Fall 2025

L14 Dynamic Modeling

CS 1530 Software Engineering

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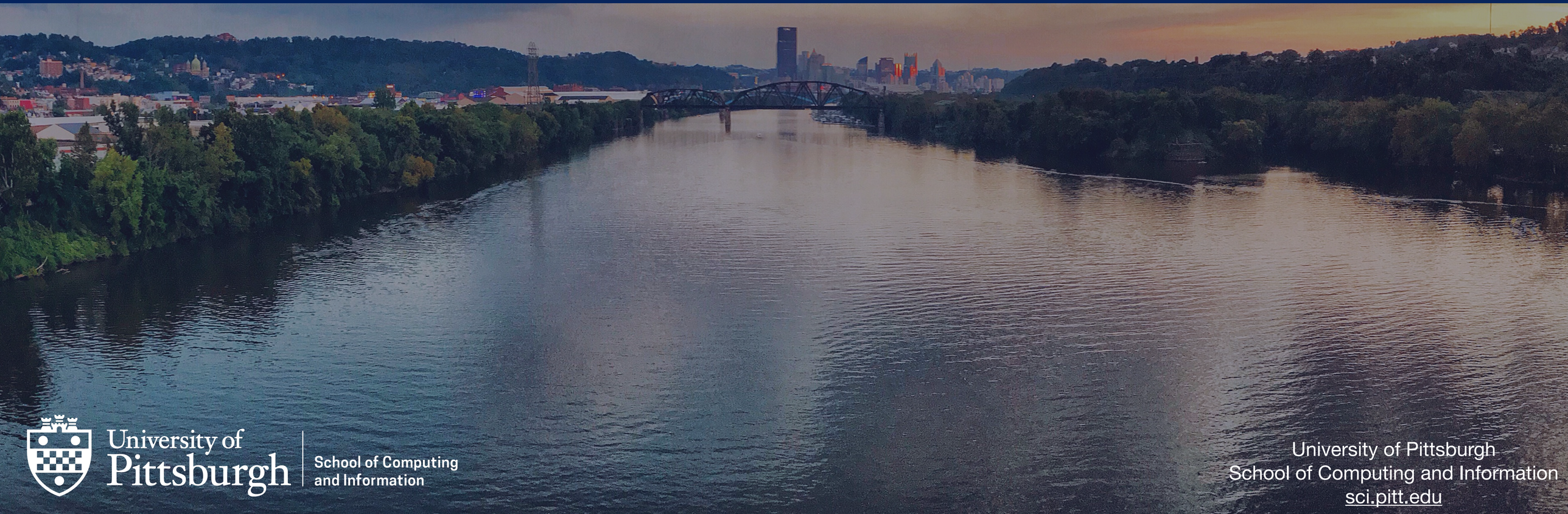

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- Material from these notes is obtained from various sources, including, but not limited to, the following:
  - Bruegge, & Dutoit. Object–oriented software engineering. using UML, patterns, and Java. Pearson, 2009.
  - Gamma, Erich, Richard Helm, Ralph Johnson, and John Vlissides. Design Patterns. Pearson, 1994.
  - Sommerville, Ian. "Software Engineering" Pearson. 2011.
  - http://scrum.org/

Learning goals

- You can model an UML activity diagram
- You can model an UML state chart diagram
- You understand the purpose of a UML communication diagram

[Example] Battery

- Design Goal 1: Battery Capacity (Range)
  - Maximize the battery capacity to provide an extended driving range for electric vehicles, allowing users to travel longer distances on a single charge.
- Design Goal 2: Battery Weight and Size (Efficiency)
  - Minimize the weight and size of the battery pack to improve vehicle efficiency and reduce energy consumption.
- Design Goal 3: Battery Lifespan (Longevity)
  - Design the battery to have a long lifespan, reducing the frequency and cost of battery replacements for EV owners.

[Example] SIMCity

- DG Usability: After completing a 10-minute tutorial, ≥ 80% of users can independently navigate the main menu and recall the core functions of the system.
- DG2 Reliability: The system ensures end-to-end data integrity by synchronizing verified sinkhole status changes across all clients within 5 minutes.
- NFRs
  - NFR1 Usability (Learnability): The system should provide a 10min tutorial to help users understand its core features (…).
  - NFR2 Usability (Navigation): Users should be able to access the menu within two steps.
  - NFR3 Usability (Accessibility): The system should support text-to-speech for improved accessibility.
  - NFR4 Robustness: The system should handle increased traffic (+ 60%) during rush hours, with higher loads in winter than in summer (+ 70%).
  - NFR5 Performance: The map should reflect new and updated reports within five minutes.
  - NFR6 Reliability: The sinkhole status should be updated within five minutes after verifying a sinkhole and after removing a sinkhole.
  - NFR7 Portability: The system should be available as a mobile app.
  - NFR8 Availability: The system should require and verify Internet connectivity for (…) functionality.

