AMSS Lecture 7: UML Activity Diagrams

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Agenda

- Fundamentals of Activity Diagrams
- Advanced Constructs and Applications

Fundamentals of Activity Diagrams

What Are Activity Diagrams?

Definition

Activity diagrams describe the **flow of control and data** between actions in a process.

Use Cases

- Model algorithms, business process, and workflows
- Detail use case realizations
- Similar to flowcharts but supporting concurrent behavior

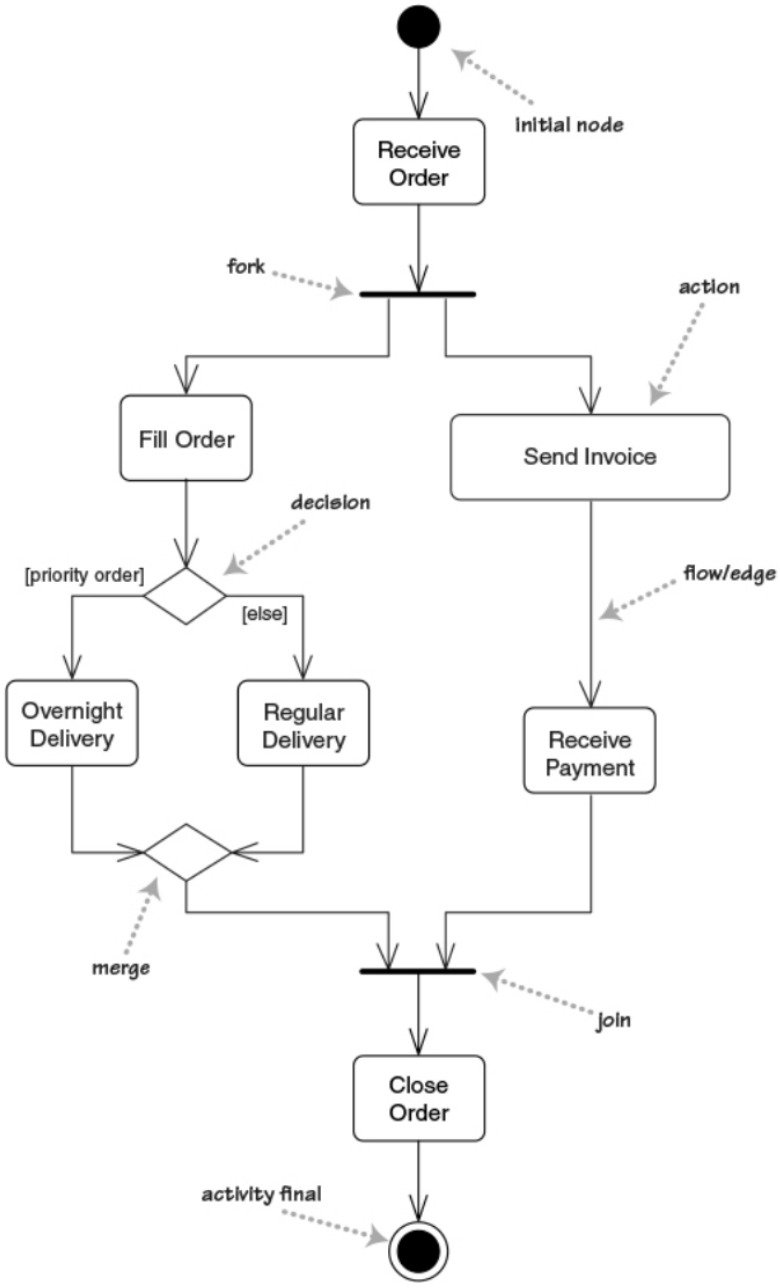
Comparison

Diagram	Focus
State Diagram	Object lifecycle
Sequence Diagram	Message order
Activity Diagram	Workflow logic

Core Elements

- **Action Nodes** – steps or tasks.
- **Control Flows** – arrows showing execution order.
- **Decision Nodes** – conditional branching.
- **Merge Nodes** – combine alternative flows.
- **Fork / Join Nodes** – manage parallel execution.
- **Initial / Final Nodes** – start and end points.

