SENG 350
- Software Architecture & Design

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UML Diagrams

Fall 2024

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UML Diagrams

- Collaboration diagrams
- Activity diagrams
- State transition diagrams

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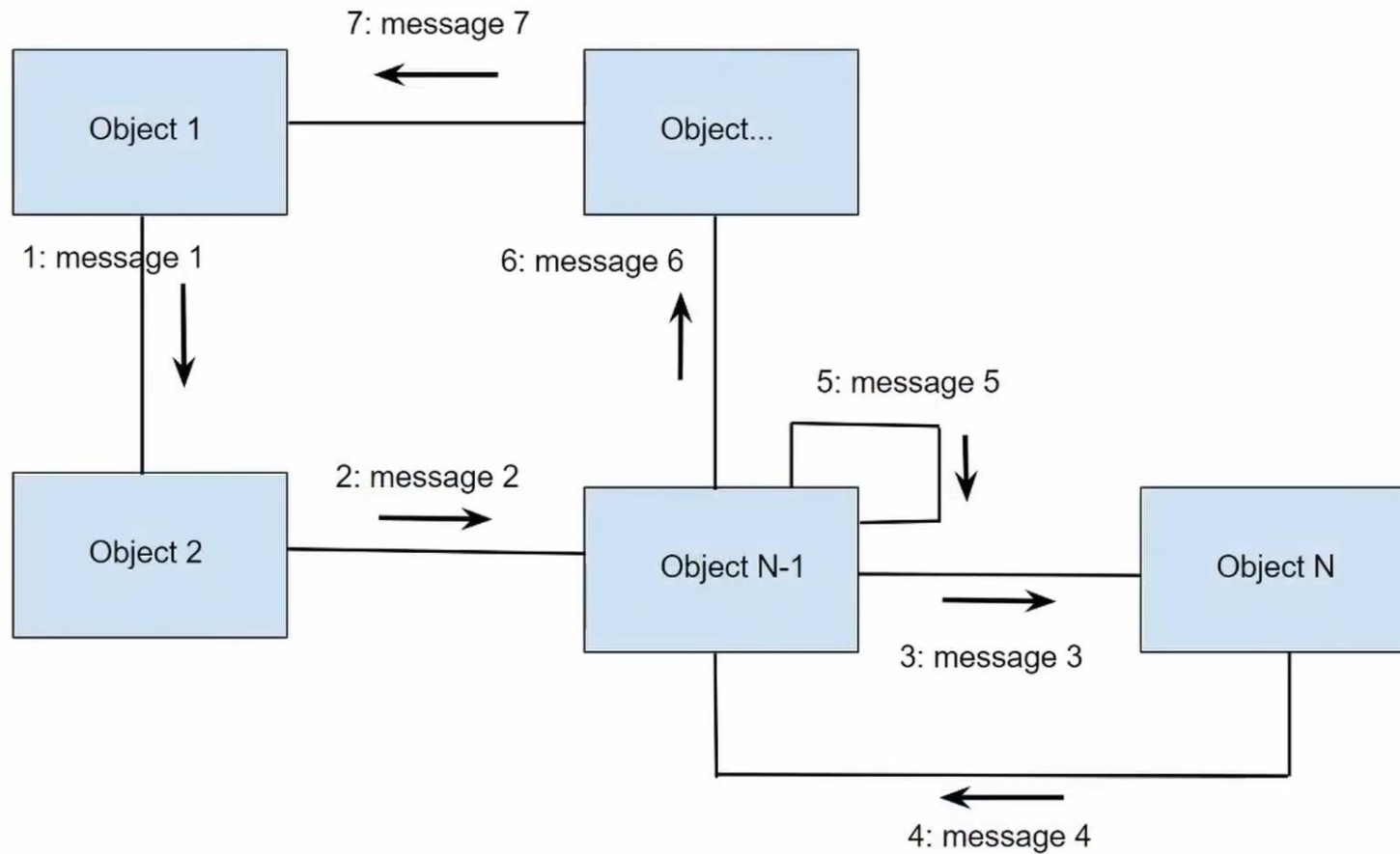
Collaboration Diagrams

What is a Collaboration Diagram

- Collaboration diagrams illustrate interactions between objects
- The collaboration diagram illustrates messages being sent between classes and objects (instances).
- Collaboration diagrams express both the context of a group of objects (through objects and links) and the interaction between these objects (by representing message broadcasts)

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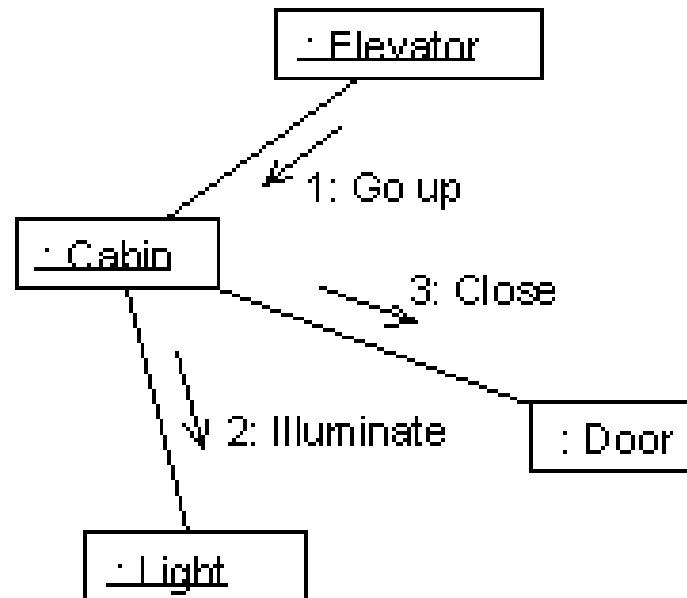
What is a Collaboration Diagram

Purpose of the Collaboration Diagram

- They are very useful for visualizing the relationship between objects collaborating to perform a particular task
- They provide a good view of interaction between objects which may be difficult to see at the class level