System design concepts — Overview

- ✅ Design goals
- → Control flow
- Subsystem decomposition
- HW/SW mapping
- Data management
- Access control
- Boundary conditions

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Please complete the

Midterm Survey

Thank you!

CS 1530 - SOFTWARE ENGINEERING - 1000 - Lecture

Students

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Today's roadmap

- Dynamic modeling
  - Overview
  - Modeling workflows (UML Activity Diagram)

Dynamic modeling

- Describes the **dynamic behavior** of parts (components) of the system
- Typically, we focus on **interesting behavior**
  - e.g., specific workflows involving the user/system with many actions
- Dynamic model can be described in many ways
  - An entity's state
  - An entity's internal behavior / behavior with the system / behavior with other entities

Dynamic modeling tools

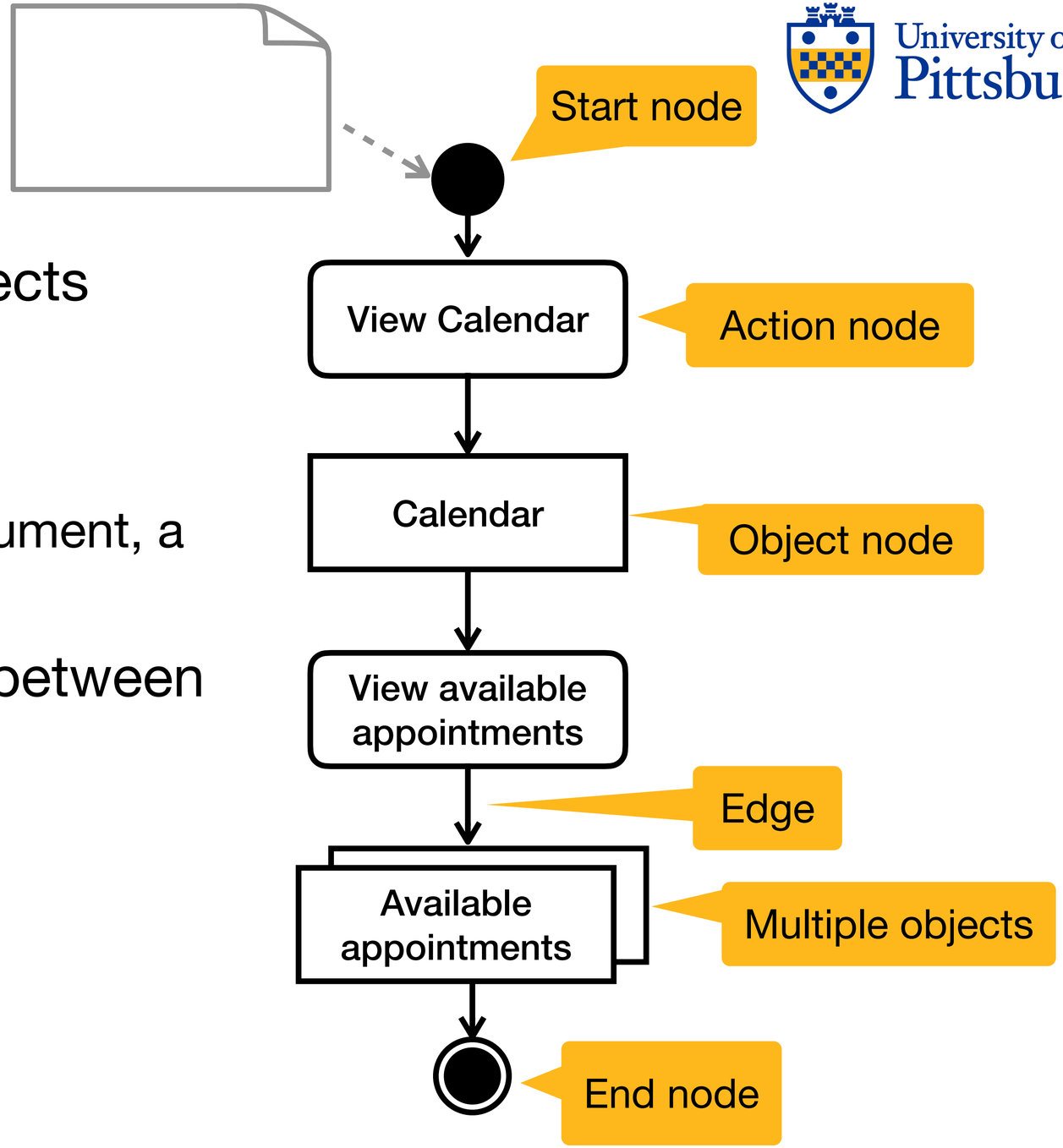
- **Activity Diagram**
  - Purpose: Represent workflows within use cases
  - Usage: Visualize complex user interactions with multiple actions/decision points
- **State Chart Diagram**
  - Purpose: Model the dynamic states and transitions of a single entity or object
  - Usage: Effective for illustrating how an object changes states in response to events
- **Communication Diagrams**
  - Purpose: Illustrate the interactions and messages exchanged among multiple entities
  - Usage: Useful for modeling collaboration and communication patterns in a system
- **Sequence Diagrams**
  - Purpose: Visualize the interactions between objects in a system over time
  - Usage: Show message sequence exchanged between objects to perform a specific function