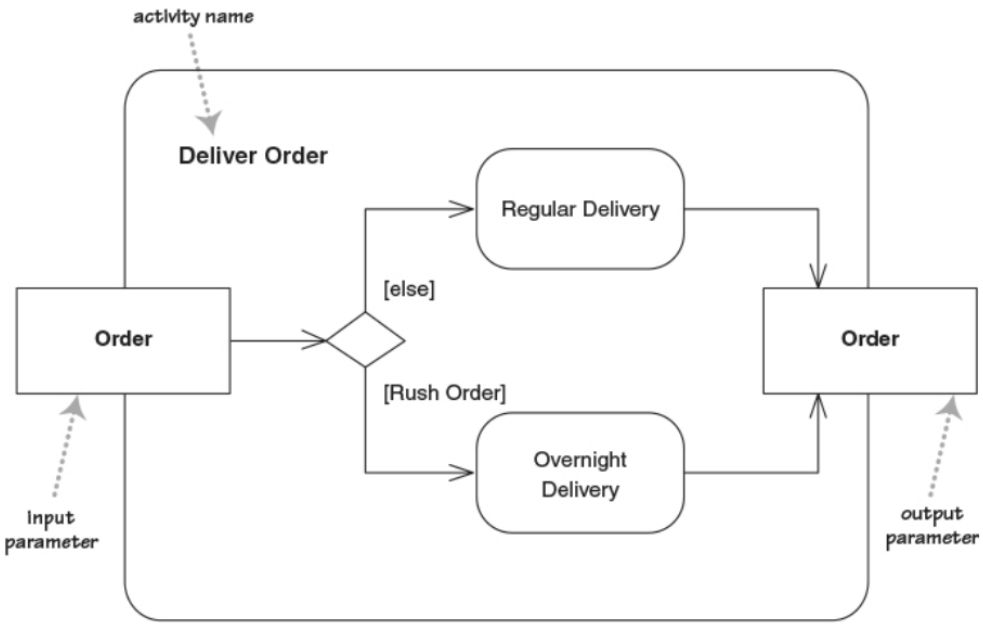
Example: Order Processing

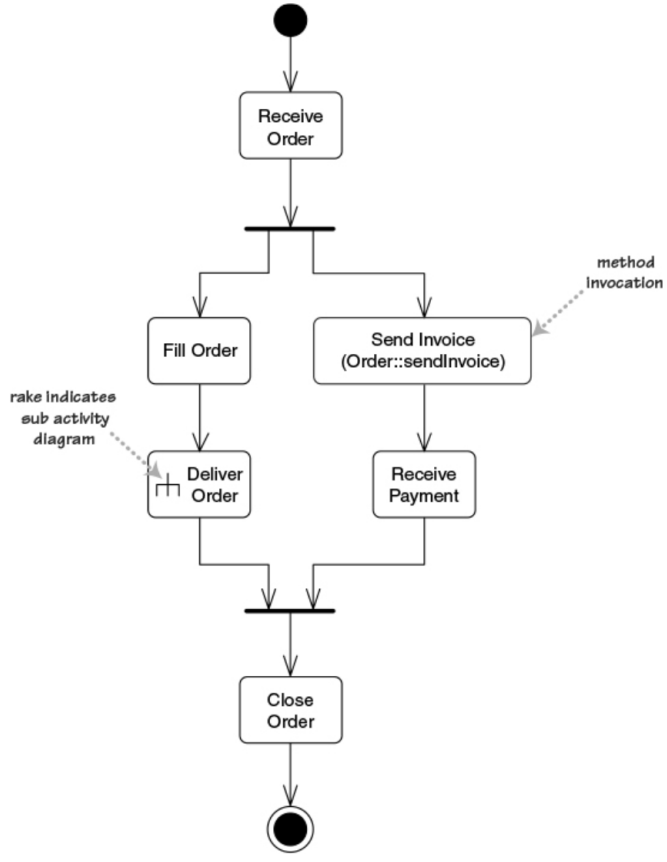


Decomposing an Action as a subactivity

An action can be implemented as:

- a method in a class
- as a sub-activity (shown using the rake symbol)





Partitions (swim lanes) – who does what?

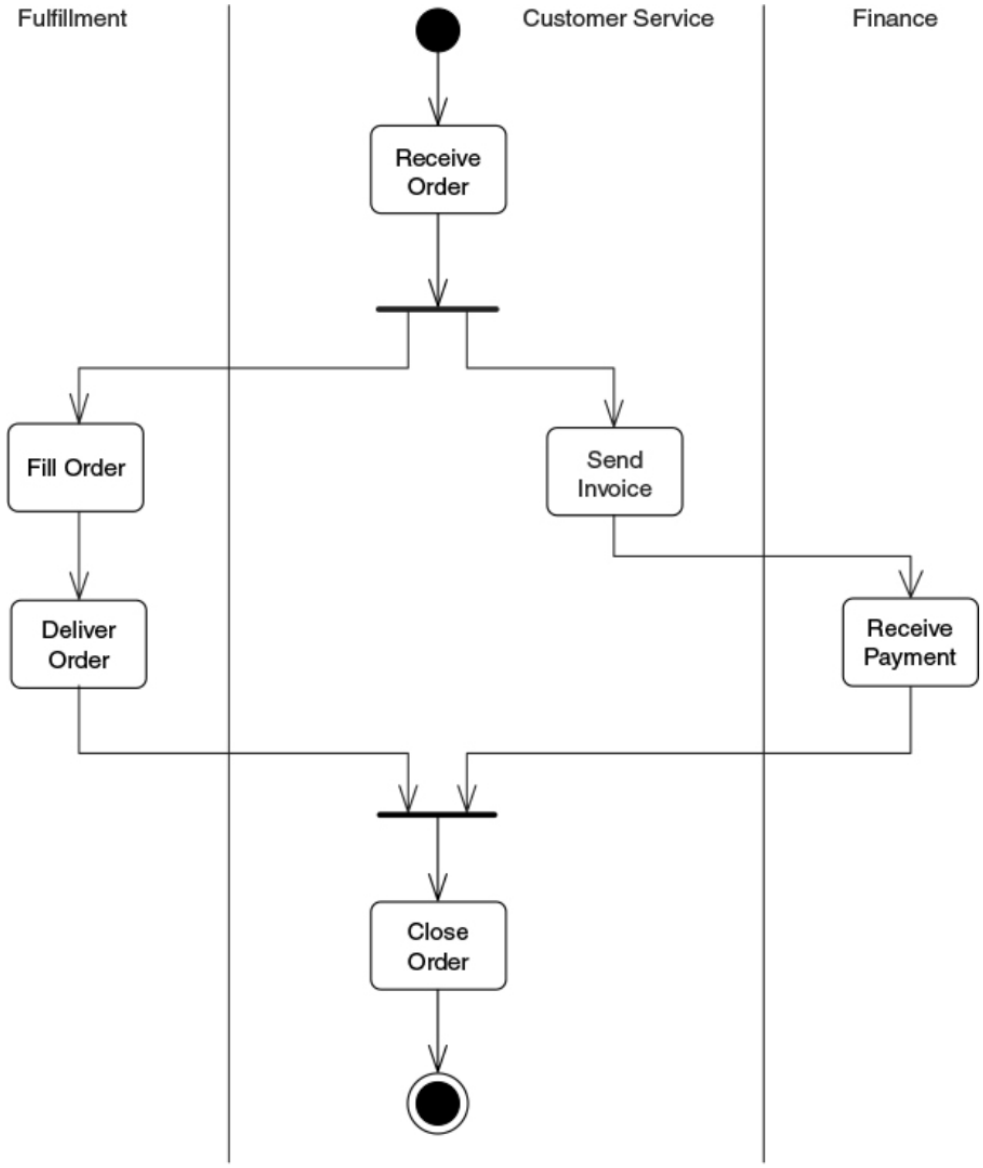


Figure 1: Which actions one class or organization unit carries out

Interactive Exercise 1: Course Registration Process

Scenario

A student registers for a course.

