

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

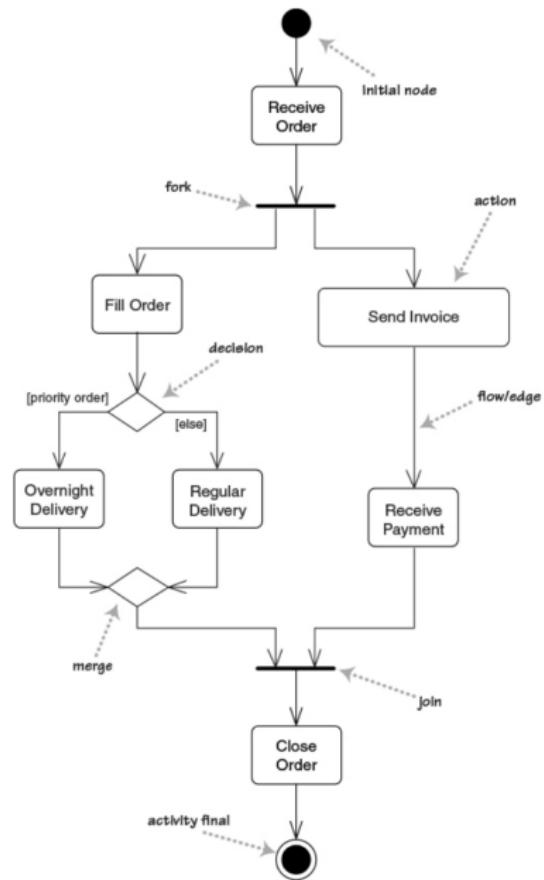
Comparison

| 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.

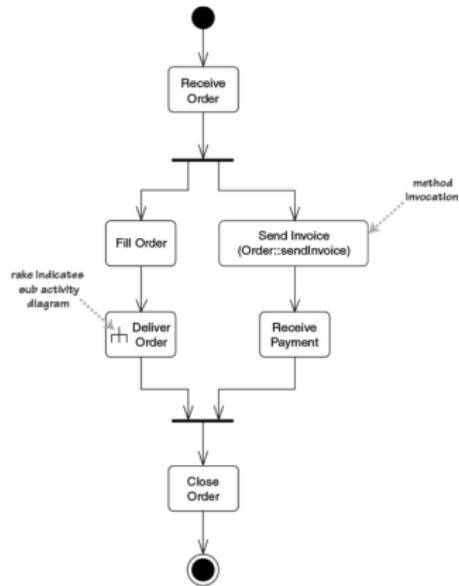
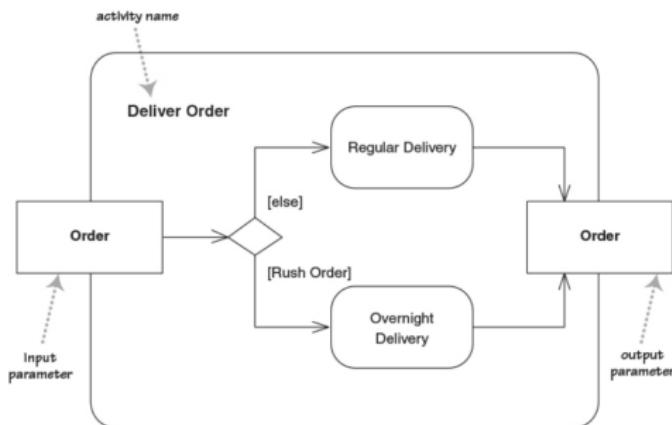
Example: Order Processing



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?

