UML Modeling II

Instructor: Yongjie Zheng

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CS 490MT/5555
Software Methods and Tools

	Structure	Behavior
Requirements		Use Case Diagrams
Design	Class Diagrams Package Diagrams	Sequence Diagrams State Diagrams Activity Diagrams

Requirements Engineering

- Requirements Elicitation
  - Interview, questionnaire, etc.
- Requirements Specification
  - User requirements
    - Natural languages
  - System requirements
    - Use case model, formal specification, etc.
- Requirements Validation and Verification
  - Review, model checking, etc.

UML Use Case Model

- A **use case model** consists of
  - Template-based description of all use cases
  - One or more use case diagrams
- A **use case** consists of
  - A number of positive and negative use case scenarios
- A **use case diagram** consists of
  - An overview of the use cases of a system
  - Relationship between actors and use cases as well as the interrelations among use cases

Use Case

- A use case is a description of system behavior in terms of scenarios illustrating different ways to succeed or fail in attaining one or more goals.
- Scenario, or use case scenario: a sequence of steps describing an interaction between a user and a system.
- Use case: a set of scenarios tied together by **a common user goal**.
  - Main Success Scenario (MSS): all-goes well
  - Extensions: variations on MSS

Use Case Template

- A use case template is often used to guide the documentation of use cases. This is a tabular structure that may consist of the fields of
  - Name
  - Goal
  - Primary actors
  - Scenarios
  - Pre- and post-conditions
- Use cases are text documents
  - The amount of detail depends on the significance of the use case

An Example of Use Case

Buy a product

Main Success Senario:

1. Customer browses and selects items to buy
2. Customer gotes to check out
3. Customer filles in shipping information
4. System presents full pricing information
5. Cusotmer fills in credit card information
6. System authorizes purchase
7. System confirms sale immediately
8. System sends confirming eamil to custoer

Extesions:

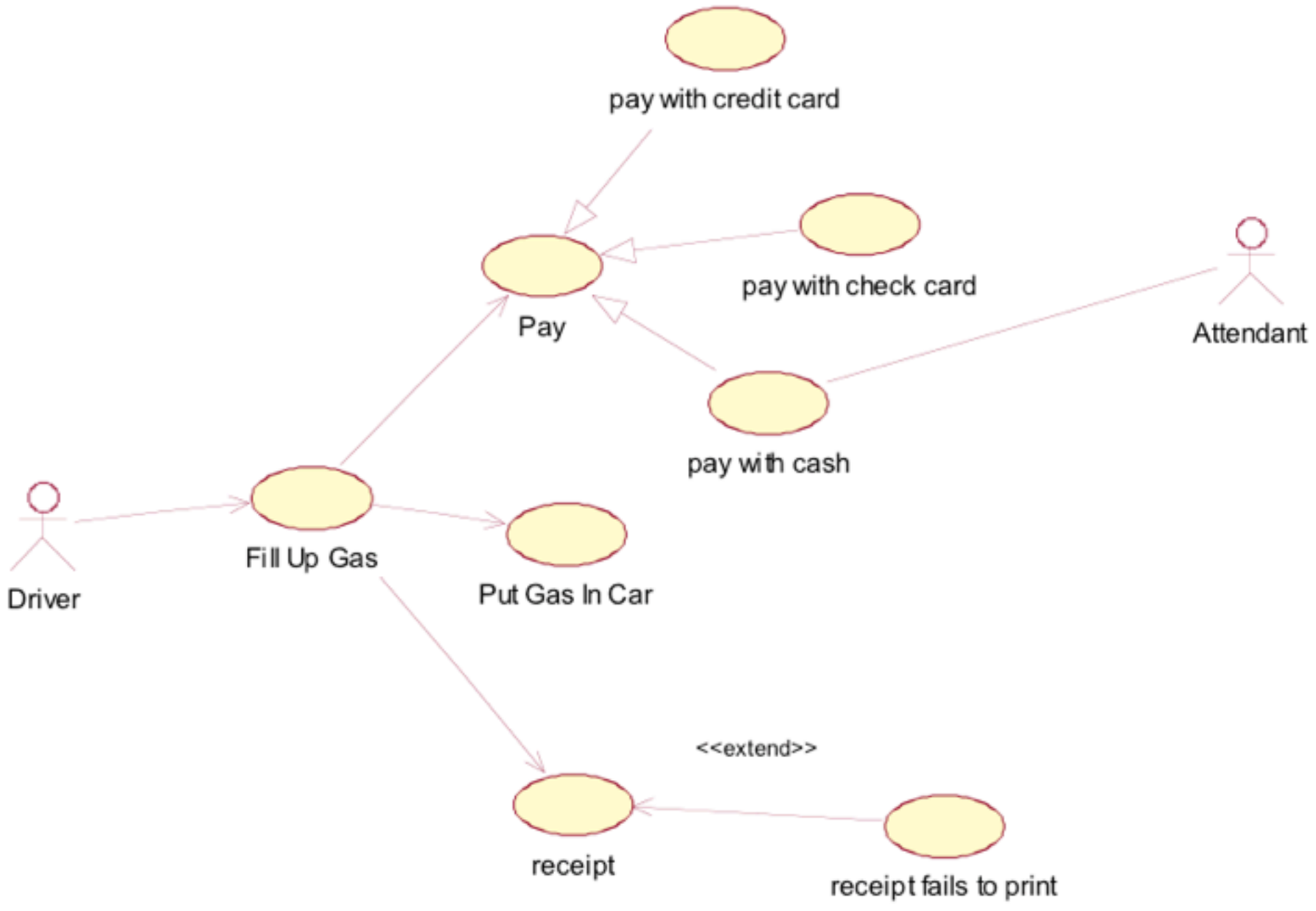
3a: Customer is regular custor
 3a1: System displays shipping, pricing, and billing information
 3a2: Customer may accept or override these defaults, goes to MSS at step 6
6a: System fails to authorize credit purchase
 6a1: Customer may re-enter credit card information or may cancel