UML activity diagrams

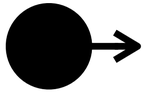
- Organize and represent the flow of activities and actions, grouping them by the interacting system or actor
- Help to more easily understand complex workflows
- Show the order of execution, enabling modeling of both simple and complex behaviors

UML activity diagrams

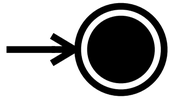
- Consist of nodes and edges
- **Nodes** describe activities and objects
  - Control nodes
  - Executable nodes
  - Object nodes (an object, e.g., a document, a SLF)
- An **edge** is a directed connection between nodes



UML activity diagram syntax



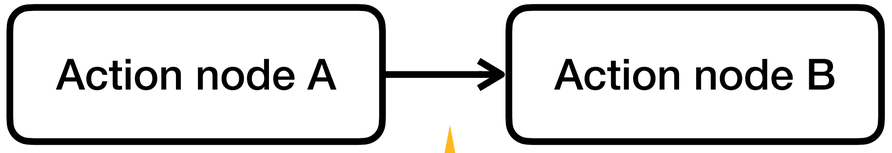
Start or initial node



End or final node

Describes an action

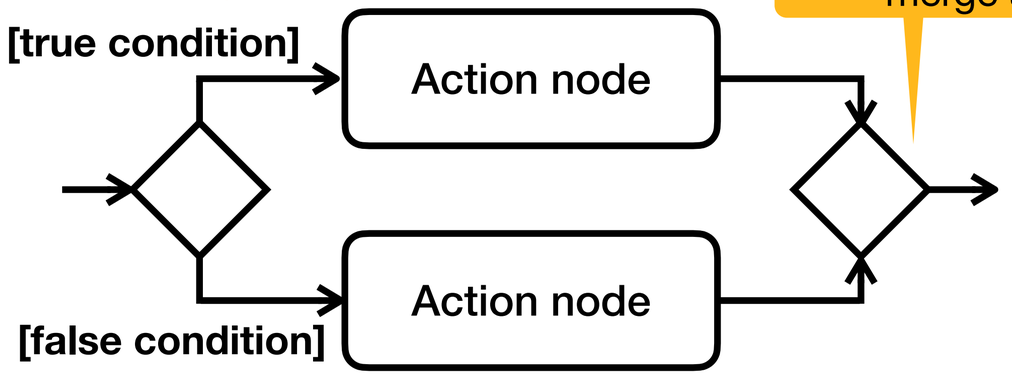
Describes an object
(often hints at data)



Control flow: action A is followed by action B

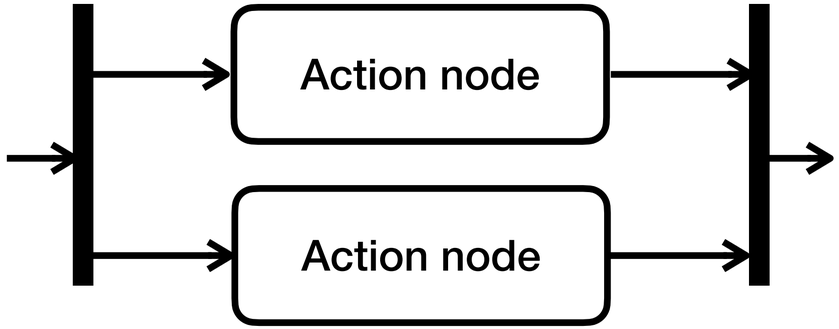
Decision node: Decide on the control flow