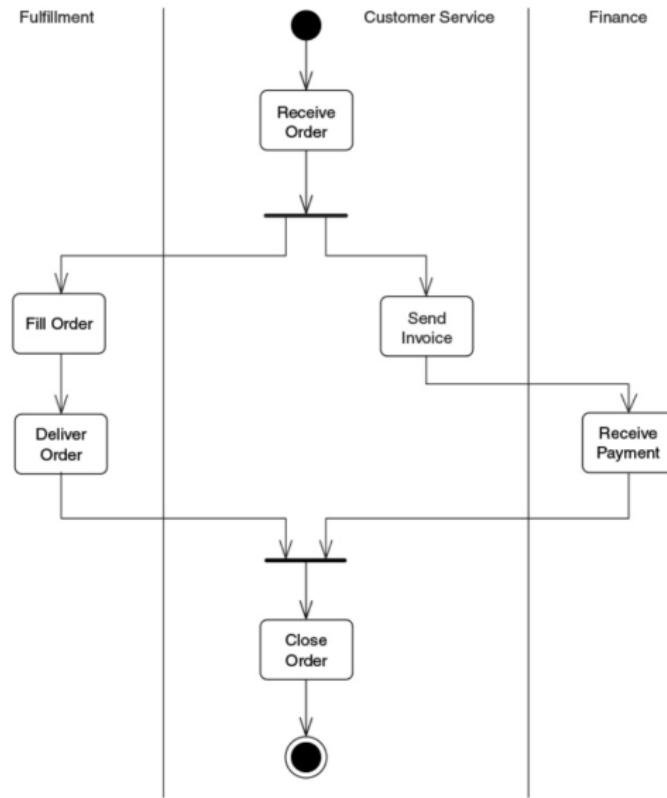


Figure 1: Which actions one class or organization unit carries out

Interactive Exercise 1: Course Registration Process

Scenario

A student registers for a course.

Steps

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

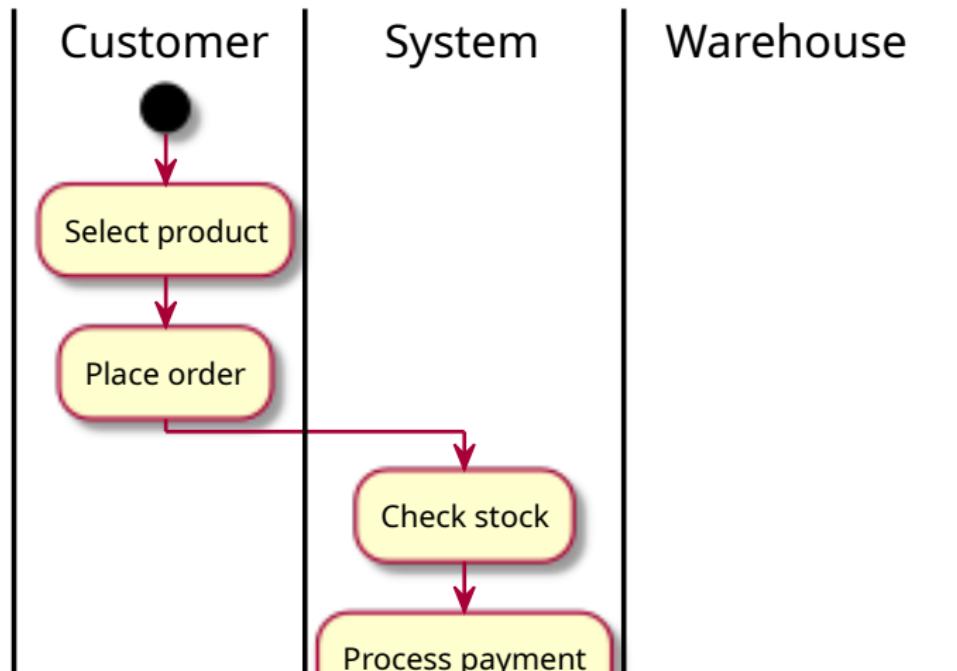
Session 2: Advanced Constructs and Applications

Swimlanes

Purpose: Show which actor or subsystem performs each action.