Steps

1. Log in
2. Check prerequisites
3. If eligible $\rightarrow$ register for course
4. Update records & send confirmation (in parallel)

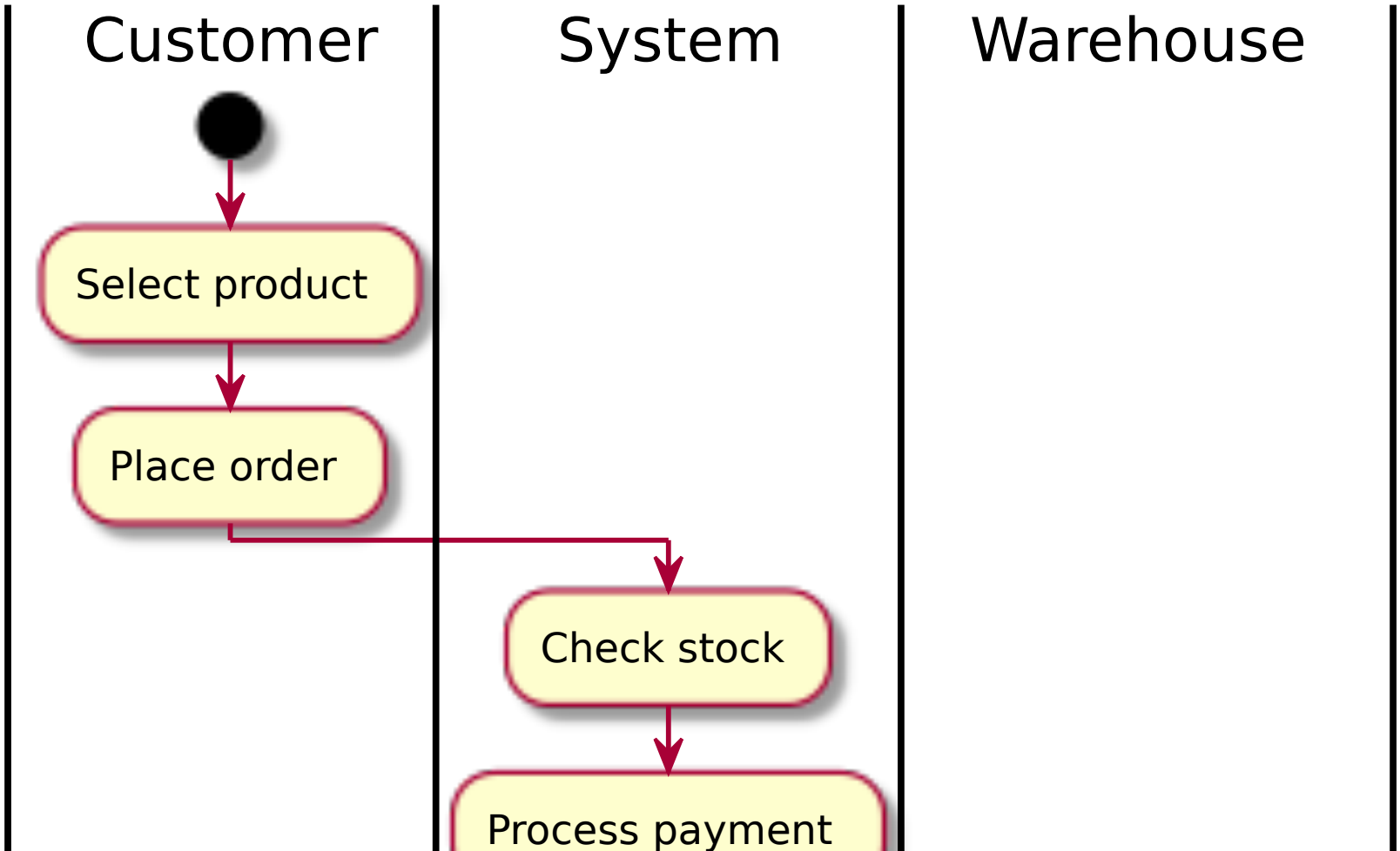
Session 2: Advanced Constructs and Applications

Swimlanes

Purpose: Show which actor or subsystem performs each action.

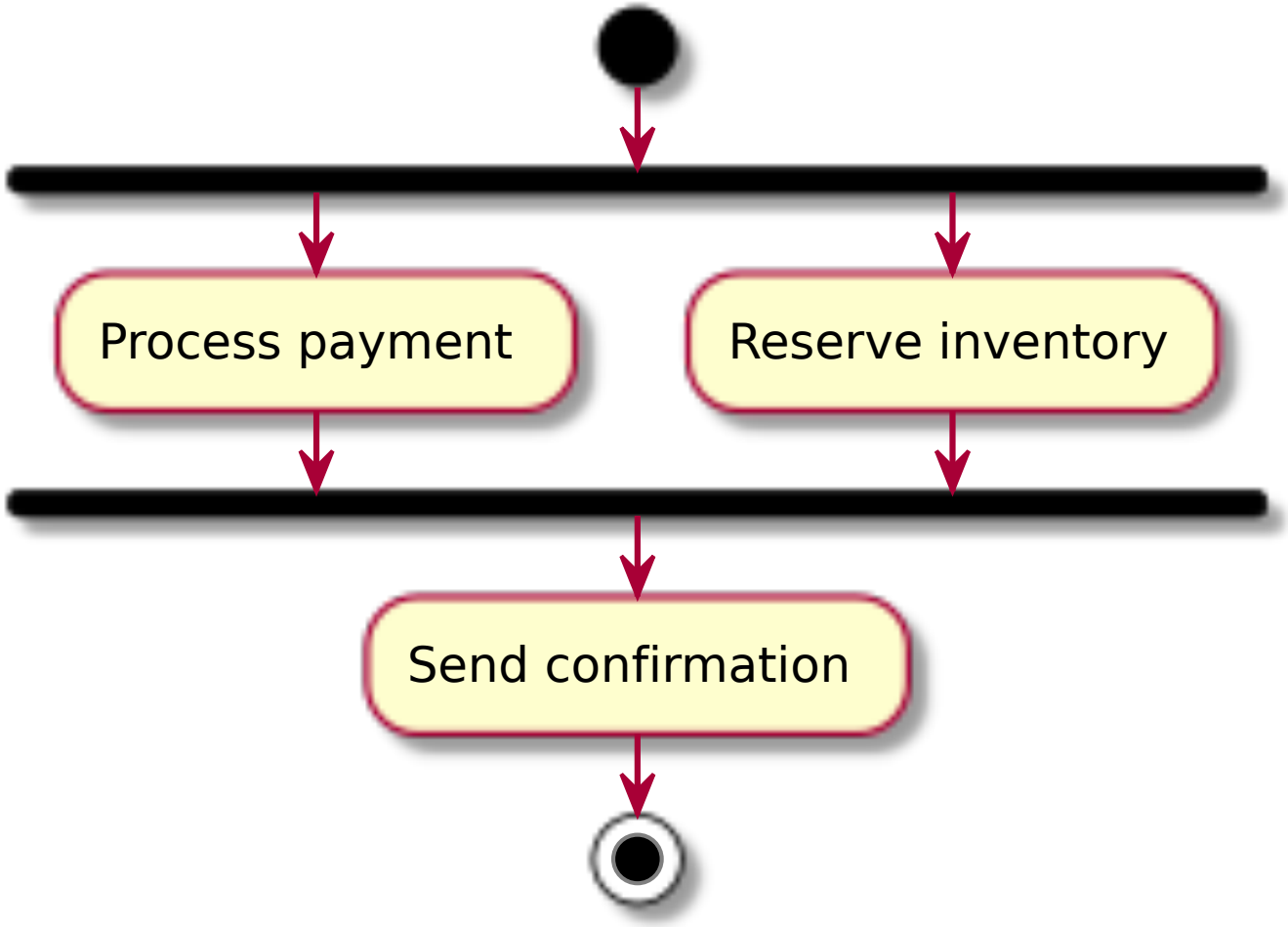
Notation: Vertical or horizontal lanes representing responsibilities.