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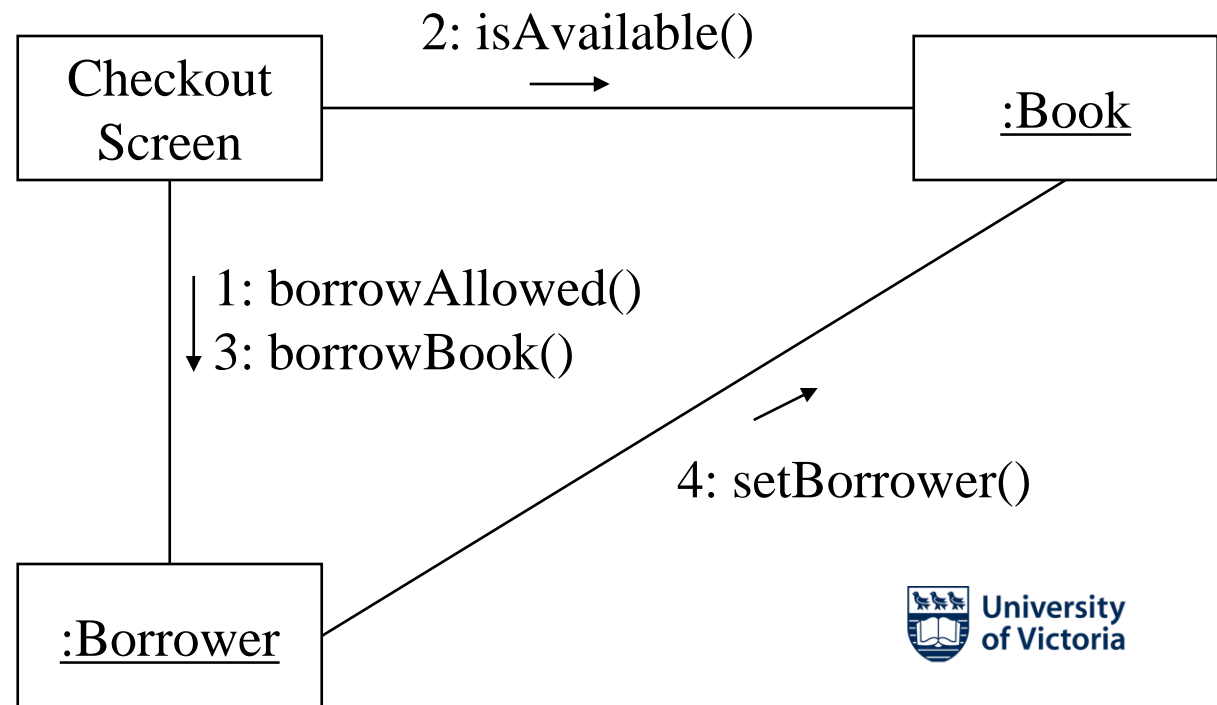
Collaboration Diagram

- Represents a Collaboration and Interaction
- Collaboration: Set of objects and their interactions in a specific context
- Interaction: Set of messages exchanged in collaboration to produce a desired result
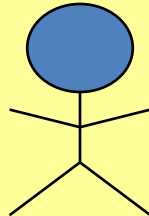
Collaboration Diagram Elements

There are three primary elements of a collaboration diagram:

- Objects
- Links
- Messages

Collaboration Diagram Syntax

AN ACTOR	
AN OBJECT	anObject:aClass
AN ASSOCIATION	_____
A MESSAGE	aMessage() ⟶

Flow by Number
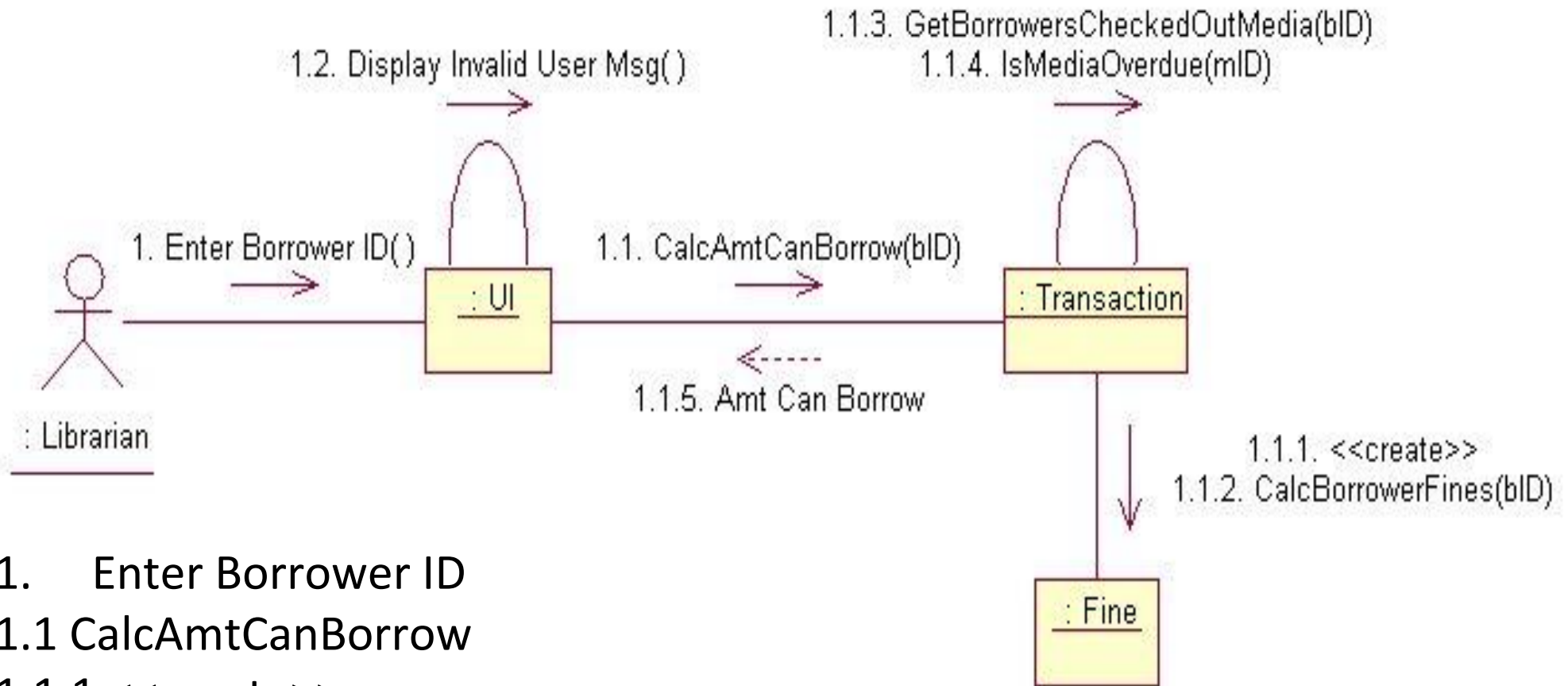
1. Enter Borrower ID

1.1 CalcAmtCanBorrow

1.1.1 <<create>>

1.1.2 CalcBorrowerFines

1.1.3 GetBorrowersCheckedOutMedia

1.1.4 IsMediaOverdue

1.1.5 Amt Can Borrow

1.2 Display Invalid User Msg

Conditional Messages

To indicate that a message is run conditionally, prefix the message sequence number with a conditional : IsMediaOverdue
This indicates that the message is sent only if the condition is met
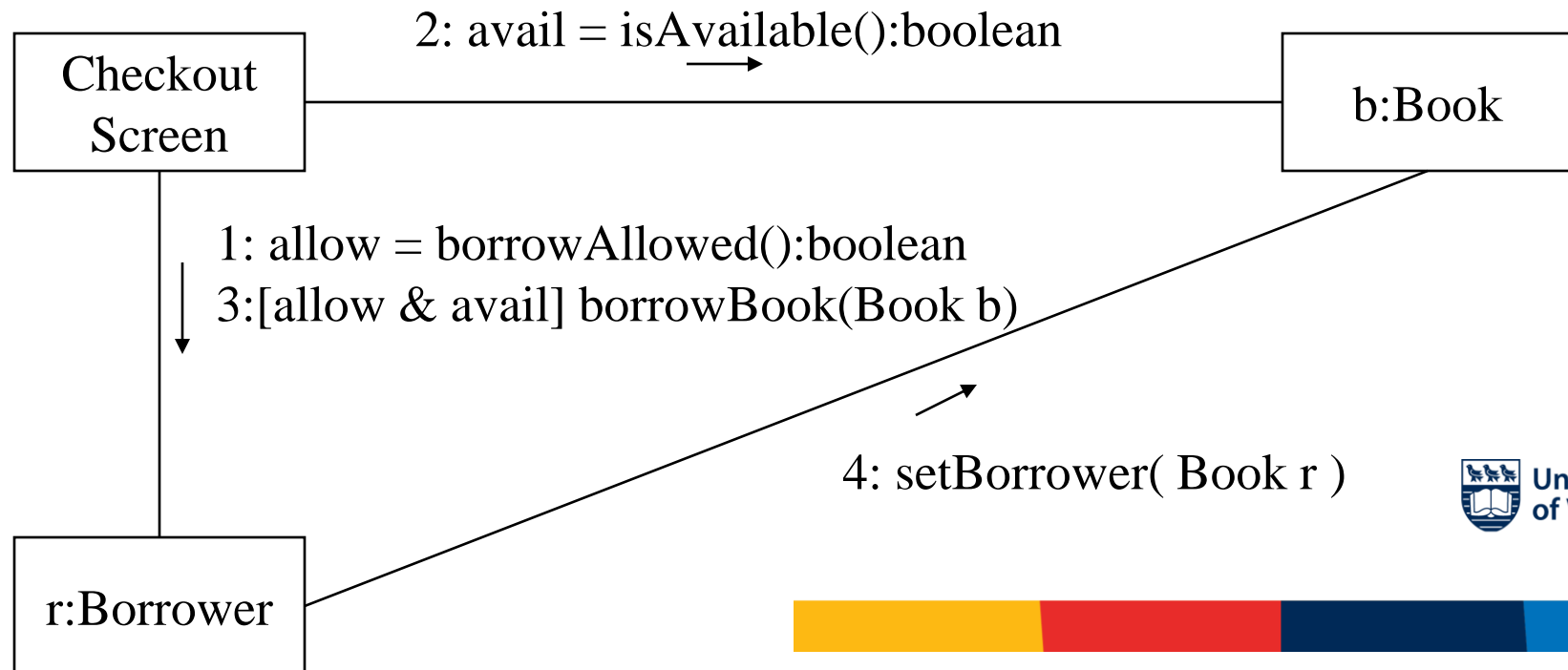
Case Study

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Case Study

Online School Portal (OSP) is a smartphone and web-based application that targets schools. It facilitates students, teachers, administration and parents. This system provides a platform that automates all the work, which is much more efficient than the legacy systems. In this software, each stakeholder can perform certain tasks to get their job done. Moreover, the application provides ease of use, implementing features of human-computer interaction. OSP includes a website and a smartphone application. The smartphone application and website are combined with a mutual server and a database.
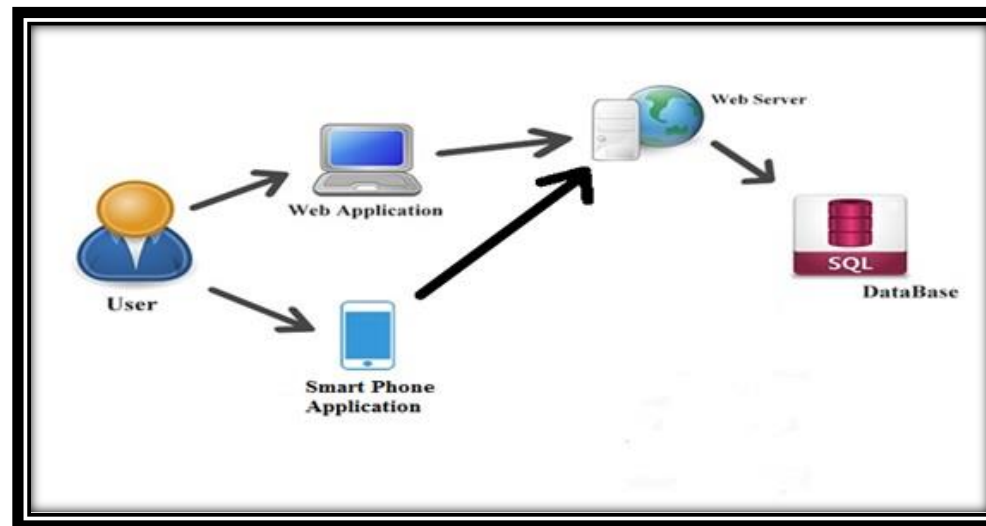
What are the mistakes in this? (2 mins)
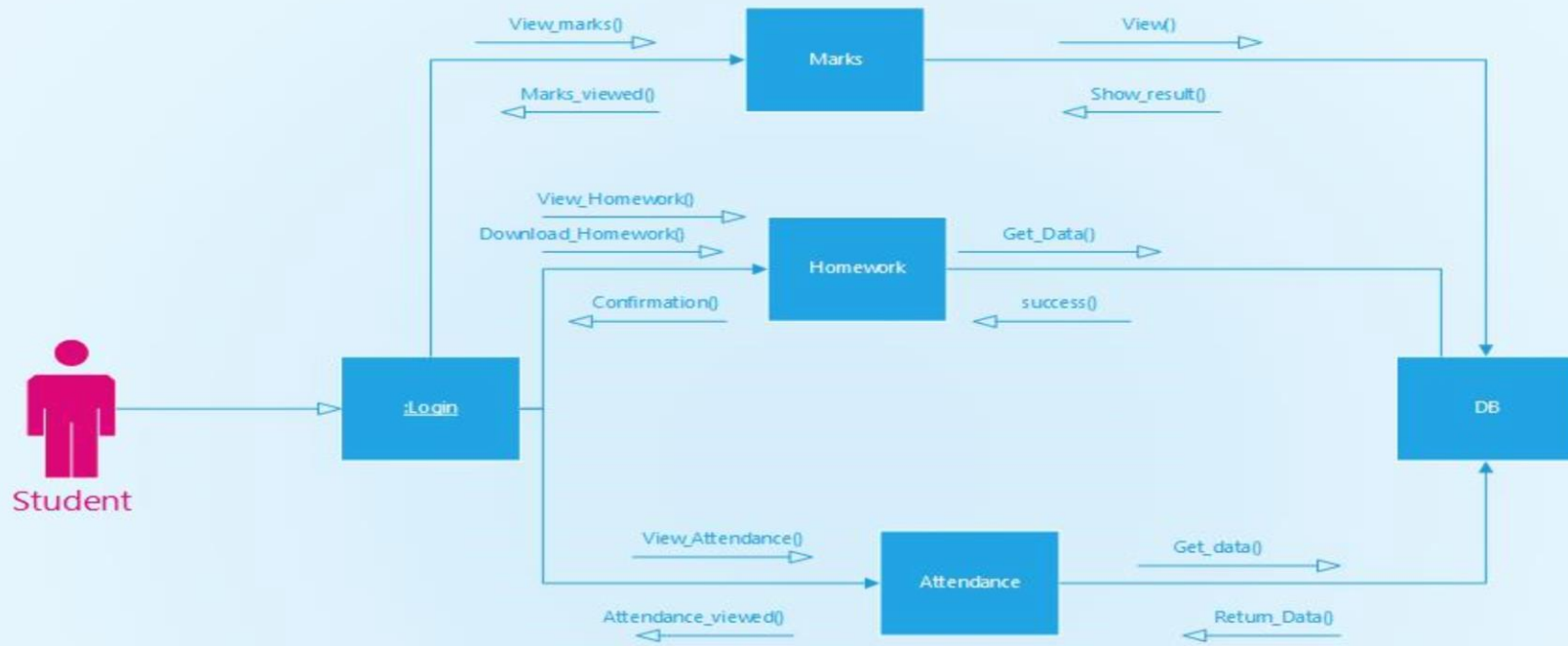
Activity Diagrams