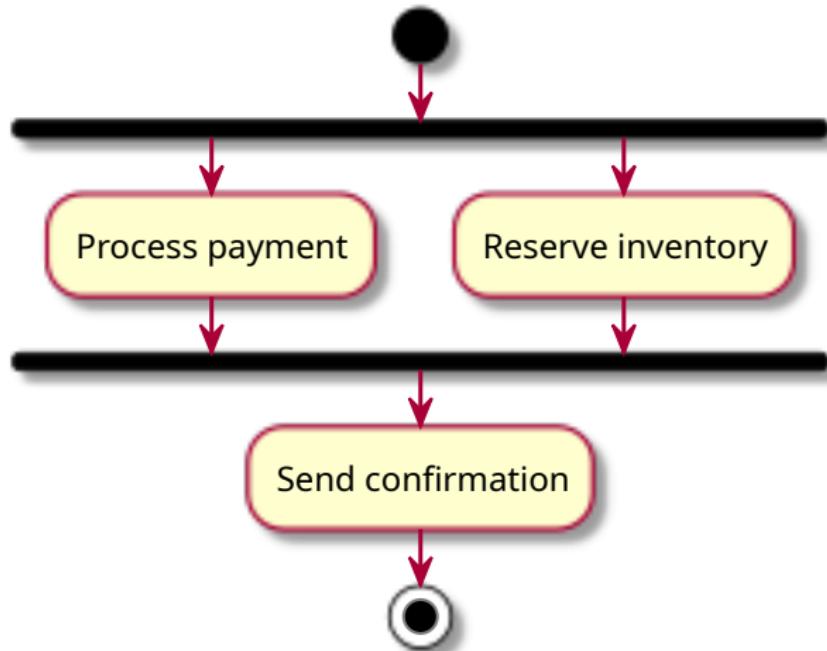
Notation: Vertical or horizontal lanes representing responsibilities.

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

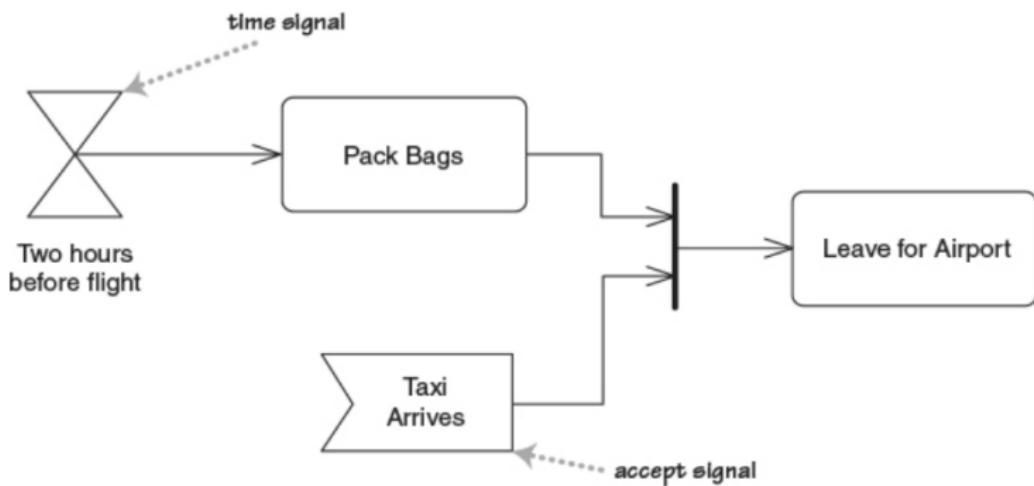
- ▶ **Control tokens:** Indicate progression of execution.
- ▶ **Object tokens:** Carry data values or objects along object flows.