Merge node: If the different control flows merge again



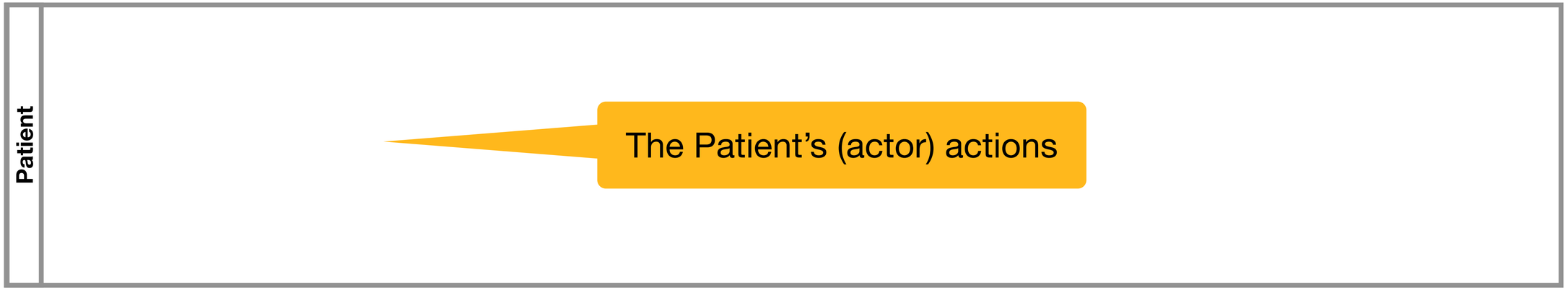
Fork node: Concurrent actions (order is not important)

Join node: Indicates the end of the concurrent actions



Activity diagrams can use **swimlanes**

- Purpose: **Group actions** by viewpoint/role to indicate **responsibilities within a process or workflow**
- A swimlane within an activity diagram represents a **boundary**