adapted from UML Distilled
(by Martin Fowler)

Use Case Diagram

- A use case diagram is a graphical notation that provides an overview of the use cases of a system.
- The main purpose of a use case diagram
  - Show all the names of the use cases, like a table of contents
  - Show relationships between actors and use cases
  - Show relationships between use cases

An Example of Use Case Diagram



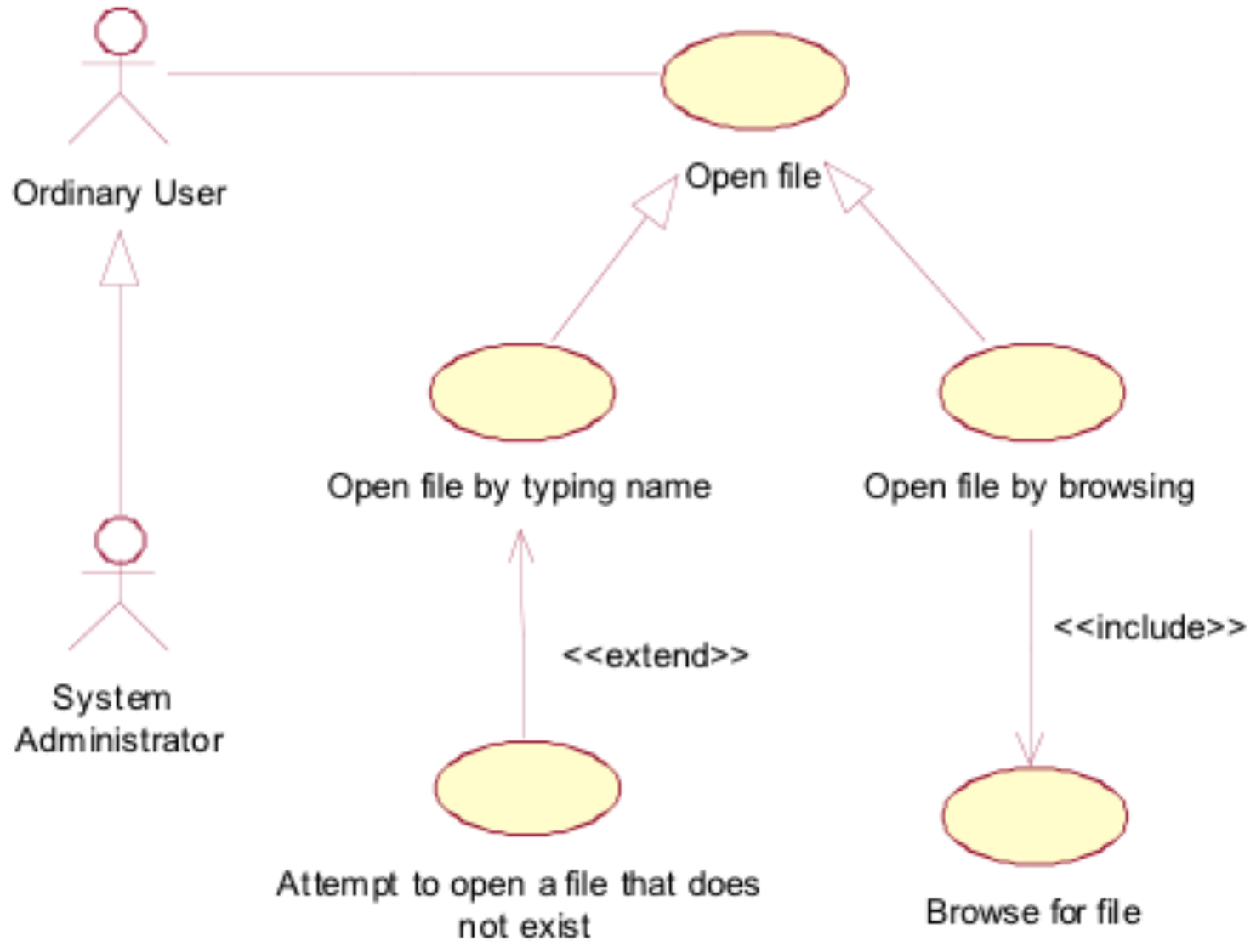
Elements of Use Case Diagrams

- Actor
  - A role that a user plays with respect to the system
  - Represented by a stick figure
- Use Case
  - Represented by an oval
- Relationship
  - Actor - Use Case
    - Actors "carry out" use cases
    - Represented by undirected lines
  - Use Case - Use Case
    - Represented by directed lines with the arrow pointing from subject to object: *Extend*, *Inherit*, *Include*.

Use Case Relationships

- Inclusion
  - One use case is a sub step of another use case, and can be reused by different use cases to avoid repetition.
  - <<include>>
- Generalization
  - One use case is similar to another use case but does a bit more, like inheritance relationship.
  - Solid line + white triangle
- Extension
  - One use case covers exceptions of another use case.
  - <<extend>>