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

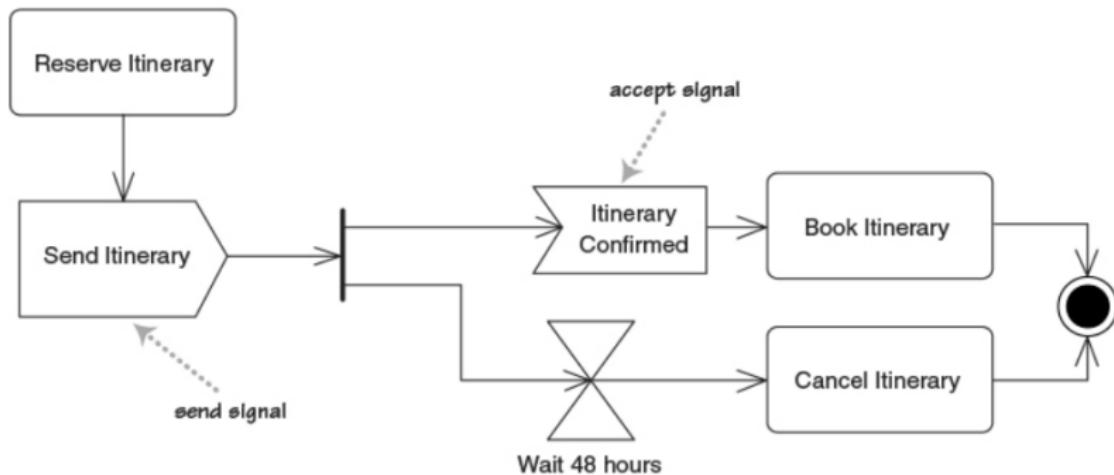
- ▶ Allow to specify entry points corresponding to events
 - ▶ receiving a signal produces one token
- ▶ Activity receives an event from an outside process
 - ▶ Time signals – triggered by the passing of time
 - ▶ Accept signals – triggered by other events



