Activity Diagrams

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Activity Diagrams

- Activity Diagrams consist of activities, states and transitions between activities and states

- Activity Diagrams describe
  - how activities are coordinated to provide a service
  - the events needed to achieve some operation
  - how the events in a single use case relate to one another
  - how a collection of use cases coordinate to create a workflow for an organisation

Slide 1: Activity Diagrams

- Activity Diagrams describe
  - how activities are coordinated to provide a service – the service can be at different levels of abstraction
  - the events needed to achieve some operation, particularly where the operation is intended to achieve a number of different things that require coordination
  - how the events in a single use case relate to one another – in particular, use cases where activities may overlap and require coordination
  - how a collection of use cases coordinate to create a workflow for an organisation
- Activity Diagrams
  - focus on the flow of activities involved in a single process
  - show how activities depend on one another
  - capture activities that are made up of smaller actions

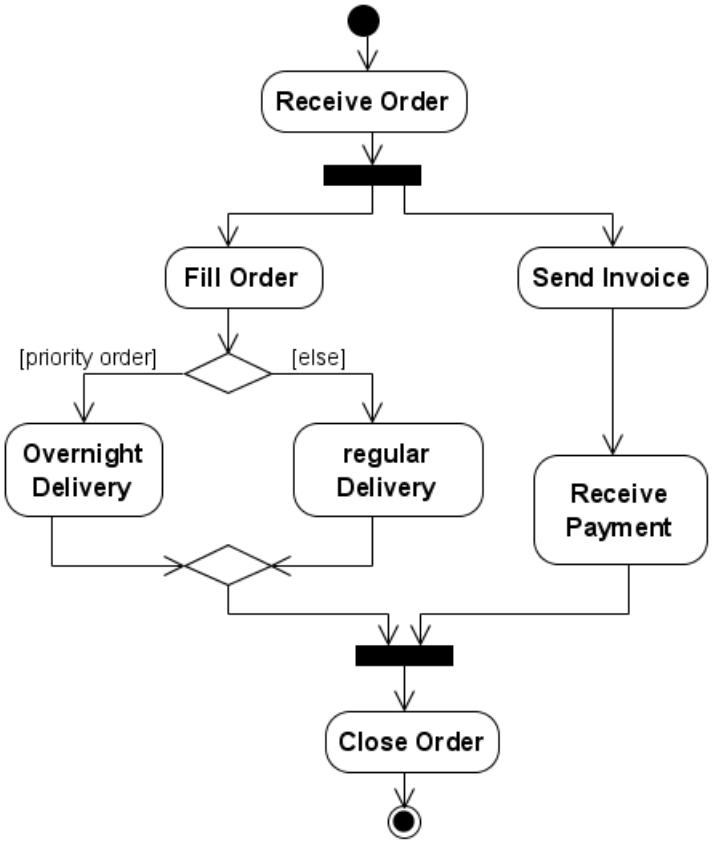
Activity Diagrams

- Model business workflows
- Identify candidate use cases, through the examination of business workflows
- Identify pre- and post-conditions for use cases
- Model workflows between/within use cases
- Model complex workflows in operations on objects
- Model in detail complex activities in a high level activity diagram

Activity Diagrams

- Activities and Actions
- Transitions and Activity Edges
- Tokens and Activity Nodes
- Control Nodes
  - Initial and Final Nodes
  - Forks and Joins
  - Decision and Merge Points
- States
- Swimlanes

Activity Diagram



Activities

- An Activity is the process being modelled
- Activities are the vertices of the diagram
- An Activity is a unit of work that needs to be carried out
- Any Activity takes time
- An activity is like a state where the criterion for leaving the state is the completion of the activity

Actions

- An Action is a step in the overall activity
- The work can be documented as Actions in the activity
- There are four ways in which an action can be triggered
  1. **On Entry** – as soon as the activity starts
  2. **Do** – during lifetime of the activity
  3. **On Event** – in response to an event
  4. **On Exit** – just before the activity completes

Transitions

- A Transition is the movement from one activity to another, the change from one state to another, or the movement between a state and an activity in either direction
- Transitions: unlabelled arrows from one activity to the next
- Transitions take place when one activity is complete and the next can commence

Activity Edges

- The flow of an activity is shown using arrowed lines called edges or paths
- Control-flow Transitions indicate the order of action states
- Object-flow Transitions indicate that an action state inputs or outputs an object

Slide 8: Activity Edges

- Time could be a factor in an activity
- Time events are drawn with an hourglass symbol