Activity Diagrams

- An activity diagram is a graphical representation of the steps involved in a process or workflow.
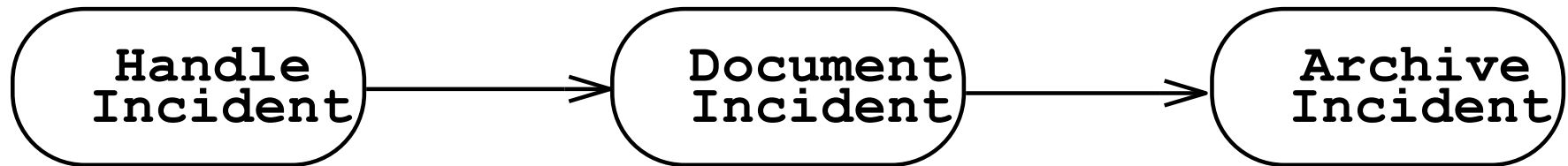
Activity Diagrams

Shows the sequence of activities in a process (manual or computerized)

- Activity Diagrams allow to model Decisions
- Activity Diagrams can model Concurrency
- Activity Diagrams: Grouping of Activities
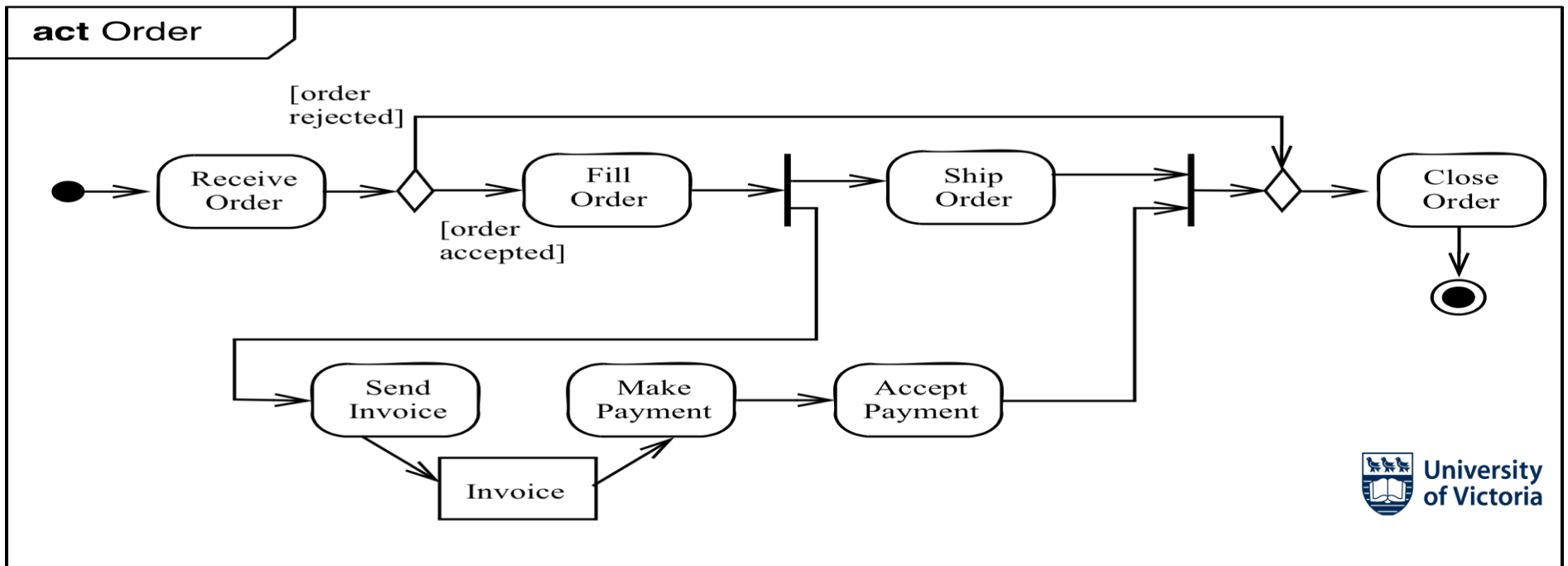
Notations

Activity name

Activity Name (manual, automatic)

Event

Events: things that happen

[cond] [else]
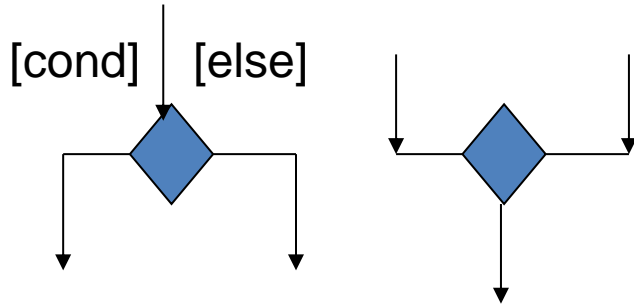
Decision branching (and Merge)

Synchronization bar (show parallel activities)
    Fork: one in, several out (start of parallel)
    Join: Several in, one out (end of parallel)

Start

End

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Activity Nodes & Edges

- An activity diagram consists of nodes and edges
- There are **three** types of activity nodes
  - Control nodes
  - Executable nodes (Most prominent: **Action)**
  - Object nodes (E.g. a document)
- An **edge** is a directed connection between nodes

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Control Nodes in an Activity Diagram