  - Helps in separating responsibilities and interactions
- Swimlanes combine the system's high-level logic with responsibilities and interactions



[Example] Swimlanes

"Depth" of the model depends on the context!

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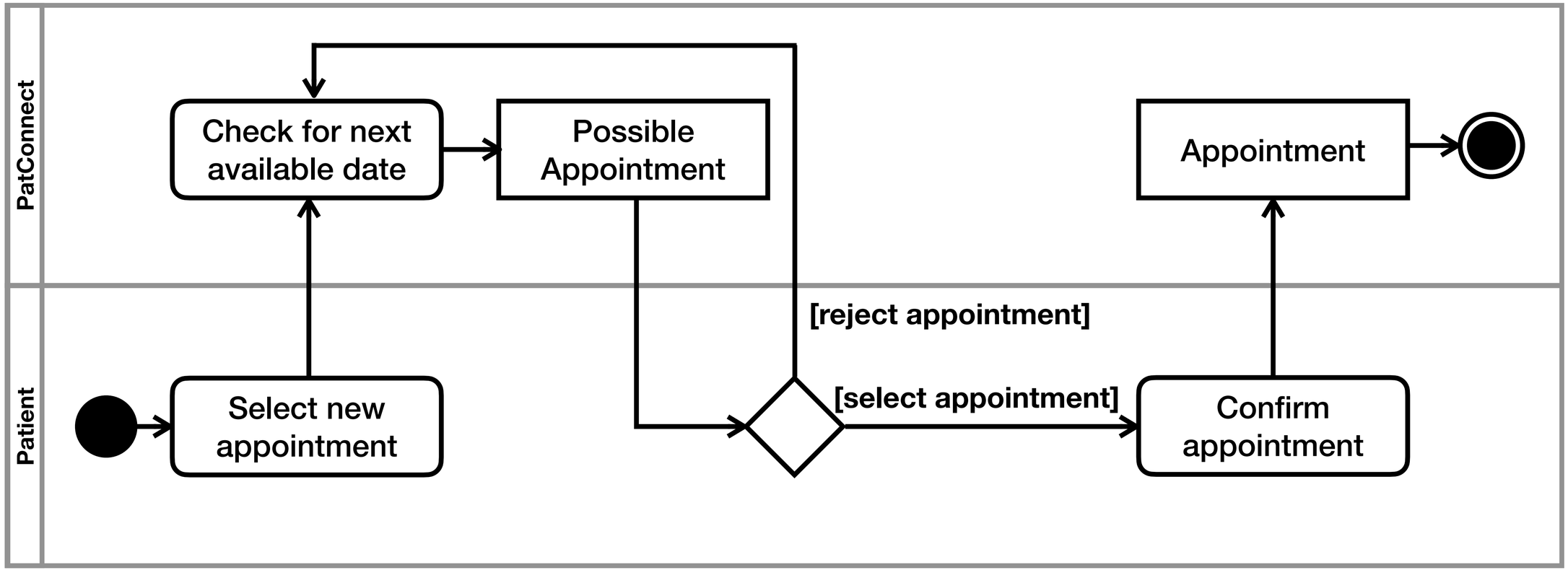
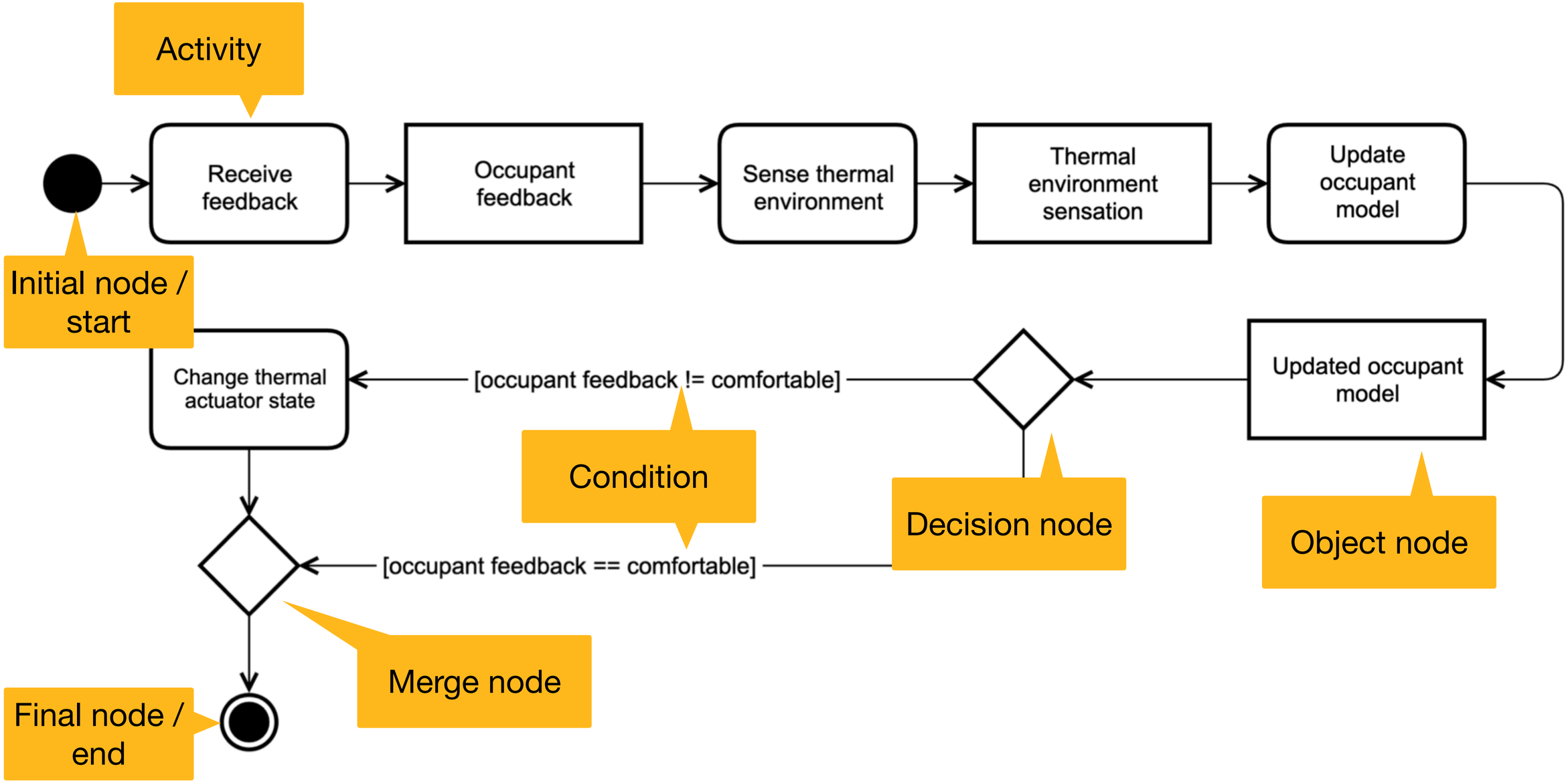
System's responsibility