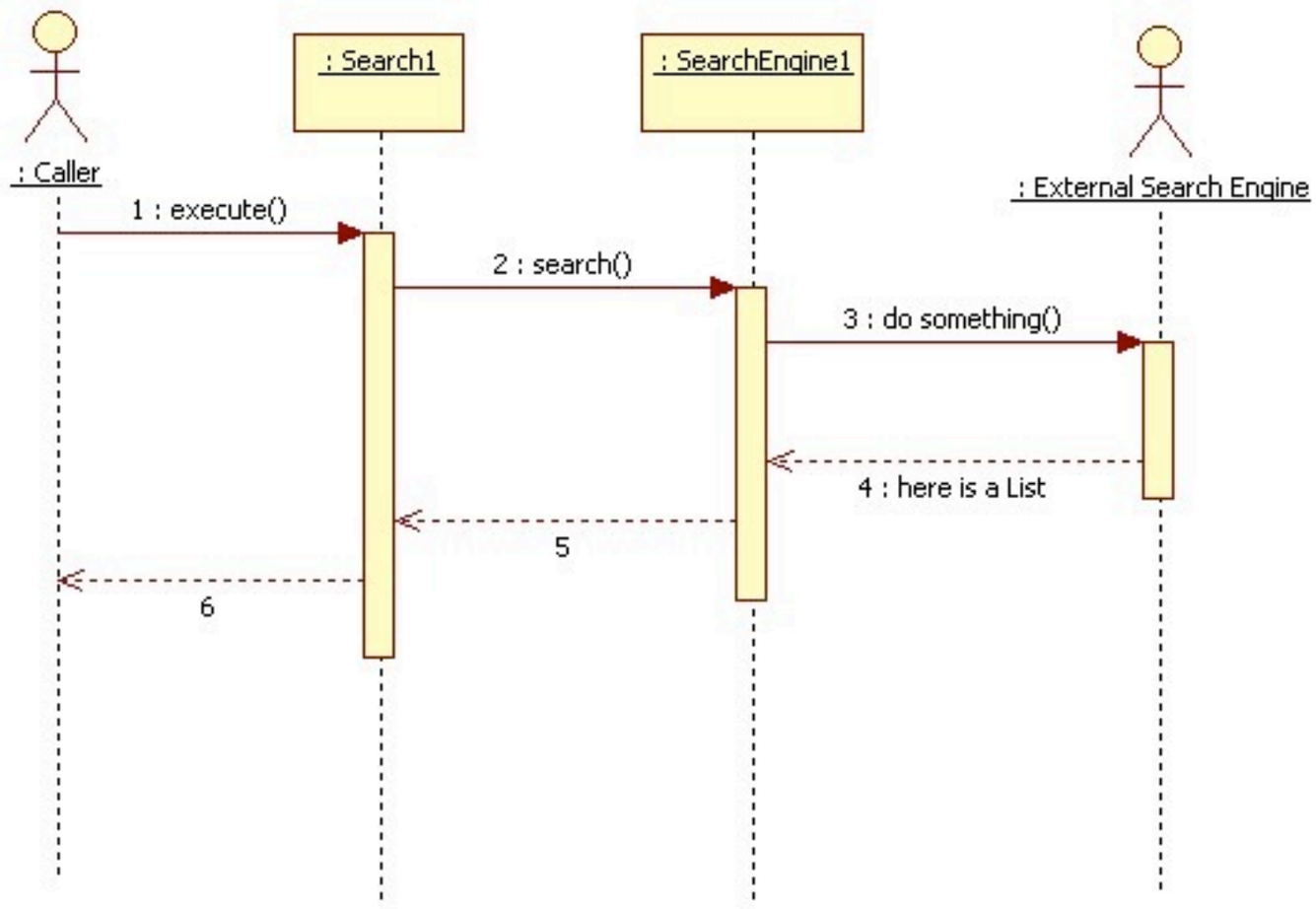
An Example


Ordinary User
Open file
Open file by typing name
Open file by browsing
System Administrator
<<extend>>
<<include>>
Attempt to open a file that does not exist
Browse for file

Sequence Diagram

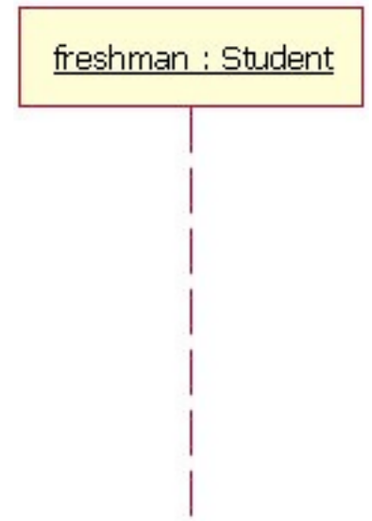
- A sequence diagram captures the behavior of a single scenario.
- The diagram shows a number of participating objects and the messages that are passed between these objects within the scenario.
- The diagram conveys information along the horizontal and vertical dimensions:
  - The vertical dimension shows, top down, the time sequence of messages/calls as they occur.
  - The horizontal dimension shows, left to right, the object instances that the messages are sent to.

An Example of Sequence Diagram



Sequence Diagram: Object

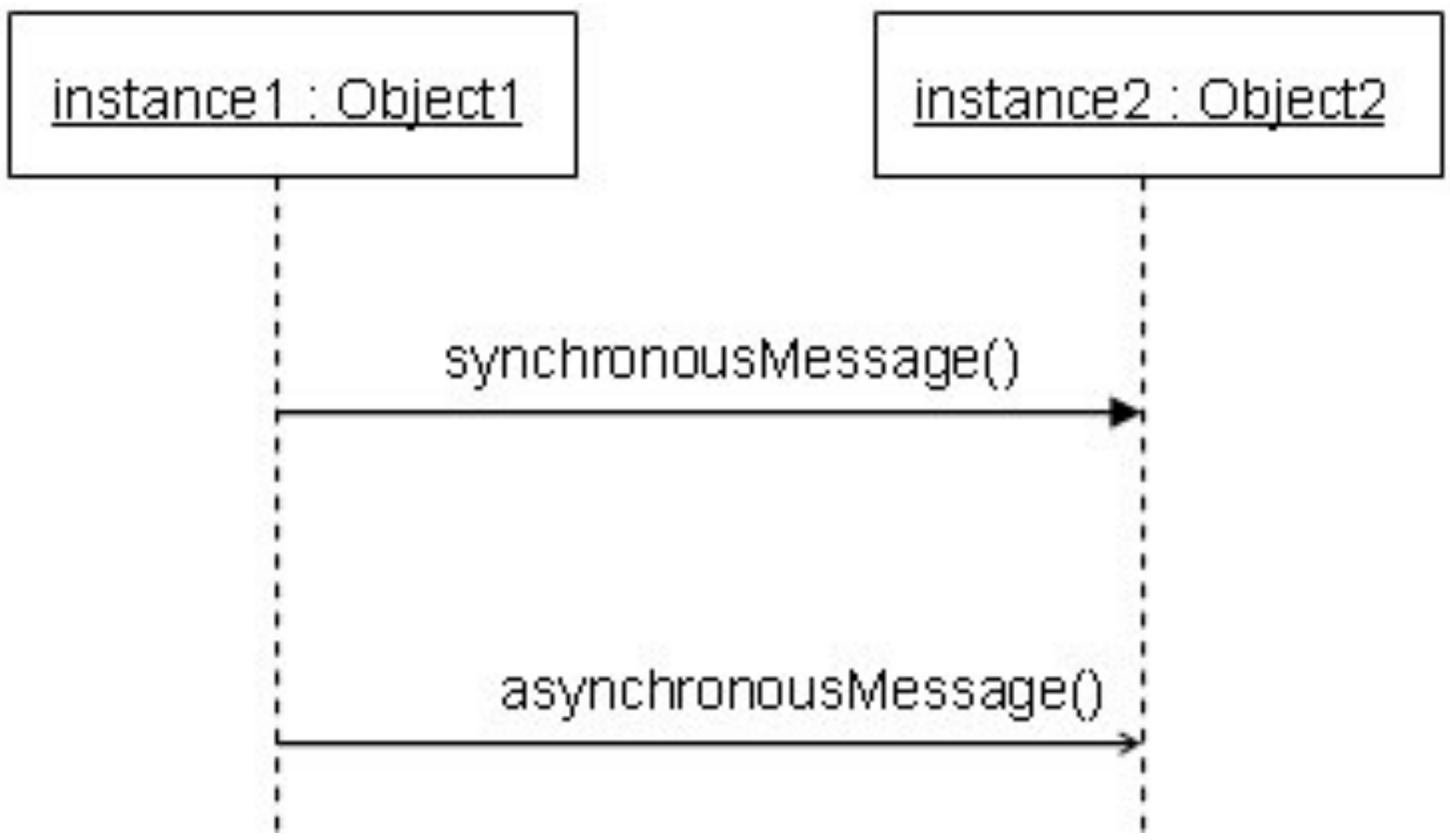
- Shown as a box at the top of a dashed vertical line.
  - Each box represents an instance of a class, or an object. (UML 1.x only)
- The vertical line is called the object's lifeline.
- An activation box is optional, and shows when an object is active.