Example: Online Purchase Process



Parallel Flows and Synchronization

Fork/Join Example:



Discussion: What happens if one parallel branch fails or is delayed?

Tokens in Activity Diagrams

Purpose of tokens

- Represent the *flow of control* or *flow of data*.
- Enable the execution of actions when they arrive at input pins or control flows.

Types of tokens

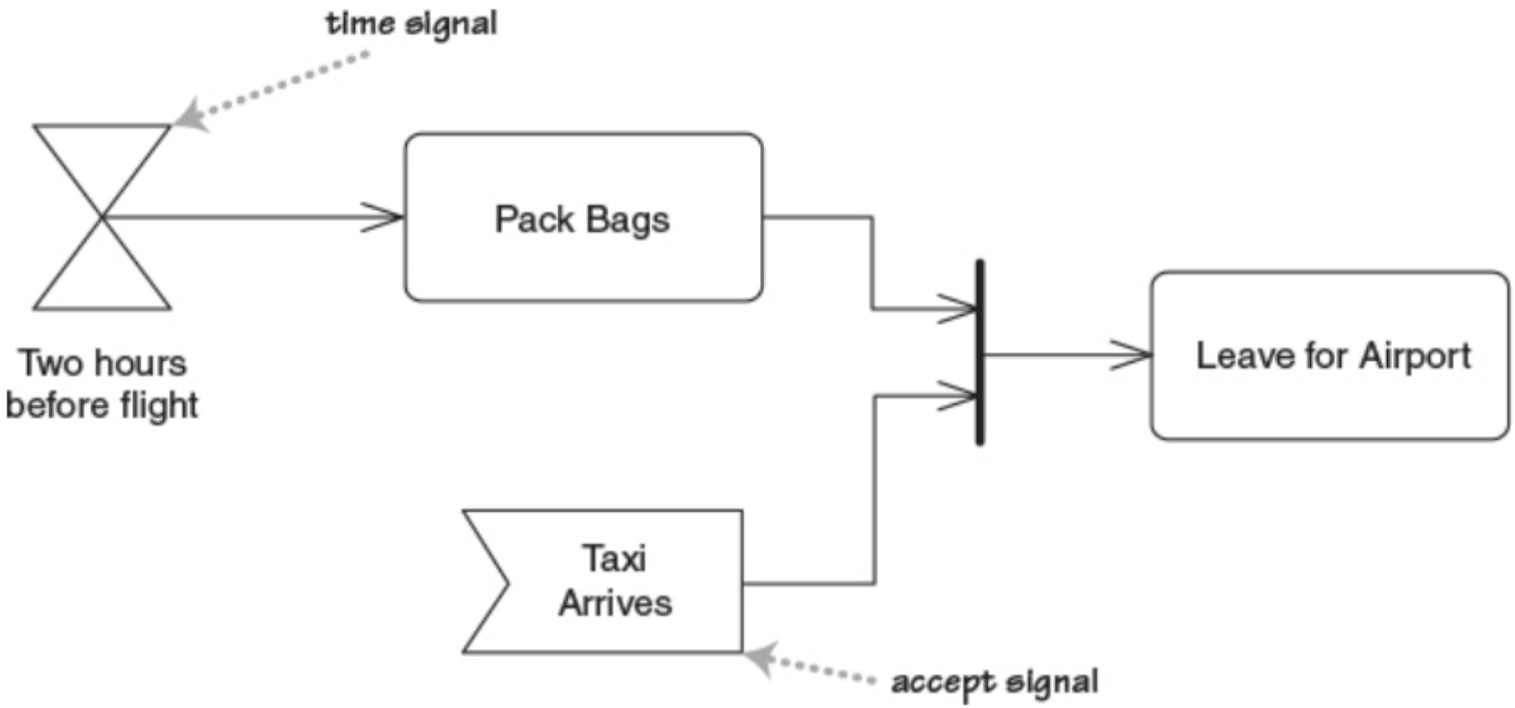
- **Control tokens**: Indicate progression of execution.
- **Object tokens**: Carry data values or objects along object flows.