Actor's responsibility



Swimlane: Describe the activities from one actor's or system's point of view

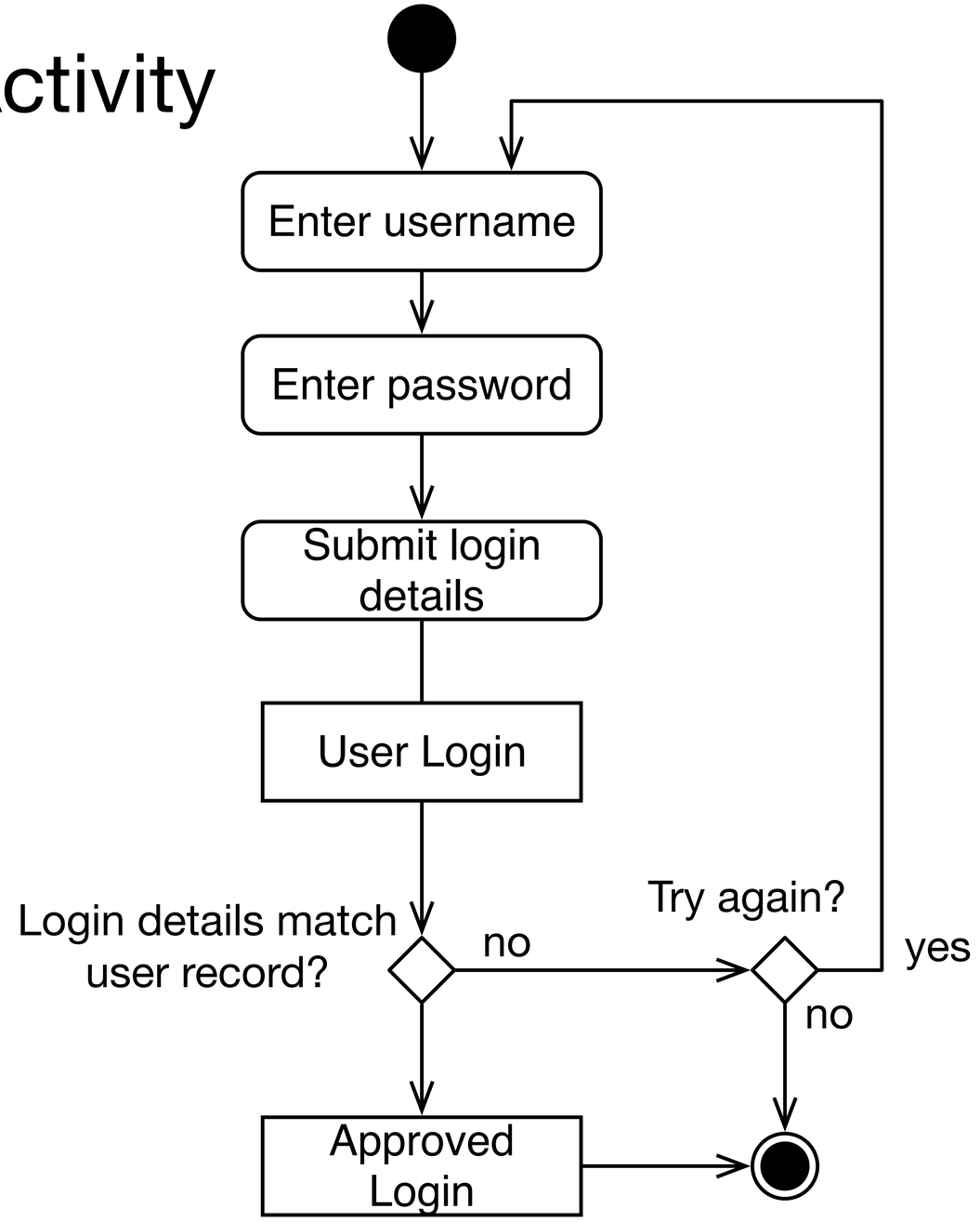
[Example] Dynamic model - activity diagram