Sequence Diagram: Message

- Analogous to method calls in a program
  - Can have parameters
- Labeled with the message name and parameters (optional).
- Synchronous messages
  - Calling object waits for call to complete
  - Indicated by a filled arrowhead (UML 2.x)
- Asynchronous messages
  - Calling object does not wait for call to complete
  - Indicated by a stick arrowhead (UML 2.x)

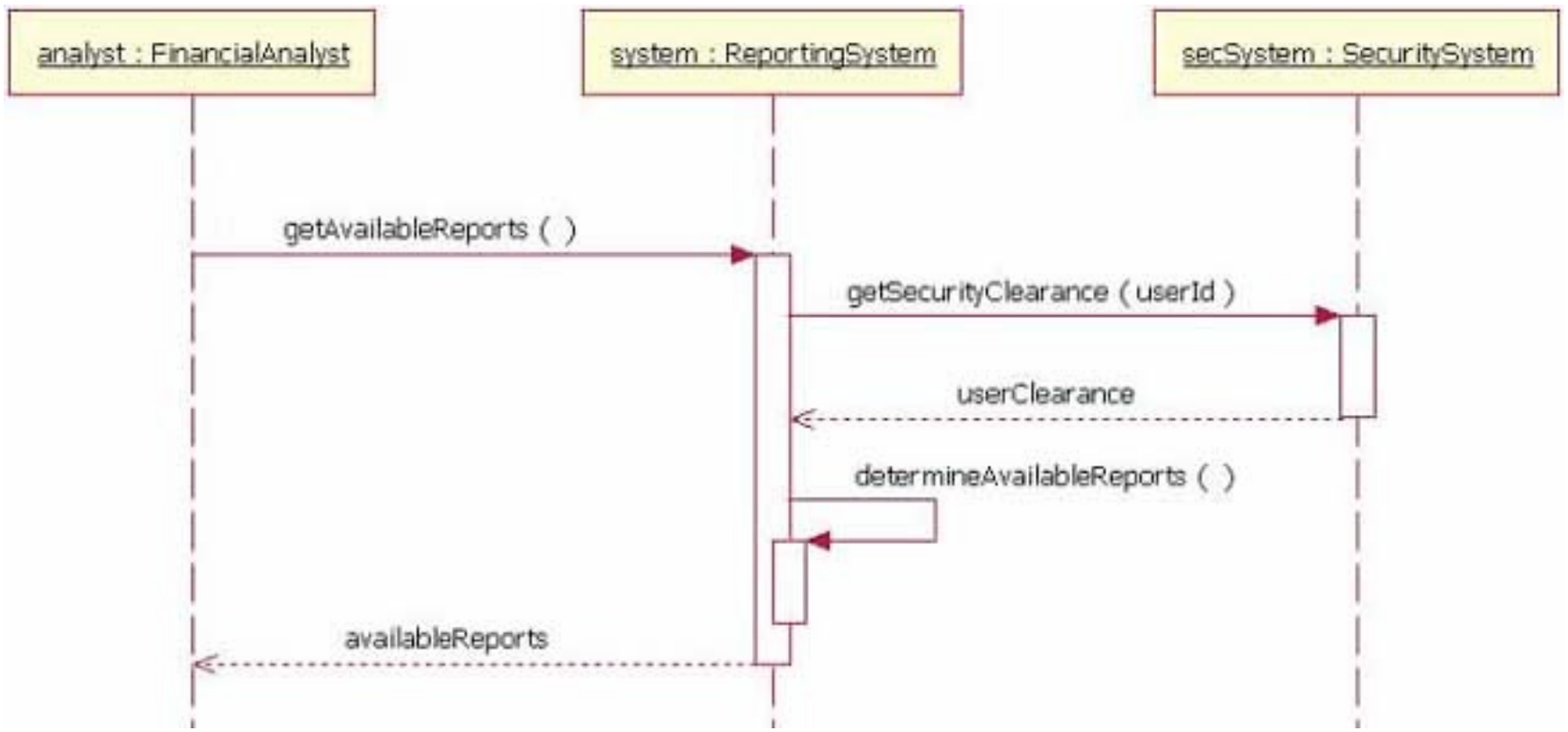
An Example


instance1 : Object1
instance2 : Object2
synchronousMessage()
asynchronousMessage()

Sequence Diagram: Message

- Special messages
  - new — shown by the position of an object
  - delete — shown through big X
- Return messages
  - Optional
  - Drawn as a dotted line with an open arrowhead back to the originating lifeline, and above this dotted line you place the return value from the operation.
- Self-calls