Tokens

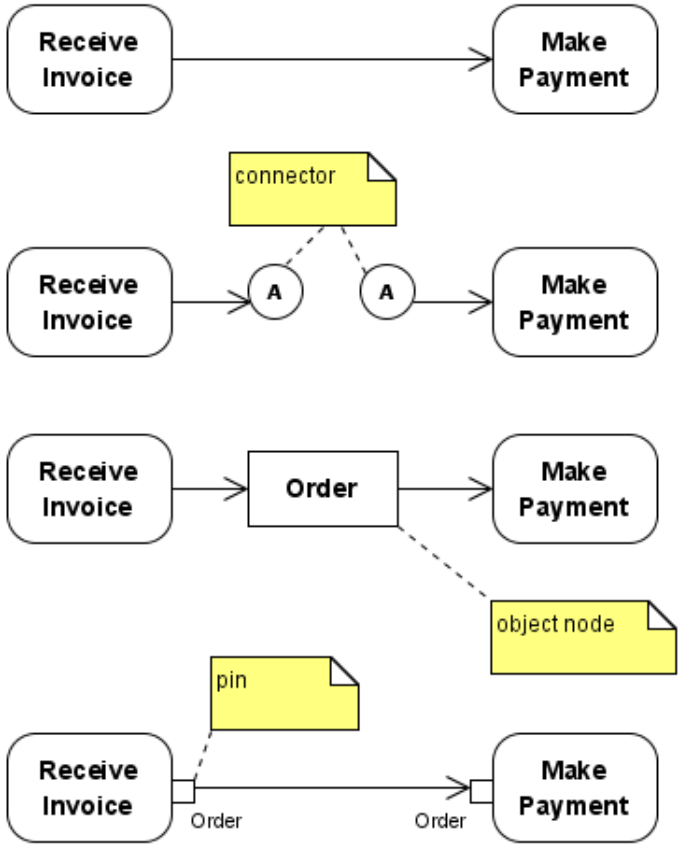
- Conceptually, UML models information moving along an edge as a token (e.g., real data, an object or focus of control)

- Each edge may have
  - a **weight** associated with it that indicates how many tokens must be available before the tokens are presented to the target action
  - a **guard condition**

Activity Nodes

- UML 2.0 defines several types of activity nodes to model different types of information flow
  - **Parameters nodes**
  - **Object nodes**
  - (input or output) **Pins** - special notation for object nodes; exception pins, value pins

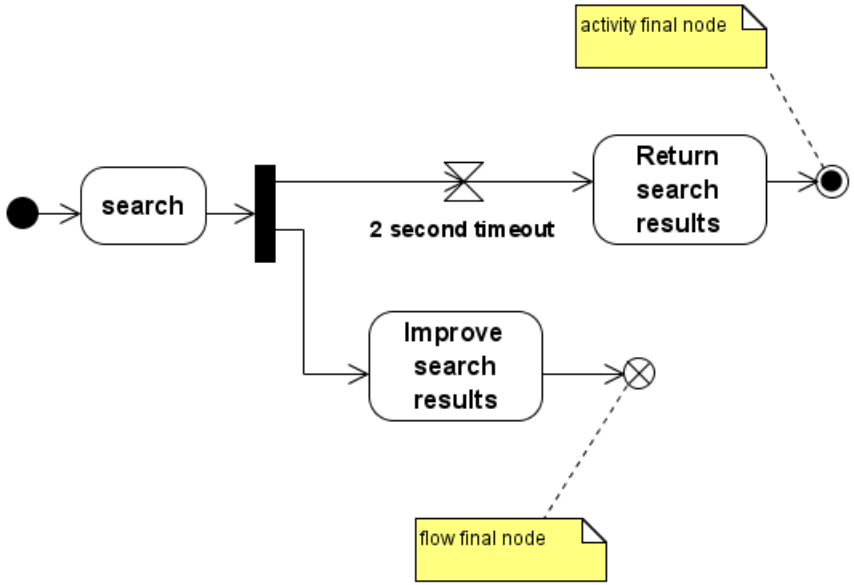
Flows and Edges



Initial and Final Nodes

- An **initial node** is the starting point for an activity
- Two types of final nodes: activity final and flow final
- An **activity final node** terminates the entire activity
- A **flow final node** terminates a path through an activity, but not the entire activity
- It is possible to have multiple initial nodes and final nodes

Final Nodes



Warnings: be careful when using a **flow final node** after a fork. As soon as the activity final node is reached, all other actions in the activity (including the ones before the **final flow node**) terminate. If you want all forked actions to finish, make sure to add a join.

Forks

- A transition can be split into multiple paths and multiple paths combined into a single transitions by using a **synchronisation bar**
- A synchronisation may have many in-arcs from activities and a number of out-arcs to activities
- A **fork** is where the paths split
- On an occurrence of the transition all the activities with arcs from the transition are initiated
- A fork node splits the current flow through an activity into multiple concurrent flows

Slide 14: Forks

In a detailed design model, you can use forks to represent multiple processes or multiple threads in a program.