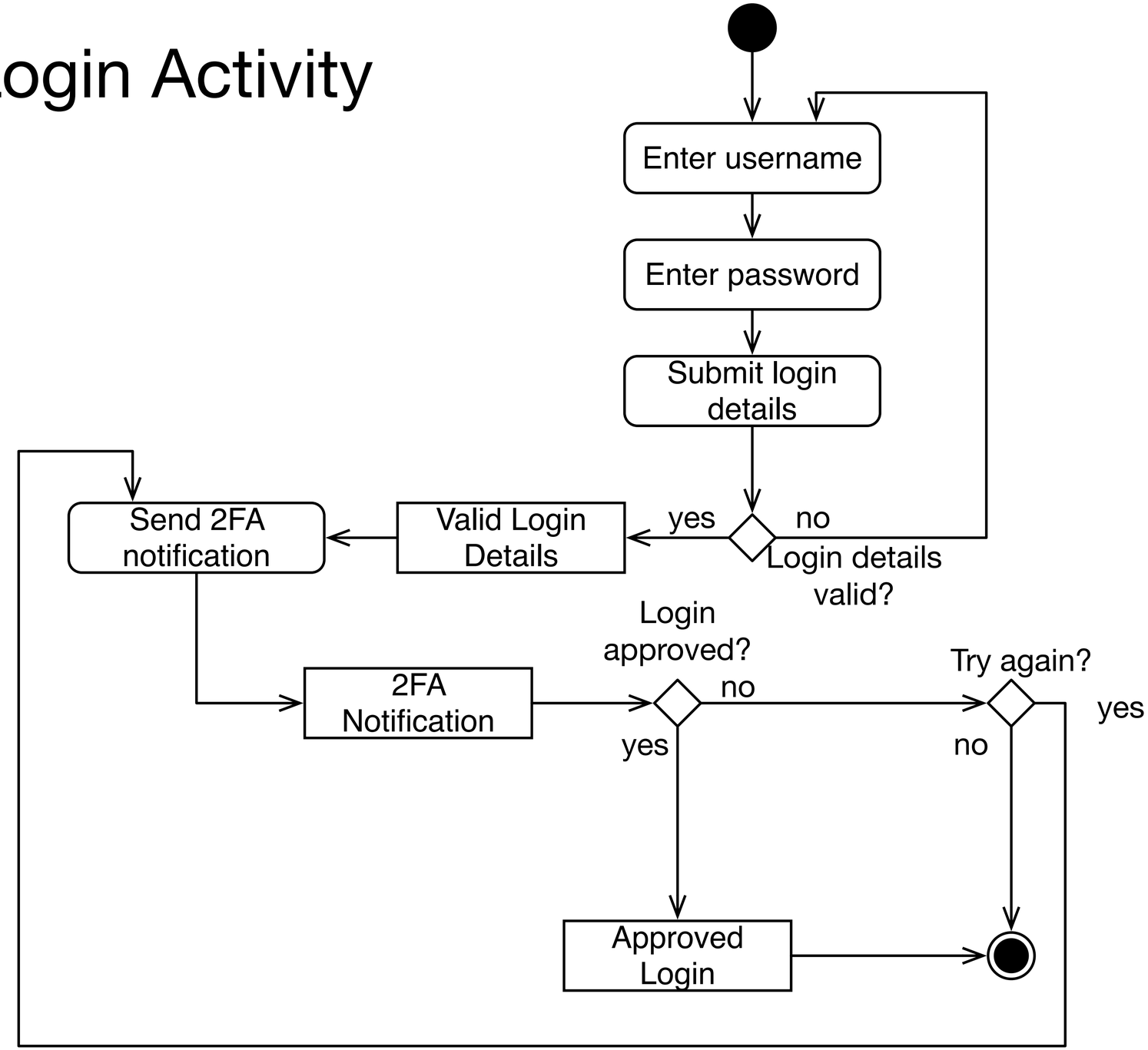
How to model an activity diagram

- Activity diagrams serve to illustrate various workflows, such as:
  - User-specific workflows
  - System workflows
  - Logical workflows
  - …
- These workflows are frequently derived from:
  - The flow of events within use cases
  - Associations found in the analysis object model