Initial node ●

Final node ◉

Fork node ▬▬▬▬▬▬

Join node

Merge node ◇

Decision node

Activity Diagram Example
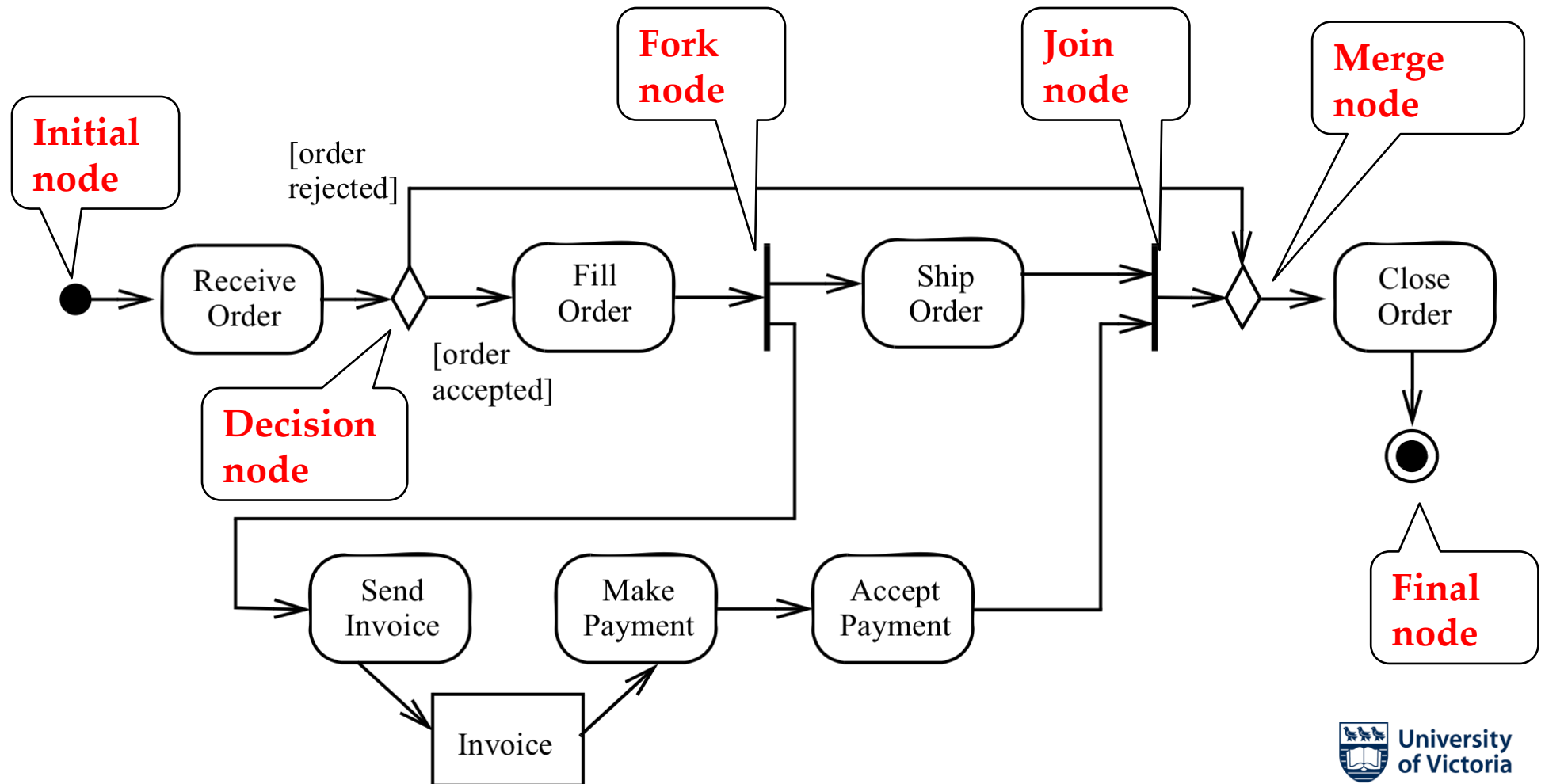
Activity Diagrams can model Concurrency

Synchronization of multiple activities
Splitting the flow of control into multiple threads
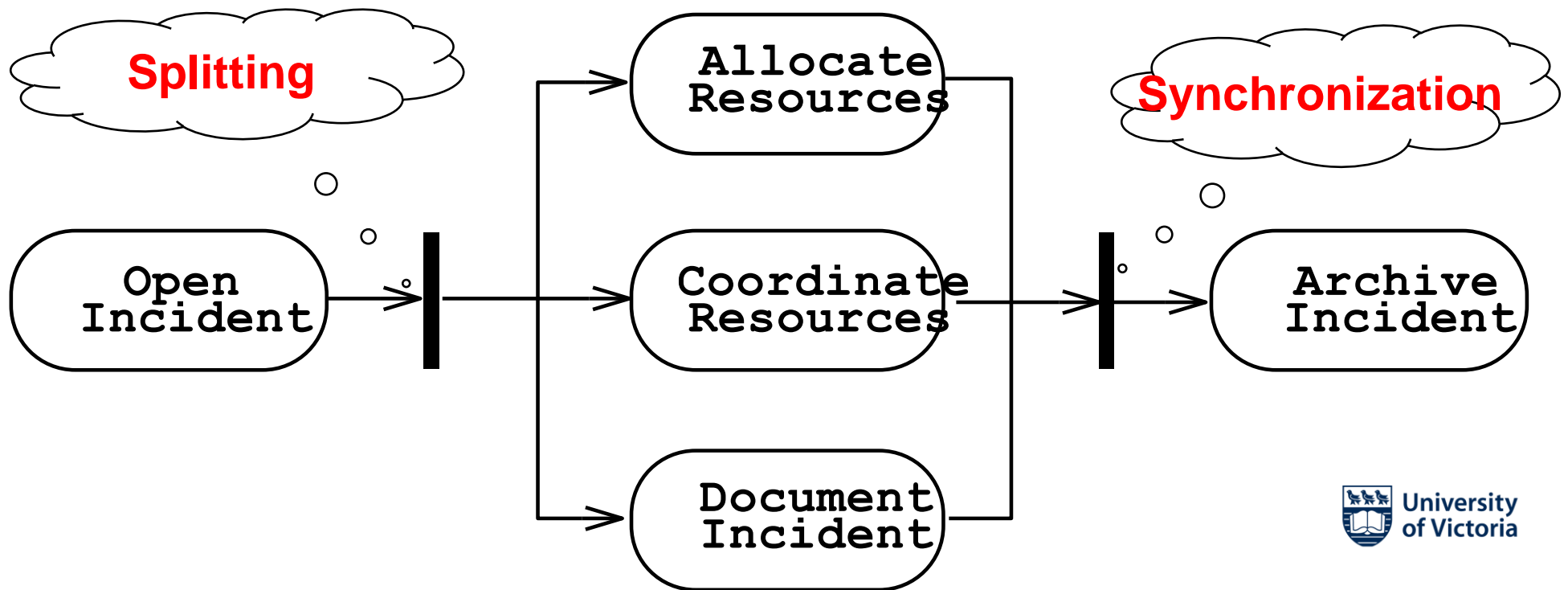
Action Nodes and Object Nodes

Action Node

Object Node

```
┌──────────┐
│ Action   │
│ Name     │
└──────────┘

┌──────────┐
│ Object   │
│ Name     │
└──────────┘
```

```
┌─────────┐      ┌─────────┐      ┌─────────┐
│ Write   │─────▶│ Thesis  │─────▶│ Review  │
│ Thesis  │      │         │      │ Thesis  │
└─────────┘      └─────────┘      └─────────┘
```