Joins

- A join is where the paths meet
- The bar represents synchronisation of the completion of those activities with arcs into the transition
- A join synchronises multiple flows of an activity back to a single flow of execution

Decision and Merge Points

- A **decision point** shows where the exit transition from a state or activity may branch in alternative directions depending on a **condition**
- A decision involves selecting one control-flow transition out of many control-flow transitions based on a condition
- Each branched edge contains a **guard condition**
- **Guard expressions** (inside []) label the transitions coming out of a branch
- A **merge point** brings together alternate flows into a single output flow - **note that it does not synchronise multiple concurrent flows**

States

- A state in an activity diagram is a point where some event needs to take place before activity can continue
- Activities and States are similar
  - States carry out actions as activities do
  - Activities need to complete their actions before exiting
  - States are used to imply waiting, not doing
- It is possible to show an object changing states as it flows through an activity

Start and End States

- The Start state is the entry point to a flow
- There can be several End states – multiple End states can be used to indicated different follow-on processes from a particular process
- Start and End states can have actions too
- **Malformed diagrams** – it is possible to form ill-formed diagrams that require multiple activations of activities or can allow deadlock

Swimlanes

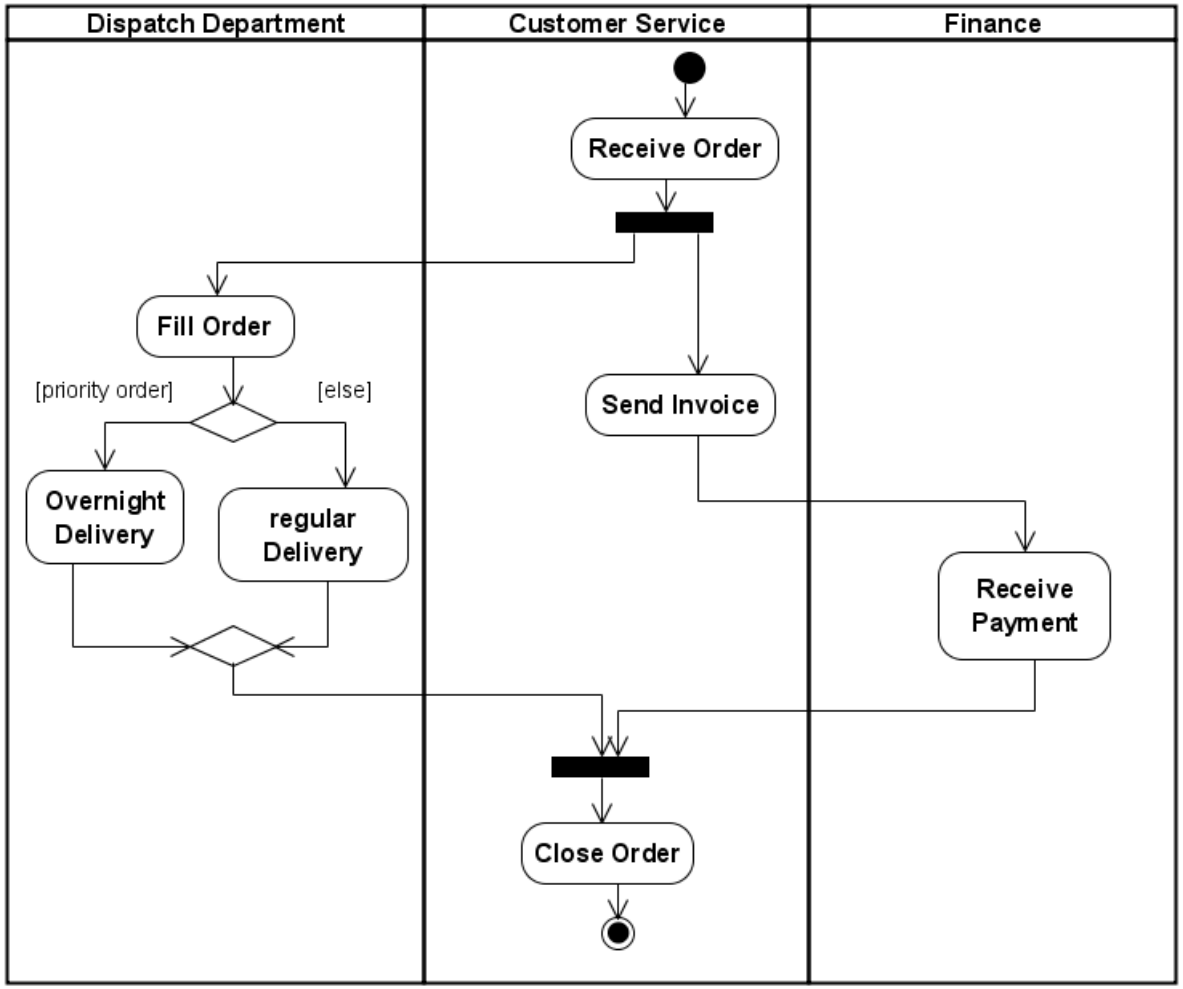
- Swimlanes (or activity partitions) indicate where activities take place.
- Swimlanes can also be used to identify areas at the technology level where activities are carried out
- Swimlanes allow the partition an activity diagram so that parts of it appear in the swimlane relevant to that element in the partition