Emiting signals and flowing into signals

One can also send signals

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

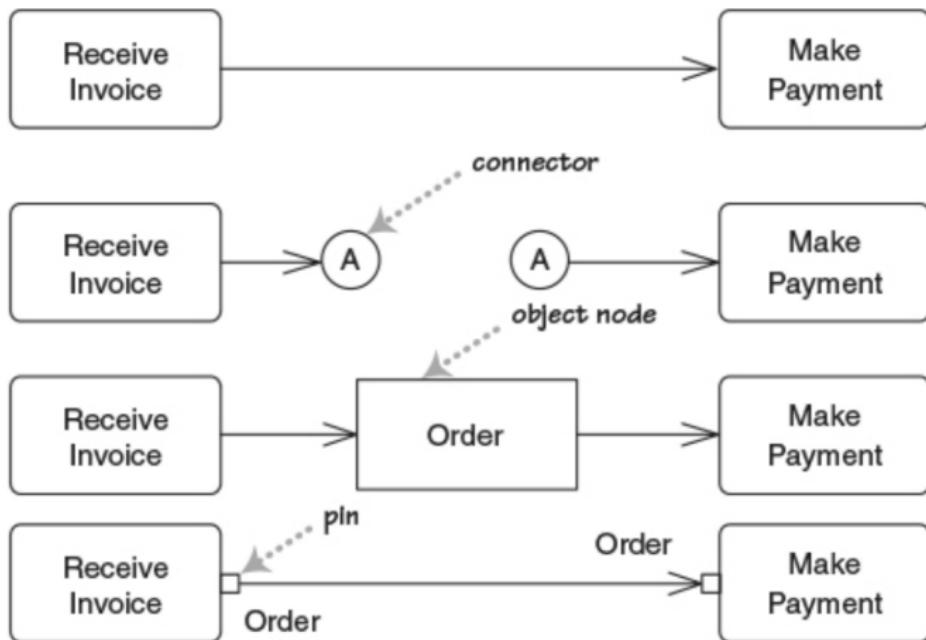


Notes

- ▶ 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

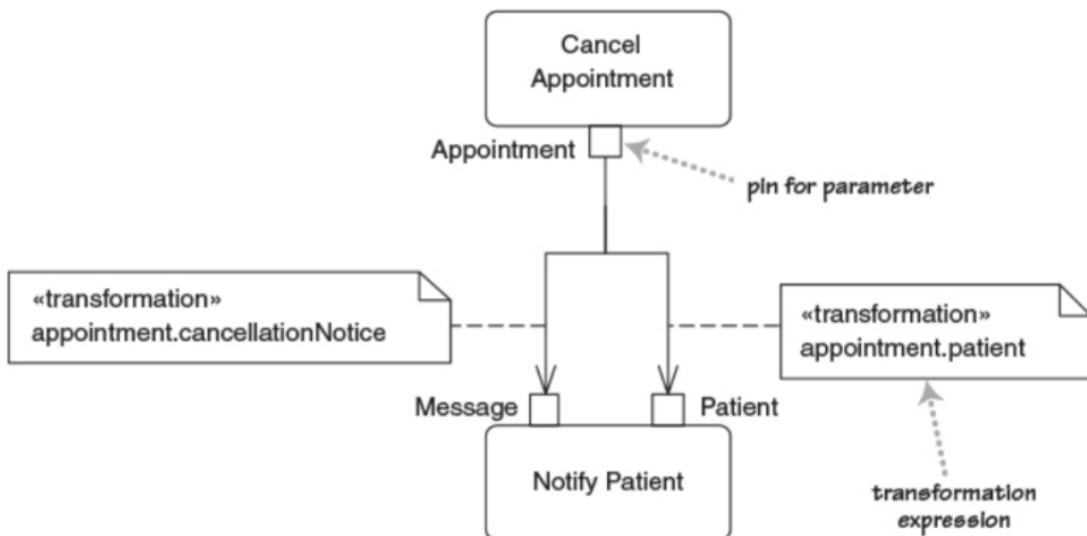
Data Flow and Object Nodes

- ▶ **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 occur once for each item in a collection
 - ▶ useful for mapping and filtering collections