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Activity Diagram Example
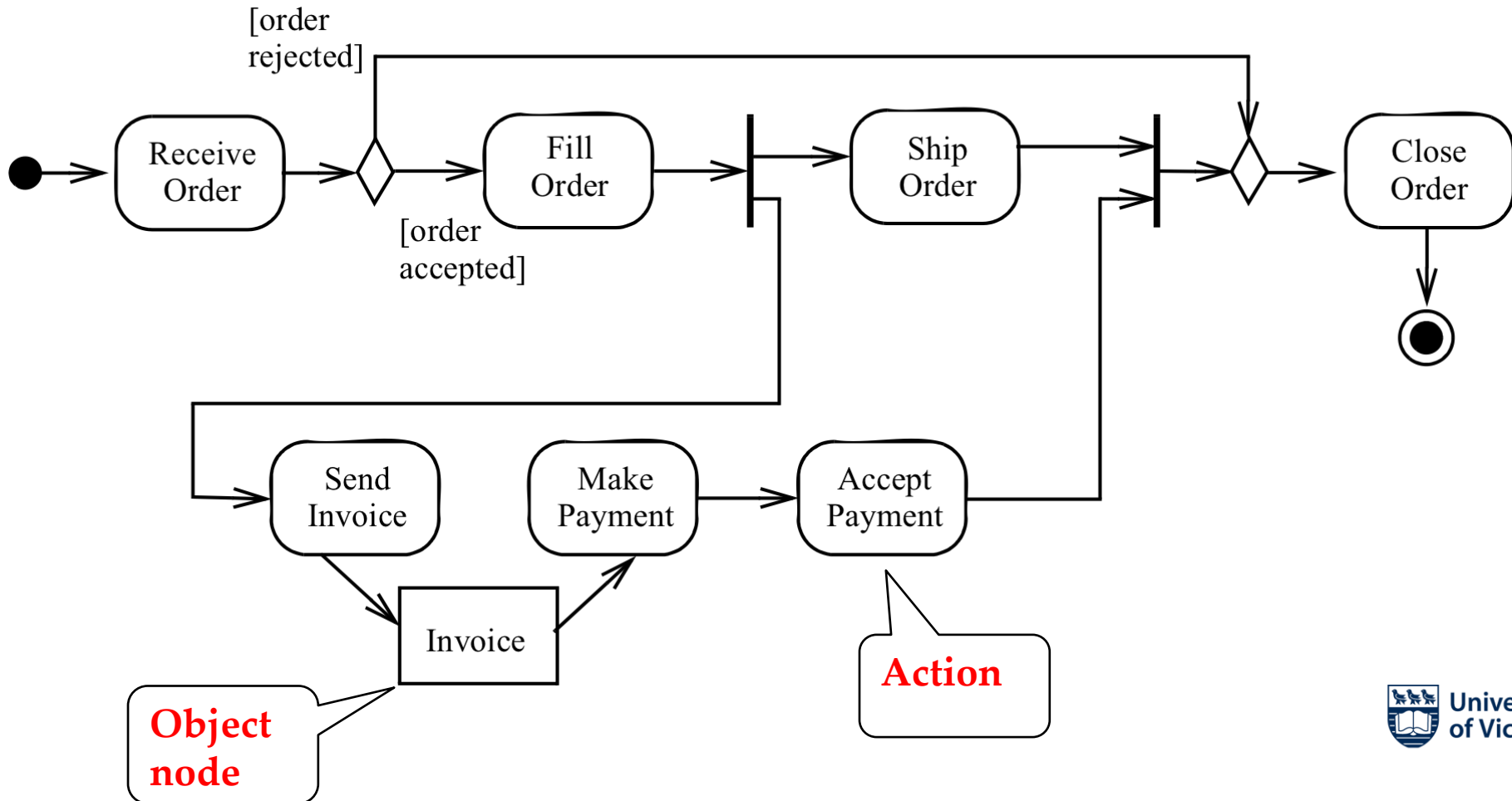
Swimlane Activity Diagram

- Swimlane Activity Diagram is a visual representation used in process modelling to depict the steps and interactions within a process involving multiple parties or departments.

- It divides the diagram into "swimlanes," representing different entities, roles, or departments involved in the process.

- Swimlane diagrams help clarify responsibilities and interactions within a complex workflow.

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Swimlane Activity Diagram Example

Customer	Sales	Contracts	Legal	Fulfillment

Initial Node

Control Flow

Partition

Swimlane

- Customer Submits PO
- Rep Logs PO, Enters Order
- Contracts Agent Reviews Order

Decision Node

No — Standard Terms?

Action

Yes

- Agent Approves Order — Pick Order
- Attorney Marks It OK
- Log Shipment
- Agent Requests Approval

Yes

Changes Acceptable?

No

Order is Shipped

Activity Final Node

- Attorney Marks It No

- Agent Cancels Order

Order is Not Shipped

Vertical and Horizonal Swimlane

When to use a Swimlane Activity Diagram

- **Complex Processes:** Use swimlane diagrams to map out complex processes involving multiple participants or departments. This helps ensure everyone understands their roles and responsibilities.
- **Cross-functional Collaboration:** Whenever a process involves collaboration between different teams or individuals, swimlane diagrams are useful for visualizing the handoffs and dependencies.
- **Process Improvement:** When you want to identify bottlenecks, inefficiencies, or areas for improvement in a process, a swimlane diagram can highlight areas where tasks are getting stuck or taking too long.
- **Documentation:** Swimlane diagrams serve as valuable documentation for existing processes. They help new employees understand how things work.
- **Communication:** These diagrams are excellent for facilitating communication and discussion among team members or stakeholders involved in the process.

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Examples of When to use a Swimlane

- **Order Processing:** A company may use a swimlane diagram to illustrate the steps involved in processing a customer order, with different lanes for sales, inventory, shipping, and finance.

- **Software Development:** In software development, a swimlane diagram can show the stages and responsibilities of different teams, such as development, quality assurance, and product management.

- **Healthcare:** Hospitals can use swimlane diagrams to map out the patient care process, including the roles of doctors, nurses, and administrative staff.

- **Supply Chain Management:** For a manufacturing company, a swimlane diagram can help visualize the various stages of the supply chain, from procurement to production to distribution.

- **Customer Support:** A swimlane diagram can illustrate how customer support requests are handled, with lanes for different support teams, escalation points, and customer interactions.

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State Transition Diagrams

State Transition Diagrams

- The basic idea is to define a machine with several states (hence the finite state machine).
- The machine receives **events** from the outside world, and each event can cause the machine to **transition** from one state to another.

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When to use State Transition Diagrams?

- State models are ideal for describing the behaviour of a single object.
- They are also formal, so tools can be built to execute them.
- Their most significant limitation is that they are not good at describing behaviour that involves several objects.
  - **For these cases use an activity diagram**

State Transition Diagrams Notation

- *State:* A condition during the life of an object in which it satisfies some condition, performs some action, or waits for some event.
- *Event*: An occurrence that may trigger a state transition. Event types include an explicit signal from outside the system, an invocation from inside the system, the passage of a designated period, or a designated condition becoming true.
- *Transition*: The change of state within an object.
- *Initial State:* The initial state (there can be only one) is the state that a new object will be in immediately following its creation
- *Final State:* A final state (there can be many) is a state that represents an object's end of existence.