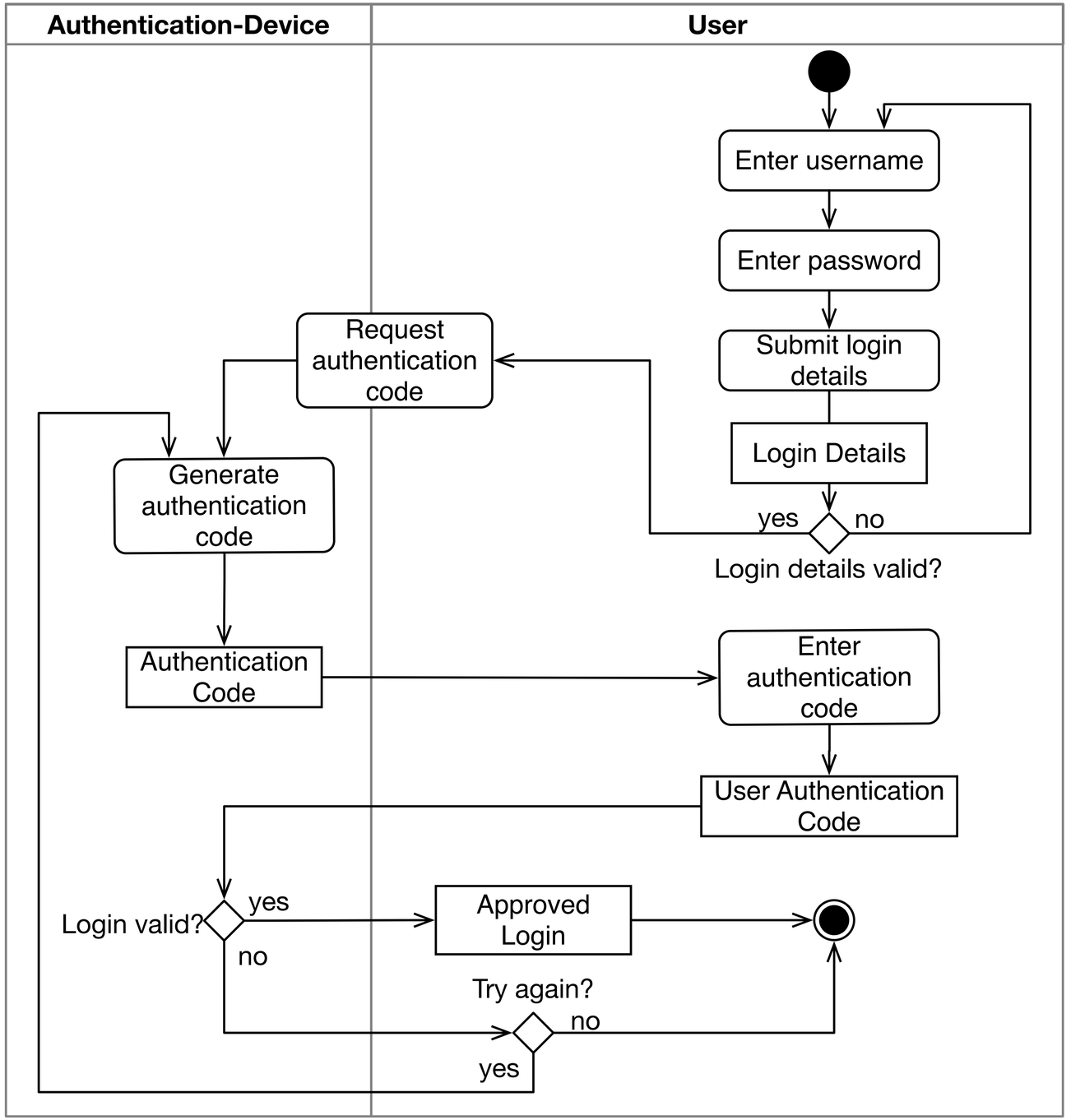
[Example] Login Activity



[Example] Login Activity



[Example] Login Activity (2FA)



L14 — In-class: Activity diagram

⏳ 20 min

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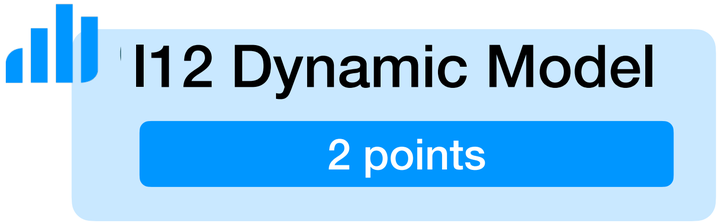
Model a UML activity diagram to describe an **interesting**, non-trivial workflow, e.g.:

- The enduser's workflow to submit a report
- The city official's workflow to confirm a report
- … (pick your own workflow!)



References

- Bruegge, & Dutoit. Object–oriented software engineering. using UML, patterns, and Java. Pearson, 2009.
- Object Management Group. Unified Modeling Language. Version 2.5.1, 2017

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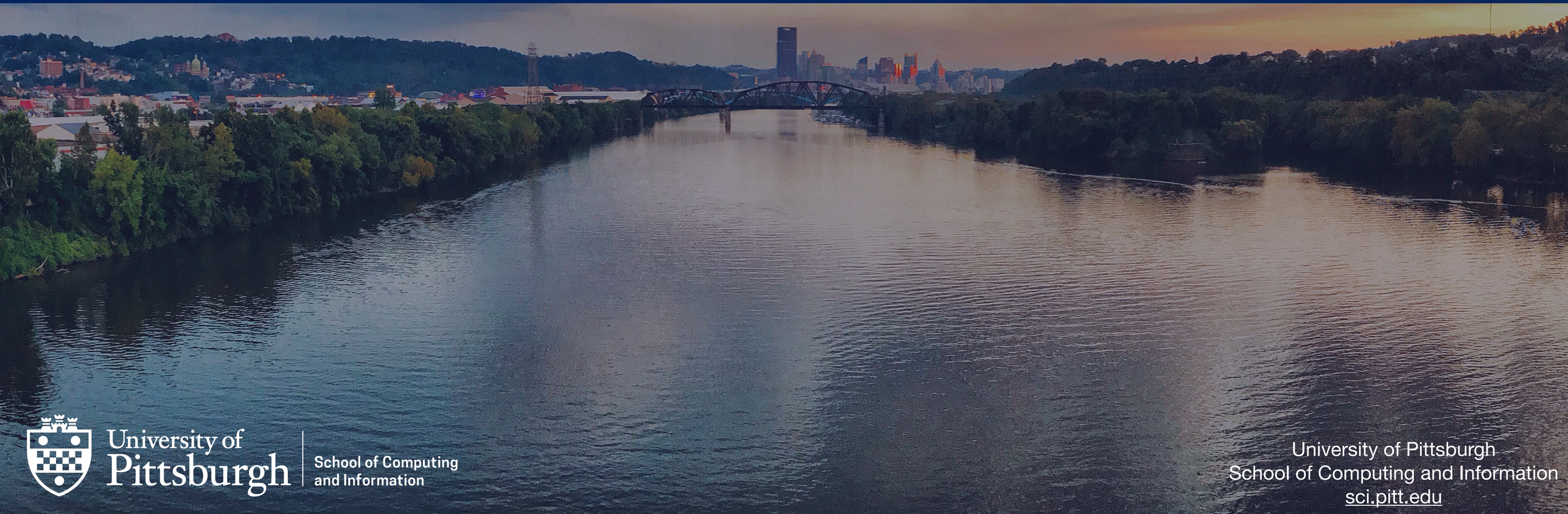

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