Token behavior

- Actions **consume** incoming and **produce** outgoing tokens.
- Fork multiplies tokens (one for each outgoing flow).
- Join synchronizes incoming tokens (one for each incoming flow).
- Decisions route tokens based on guard conditions.

Signals

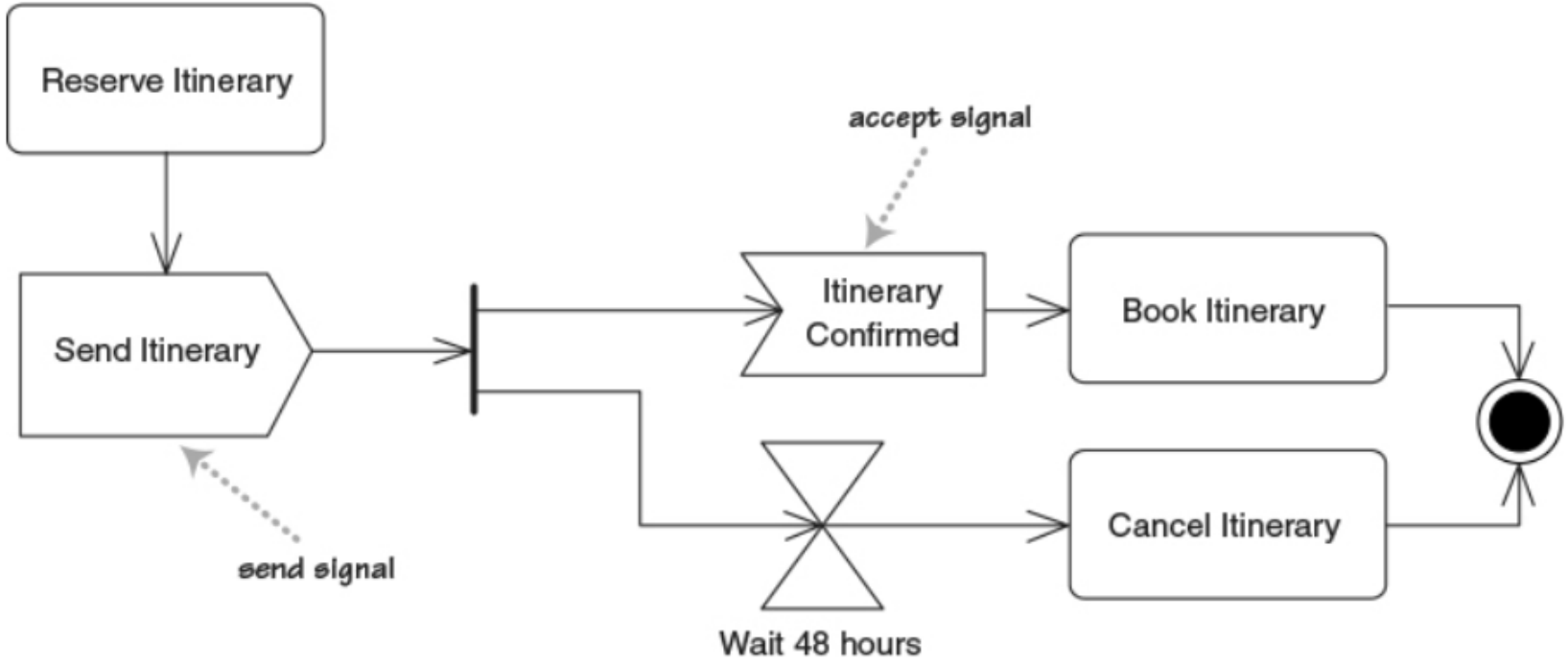
- Allow to specify entry points corresponding to events
  - receiving a signal produces one token
- Activity receives an event from an outside process
  - Time signals – triggered by the passing of time
  - Accept signals – triggered by other events