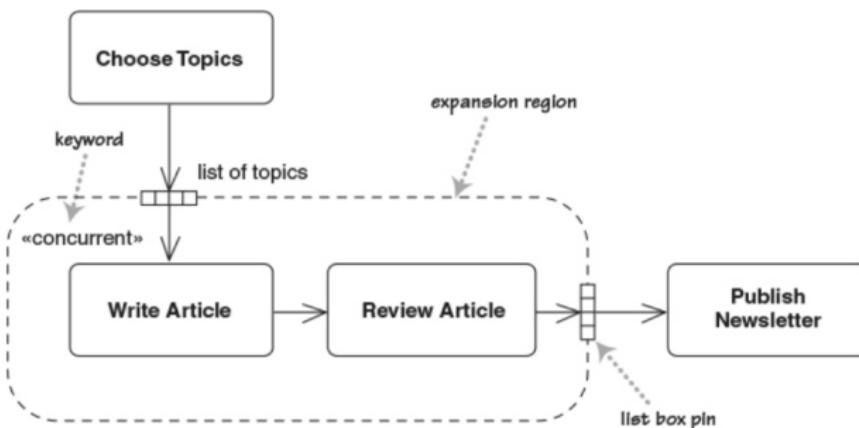


Figure 2: Mapping actions to a collection

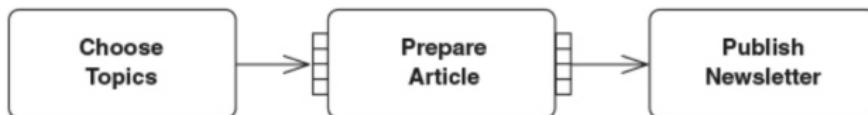


Figure 3: Shorthand for single action map

Flow final: stop a flow without ending entire activity

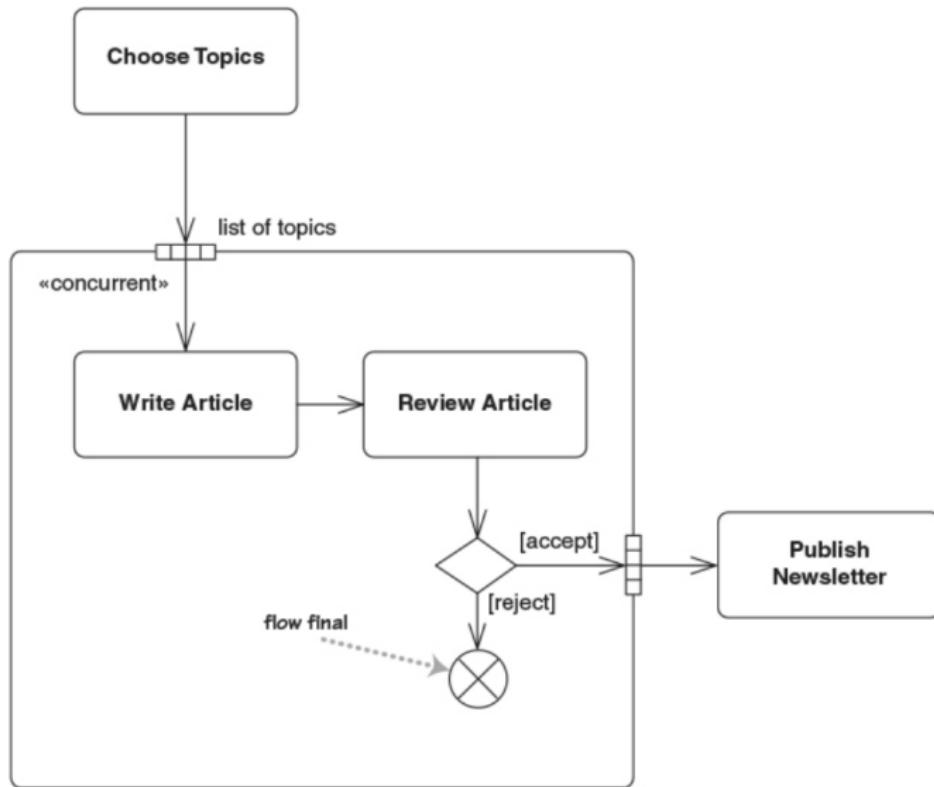
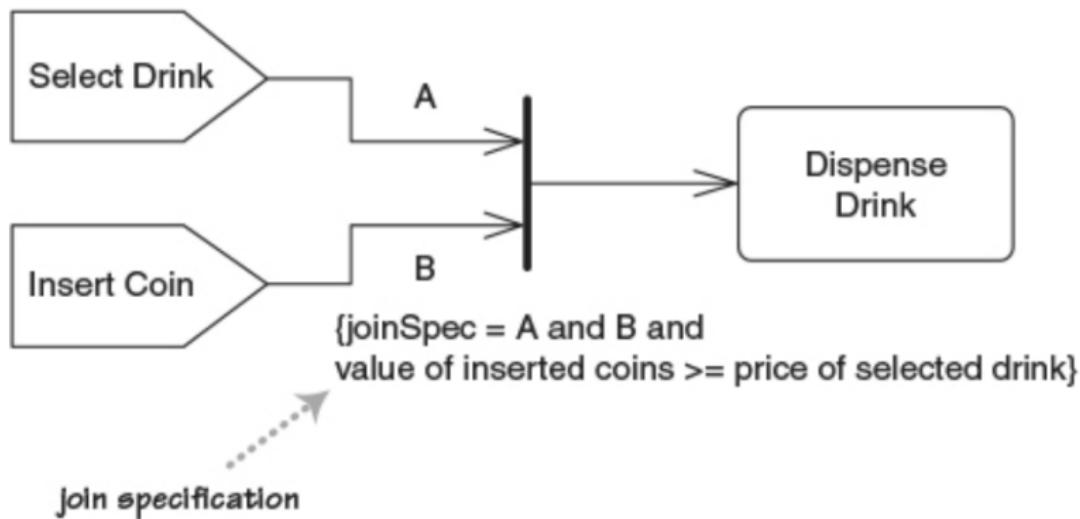


Figure 4: Filter and Map actions to a collection

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 ~ Petri Net transitions.
- ▶ Activity Diagram edges / pins ~ 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 → 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.