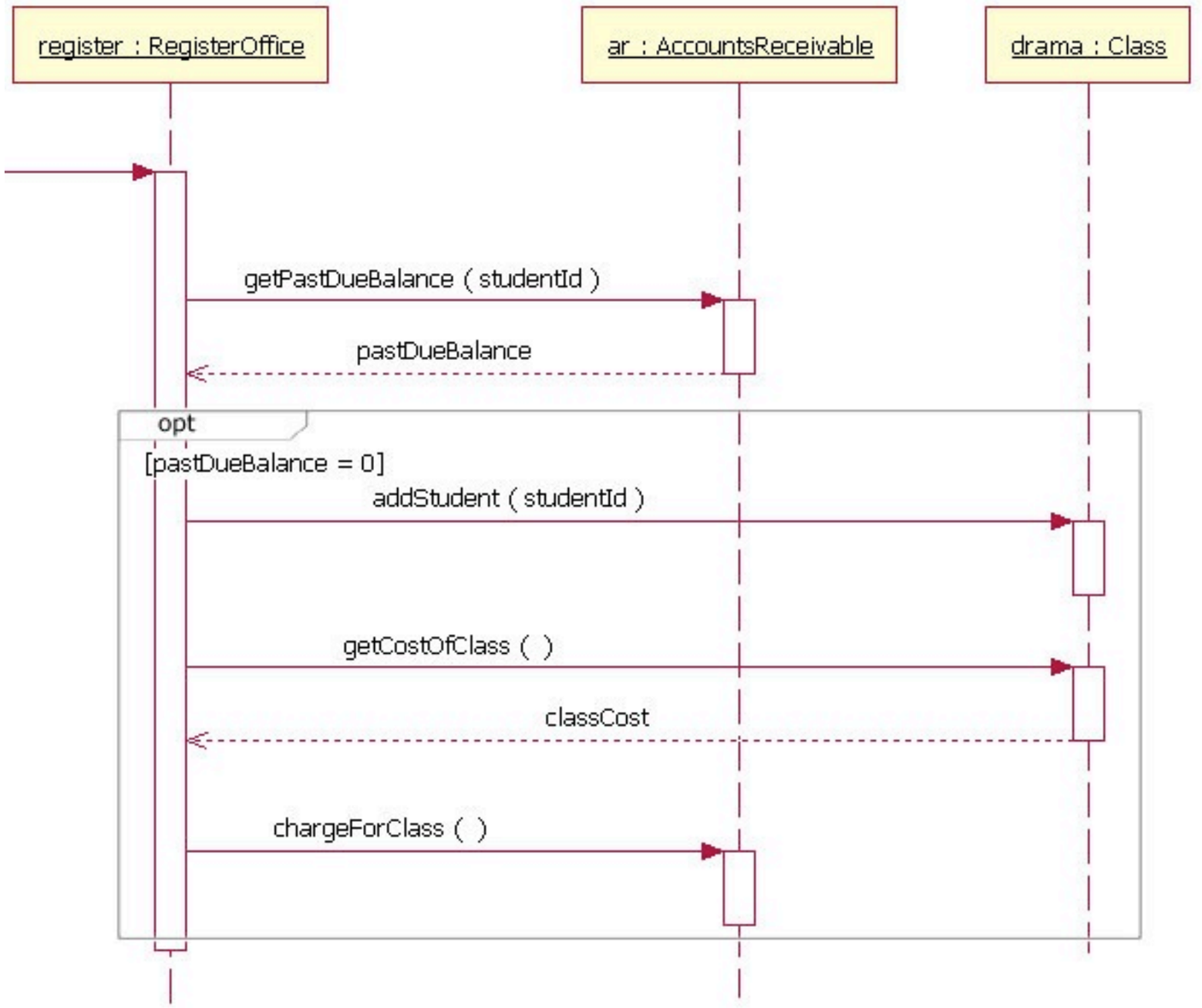
Another Example



Sequence Diagram: Frame

- Frames are regions or fragments of the diagrams to support conditional and looping constructs. They have a frame operator and a guard.
- Frame Operator
  - loop – loop fragment while guard is true.
  - opt – execute fragment while guard is true
  - alt – alternative fragment for mutual exclusion conditional logic expressed in the guards
  - par – parallel fragments that execute in parallel