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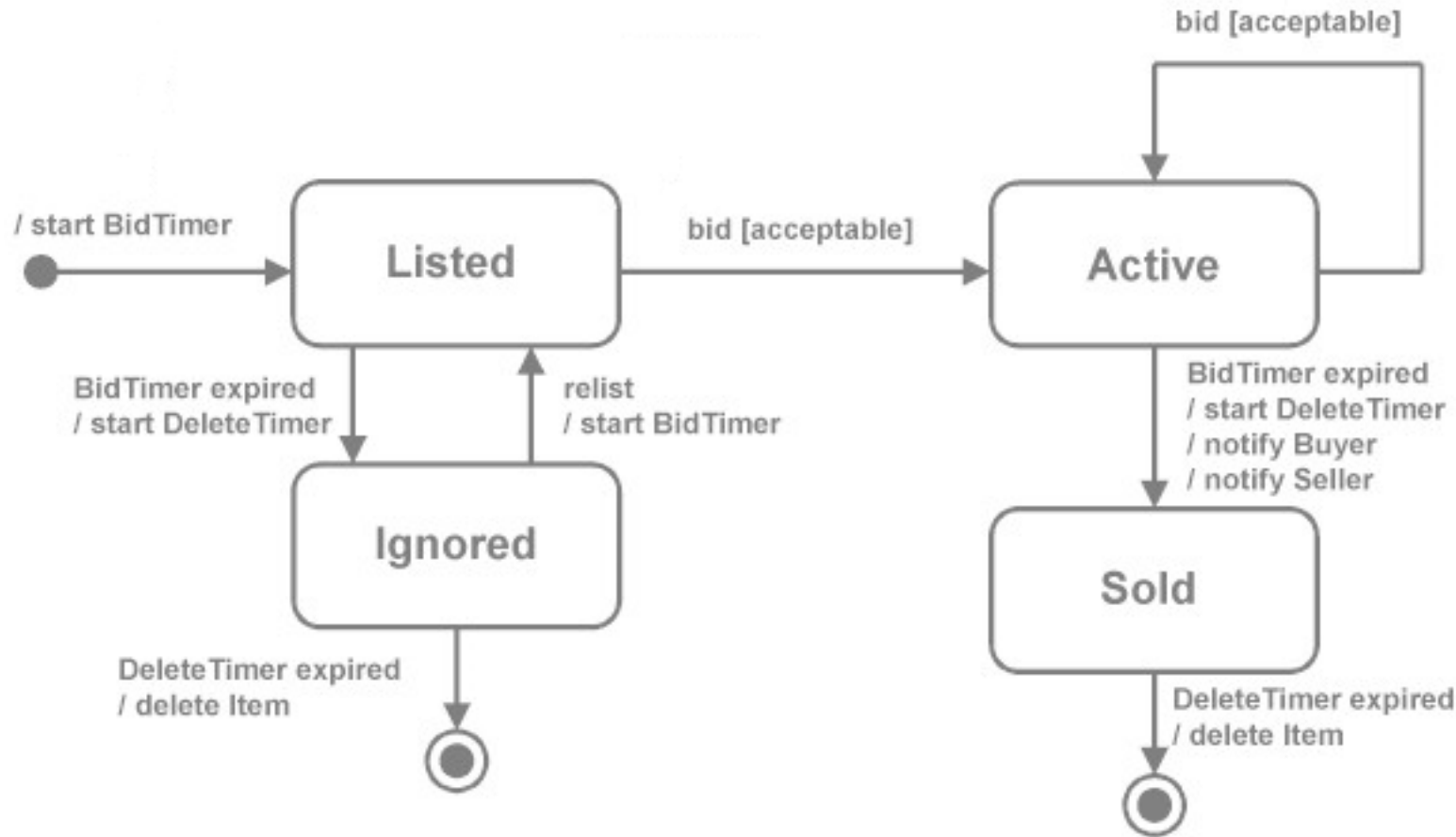
State Transition Diagram Example 1

- The next slide's example shows a simple state-transition diagram for a media player with three buttons: stop, play, and pause.
- The player's initial state is stopped.
- In each state, only the buttons for the other states can be pressed (e.g. in play, only the stop and pause buttons can be pressed).
- Pressing the pause button when the player is stopped does not result in any change to the player.
- The circular arrow indicates the event (press pause when the state is Stopped) that does not cause any state change.

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State Transition Diagram Example 1 (contd.)
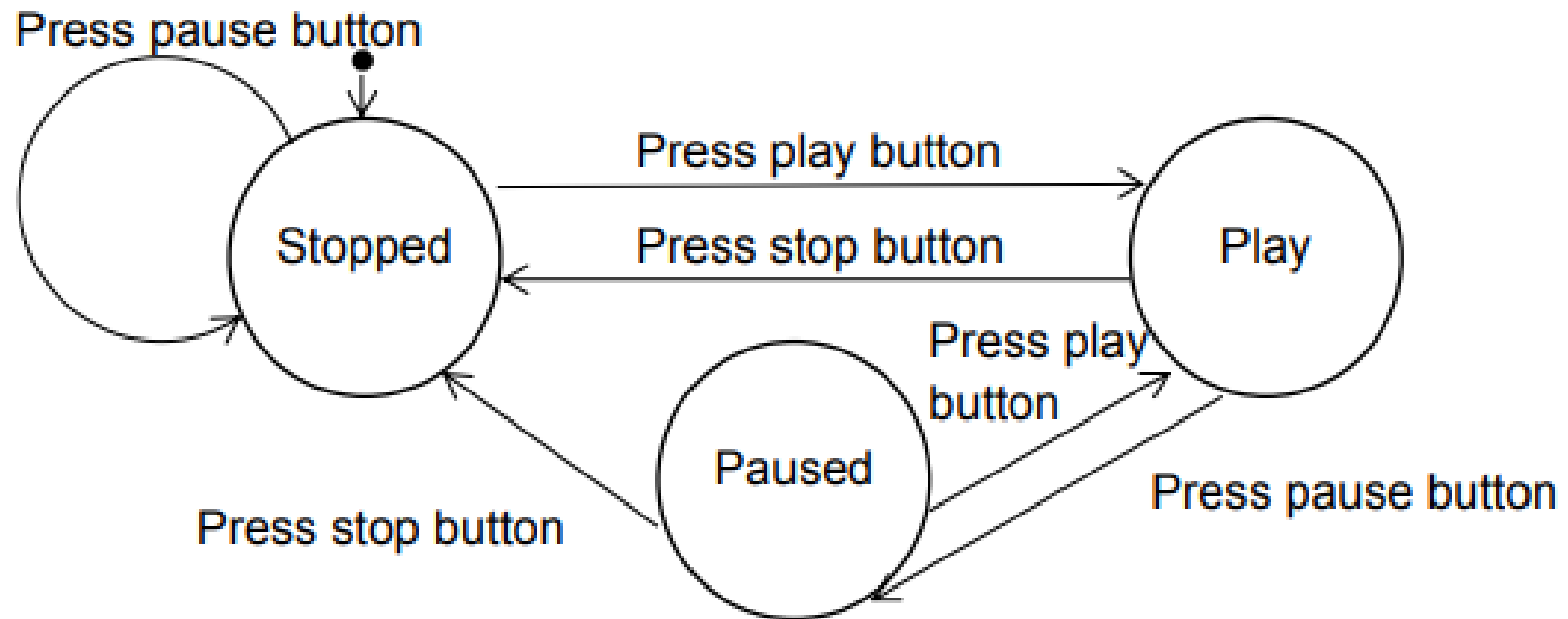
State Transition Diagram Example 2