Emiting signals and flowing into signals

One can also send signals

- e.g., send a message, waiting for a reply

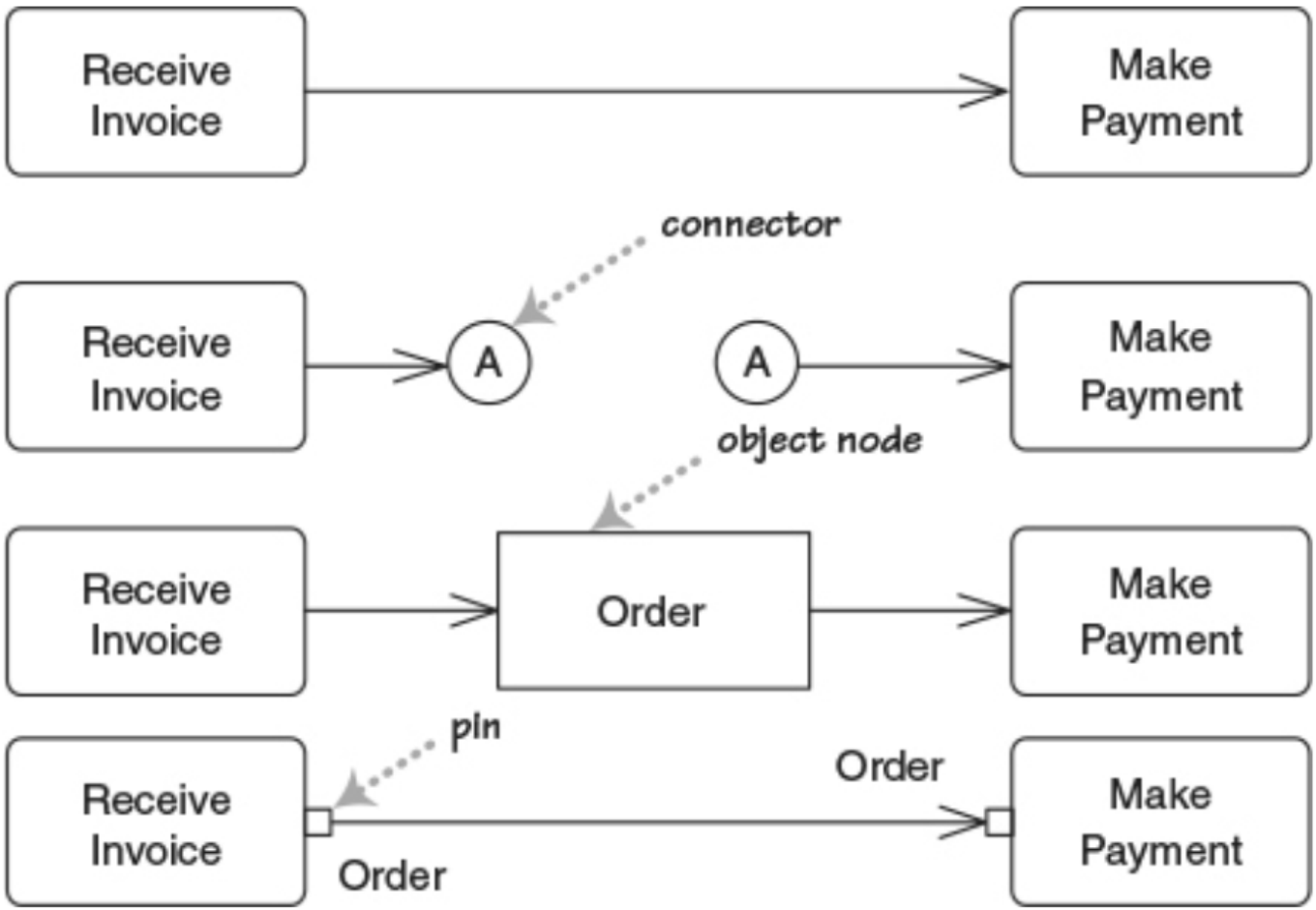


Notes

- the two flows are racing: first to end completes the activity
- Flow going into an accept signal means:
  Start listening only when flow enters the signal

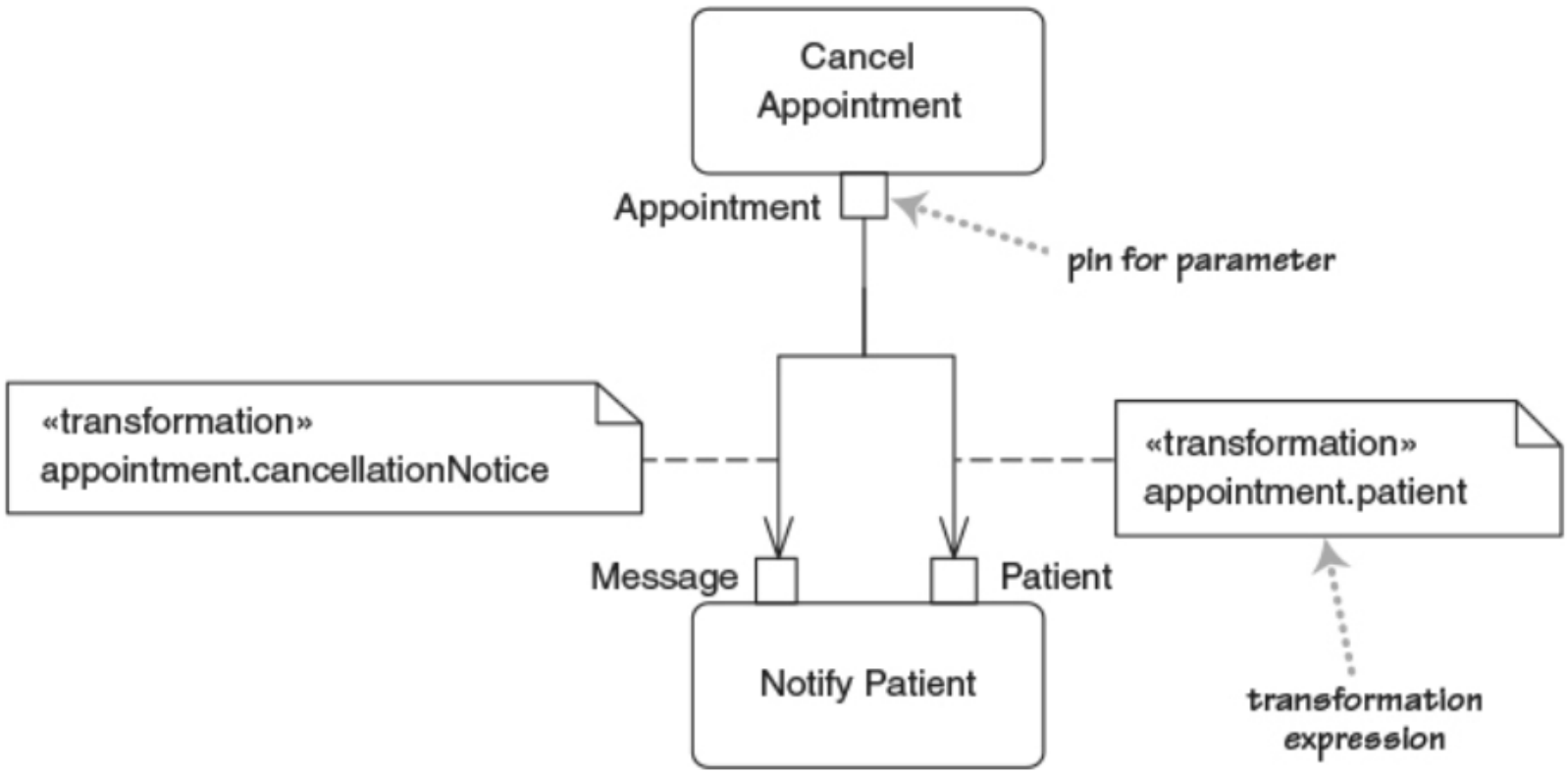
Data Flow and Object Nodes

- **Connectors** Allow splitting the draw of an edge in two parts
- **Object nodes** represent data produced/consumed by activities.
  - correspond to object tokens
  - Used to visualize data movement alongside control flow.
  - Can also be specified using **pins**



Pins: argument passing and transformation

- Pins allow showing information about parameters
- Output parameters of action should match input of next
  - One can use **transformations** to ensure that
- With pins we can have multiple flows entering same action