  - region – critical region within which only one thread can run
- Guard
  - [conditional clause]

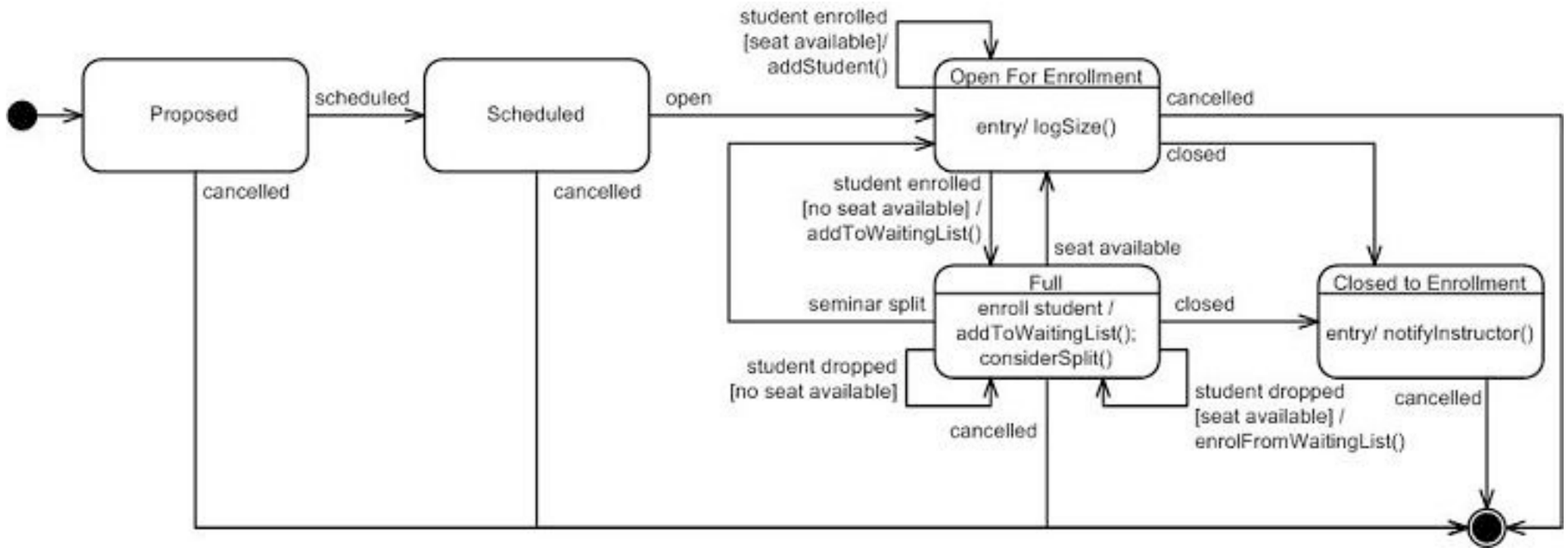
An Example of Frames



State Diagram

- A state diagram describes all of the possible states that a particular object can get into and how the object's state changes as a result of events that reach the object.
- State diagrams are good at describing the behavior of an object across several use cases.