State vs Activity Diagram

State Transition Diagram:
- A state transition diagram shows an object's different states and the transitions between those states based on the events.
- A state chart diagram consists of states, transitions, and events.

Activity Diagram:
- An activity diagram is a graphical representation of the steps involved in a process or workflow.
- It is used to model the flow of activities within a system, including decisions, loops, and concurrent activities.
- An activity diagram consists of activities, actions, and transitions.

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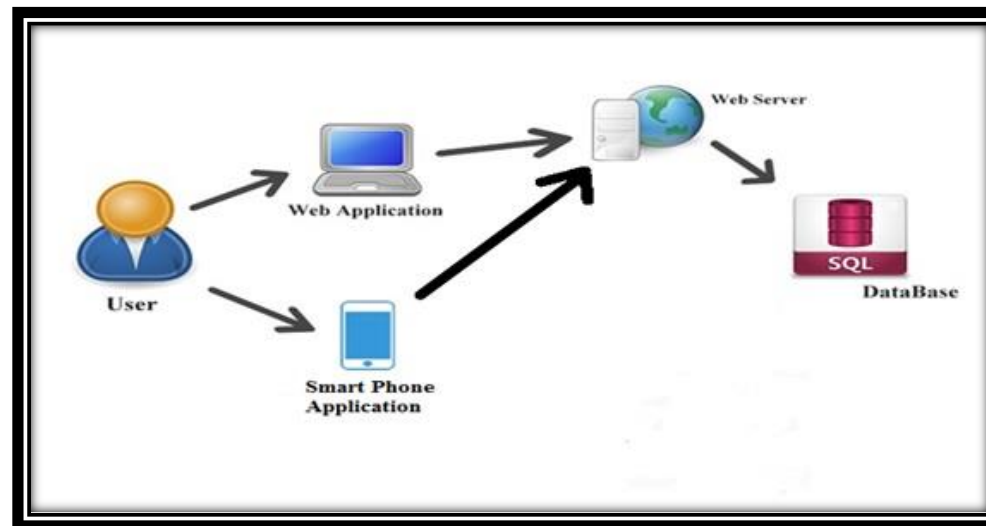
Activity or State? Find Issues (2 mins)
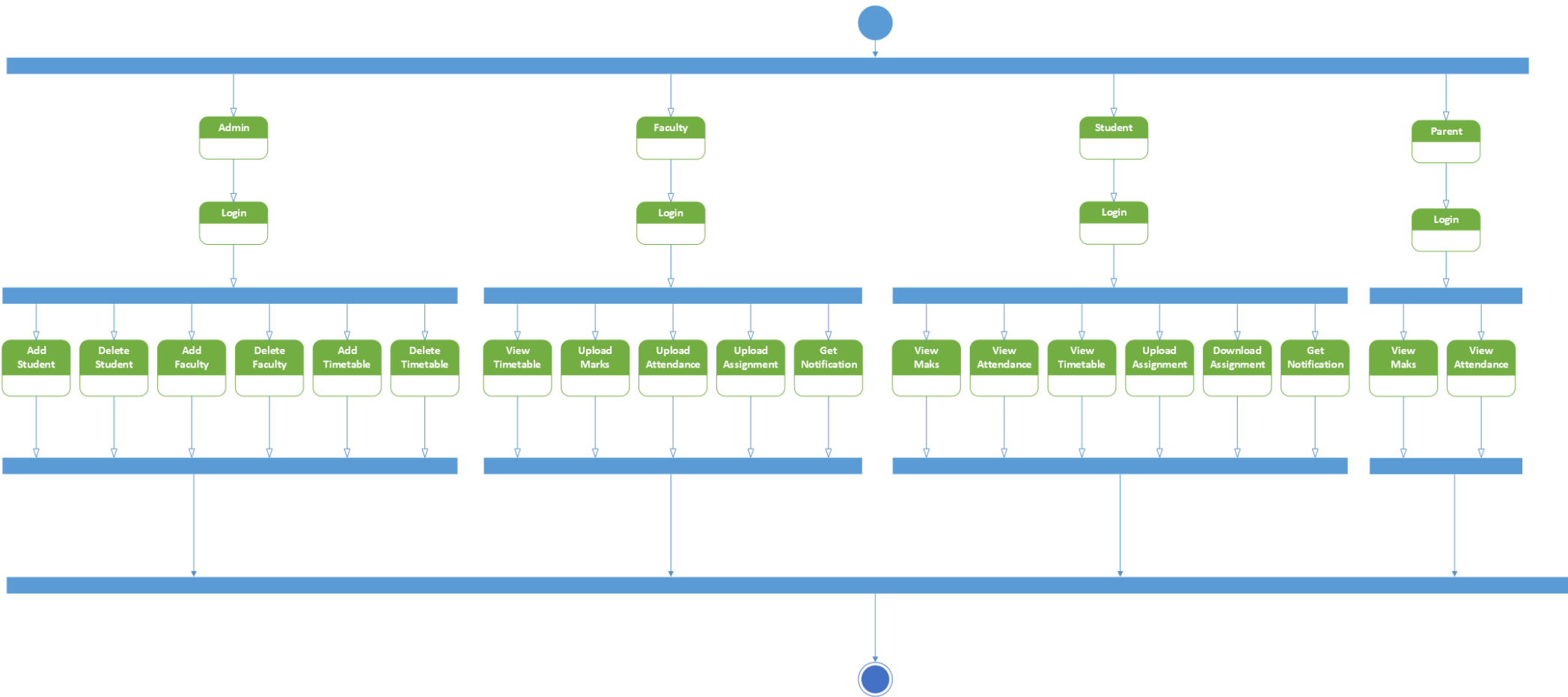
Activity (3 member group) (15 mins)

Online School Portal (OSP) is a smartphone and web-based application that targets schools. It facilitates students, teachers, administration and parents.

The admin has high authority. The admin should log in, log out, add/delete/update, and view admin, parent, faculty, and student records. The admin can also view/update his/her profile and that of others.

As part of the activity, you must create an Activity Diagram using PlantUML.

Submit in Week 3 on Teams

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Upcoming Lecture

- Sequence diagrams
- DFD
- CFD
- ERD

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