- In business modelling, pins show resources

Expansion regions: multiple action invocations

- Area where actions ocurr once for each item in a collection
  - useful for mapping and filtering collections

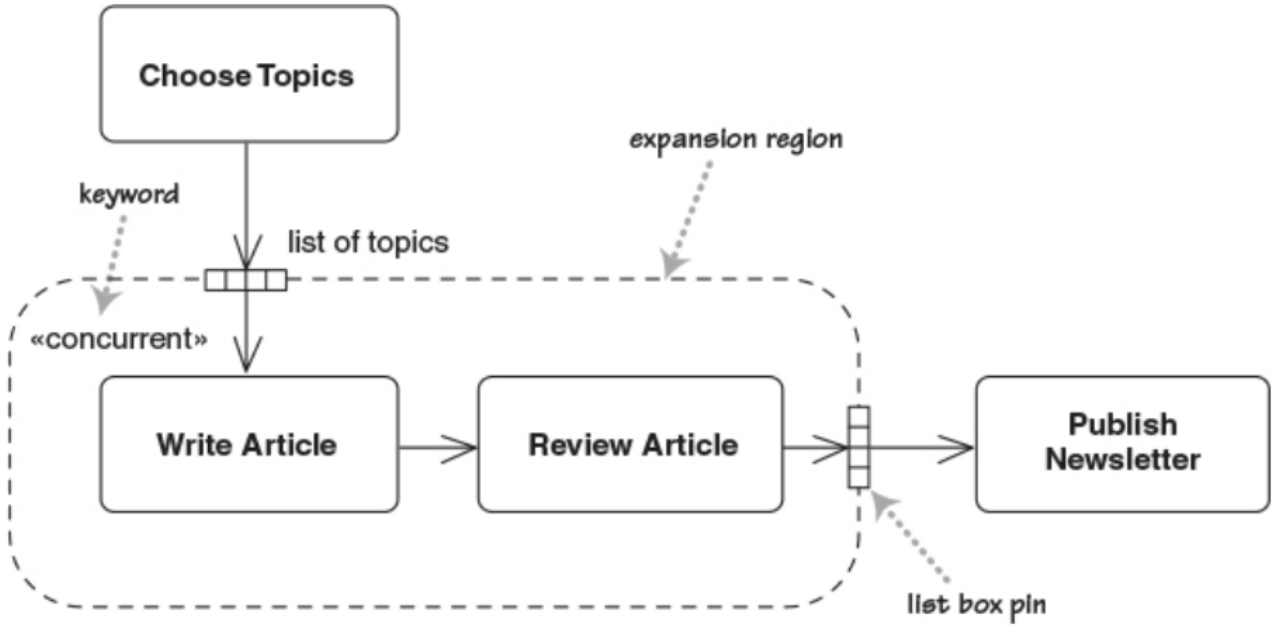


Figure 2: Mapping actions to a collection

Figure 3: Shorthand for single action map

Flow final: stop a flow without ending entire activity

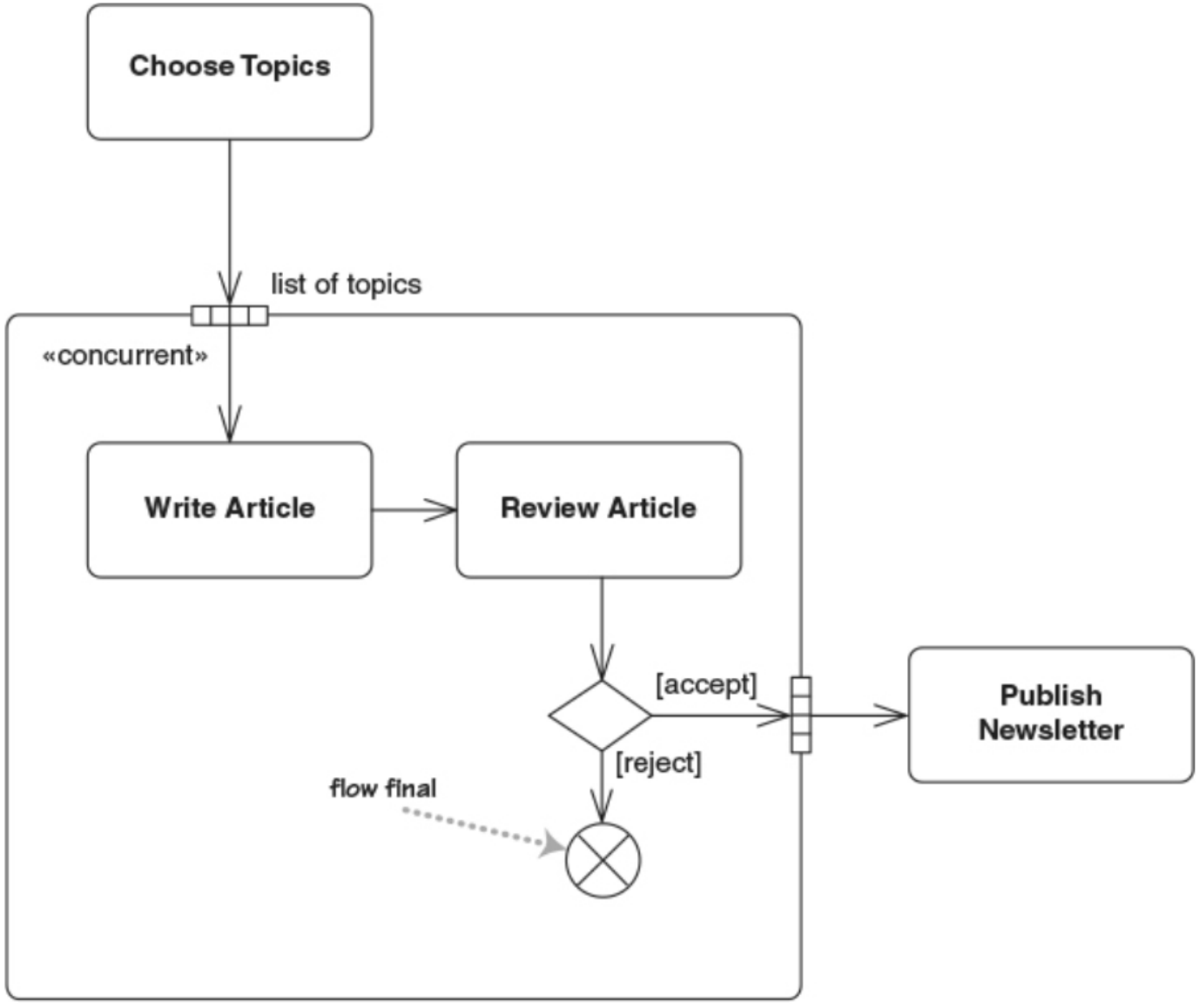
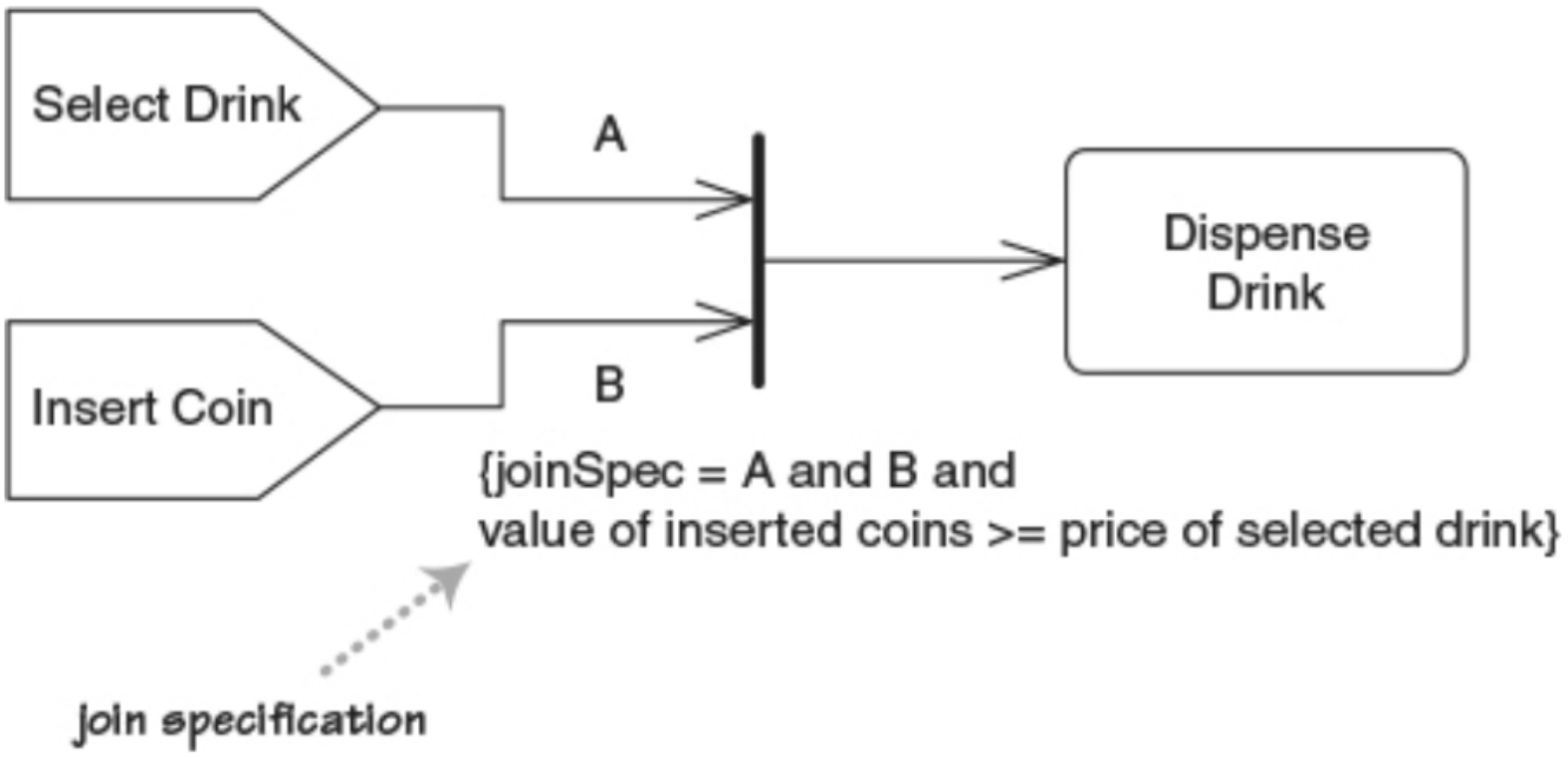


Figure 4: Filter and Map actions to a collection

Join specifications: conditions attached to a join node



Comparison to Petri Nets

Conceptual similarity

- Both use tokens to represent the *dynamic state* of the system.
- Movement of tokens represents progress in execution.

Key differences

- Activity Diagrams: object tokens; semiformal semantics.
- Petri Nets: tokens (usually) indistinguishable; formal semantics

Execution correspondence

- Activity Diagram actions $\sim$ Petri Net transitions.
- Activity Diagram edges / pins $\sim$ Petri Net places.
- Token flow in both describes enabling and firing of behaviors.

Why the comparison matters

- Petri Nets provide a *formal* foundation to analyze concurrency, conflicts, and reachability.
- Activity Diagrams can be mapped to Petri Nets for verification or simulation.

Interactive Exercise 2: Airport Check-in Process

Create an activity diagram with two swimlanes and one parallel branch.

Actors: Passenger, System

Requirements

- Passenger checks in.
- System verifies ticket.
- If baggage overweight $\rightarrow$ pay fee.
- In parallel: print boarding pass + update database.

Wrap-Up

Concept	Description	Example
Action	Step in process	"Process payment"
Decision	Conditional branch	"Is stock available?"
Fork/Join	Parallel execution	"Ship + Notify"
Swimlane	Role-based grouping	"Customer vs. System"

Key Takeaways

- Activity Diagrams model workflows and concurrent processes.
- Ideal for requirements and process-level modeling.
- Useful bridge from analysis to system design.