An Example of State Diagram



State Diagram: State

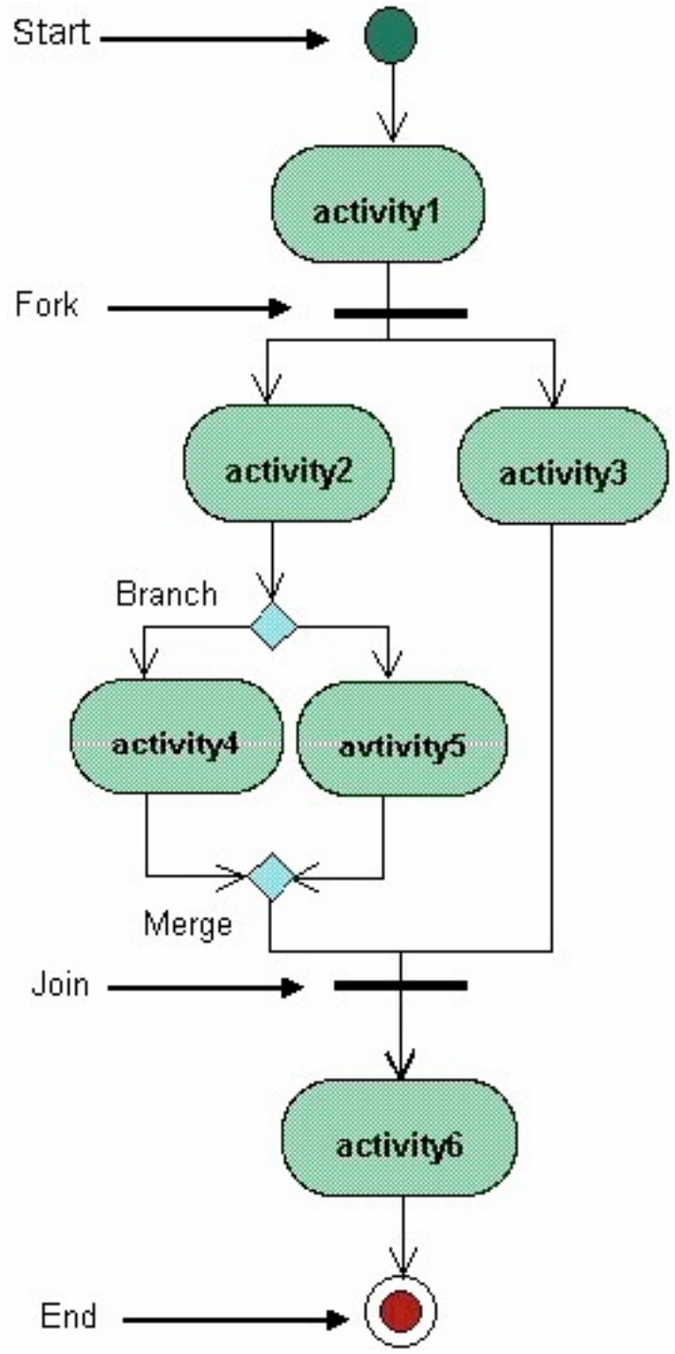
- Represented by rounded rectangles.
- An object starts in an initial state, represented by the closed circle, and can end up in a final state, represented by the bordered circle.
- If a state responds to an event that does not cause a transition, you can show this by putting text in the form of event/activity in the state box (i.e. internal activity).
  - Entry/activity: method to be invoked when the object enters the state
  - Exit/activity: method to be invoked when the object exits the state
  - do/activity: method to be run when the object is in the state (i.e. ongoing activity).

State Diagram: Transition

- Line with line arrowhead
- Represents movement from one state to another
- The format of a transition label is: *Event [Guard] / Action*.
  - Event (optional) causes the transition
  - Guard (optional) must be true for the transition to be triggered
  - Action (optional) is the invocation of a method
- An unlabeled transition occurs immediately or as soon as any activity associated with the given state is completed.
- Only one transition can be taken out of a given state under any condition.

Activity Diagram

- An activity diagram describes the sequencing of activities, with support for both conditional and parallel behavior.
- An activity diagram does not convey which class is responsible for each activity.



Activity Diagram

- Conditional behavior
  - Branch
    - When the incoming transition is triggered, only one of the outgoing transitions can be taken.
  - Merge
    - Marks the end of conditional behavior started by a branch.
- Parallel behavior
  - Fork
    - When the incoming transition is triggered, all of the outgoing transitions are taken in parallel.
  - Join
    - The outgoing transition is taken only when all the states on the incoming incoming transitions have completed their activities.

To summarize

- A **Use Case Diagram** presents an external view of the system.
- A **Sequence Diagram** presents the behavior of several objects within a single scenario.
- A **State Diagram** presents the behavior of an object across several use cases.
- An **Activity Diagram** presents the parallel behavior and concurrent programs.

Reminder

- Lab #3 is on next Tuesday.
- Assignment #3 will be out after the lab.
- Assignment #2 is due next Monday, midnight.