.

- We name them anyway so that we can distinguish between instances of a class and potentially static operations (in which case, we have the type only).

Sequence Diagrams

- Sequence diagrams are not usually implemented directly.
- They serve to help you find logical or architectural inconsistencies before it becomes time to develop the program.
- They also show dependencies of objects and methods.
  - You can see what activities are going to be involved in a process by examining the sequence diagram.

The Role of a Sequence Diagram - 1

- Activity diagrams should represent a code view of a system.
- Sequence diagrams should represent a higher level view of interactions. Otherwise, you gain nothing from them that you don't gain from looking at the source code or the activity diagrams.
- There is no need for a sequence diagram to be detail heavy.
  - Broad strokes allow you to get the most out of them.

The Role of a Sequence Diagram - 2

- Sequence diagrams also serve as a way to co-ordinate interfaces between multiple developers.
  - If everyone has access to the sequence diagram, they can see what methods their classes need to expose and what data they are expected to return.
- Sequence diagrams are a useful part of your analysis and design toolkit, but not necessarily a part that will inform the implementation of your systems.

Conclusion

- Dynamic modelling represents the state of the system as it changes over time, or as it reacts to user input.
- Activity diagrams serve as a template for implementing code.
  - They are a low-level view of how processes and objects interact.
- Sequence diagrams are a high level planning and design tool.
  - They don’t get implemented directly.

Topic 5 – Dynamic Analysis and Design

Any Questions?

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