Slide 19: Swimlanes

Partitions may be constructed on the basis of:

- the class and actor doing the activity
- Partitioning by class and actor can help to identify new associations that have not been documented in the class model
- the use case the activity belongs to
- Partitioning by use cases can help document how use cases interact

Slide 19: Smimlanes – Example



Sending and Receiving Signals

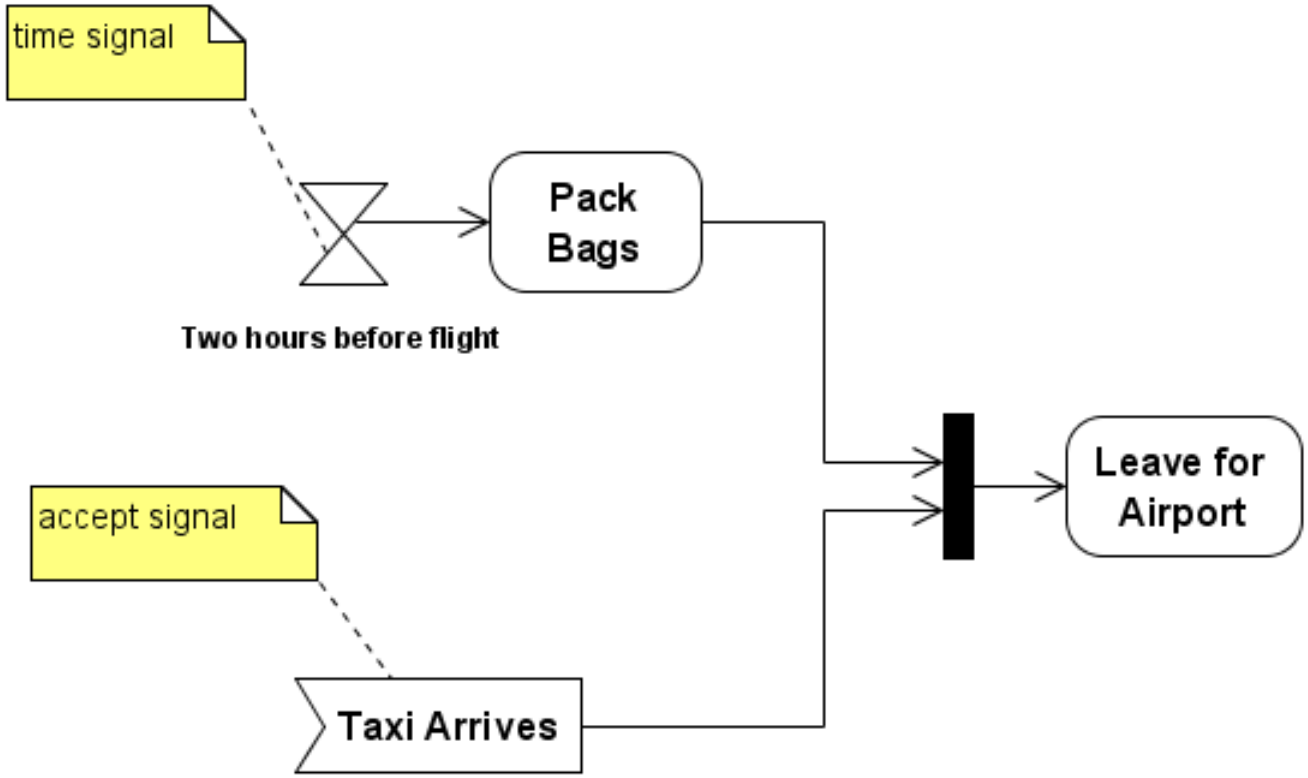
- In activity diagrams, signals represent interactions with **external participants**
- Signals are messages that can be sent or received
- A receive signal has the effect of waking up an action in your activity diagram
- Send signals are signals sent to external participants

Slide 20: Sending and Receiving Signals

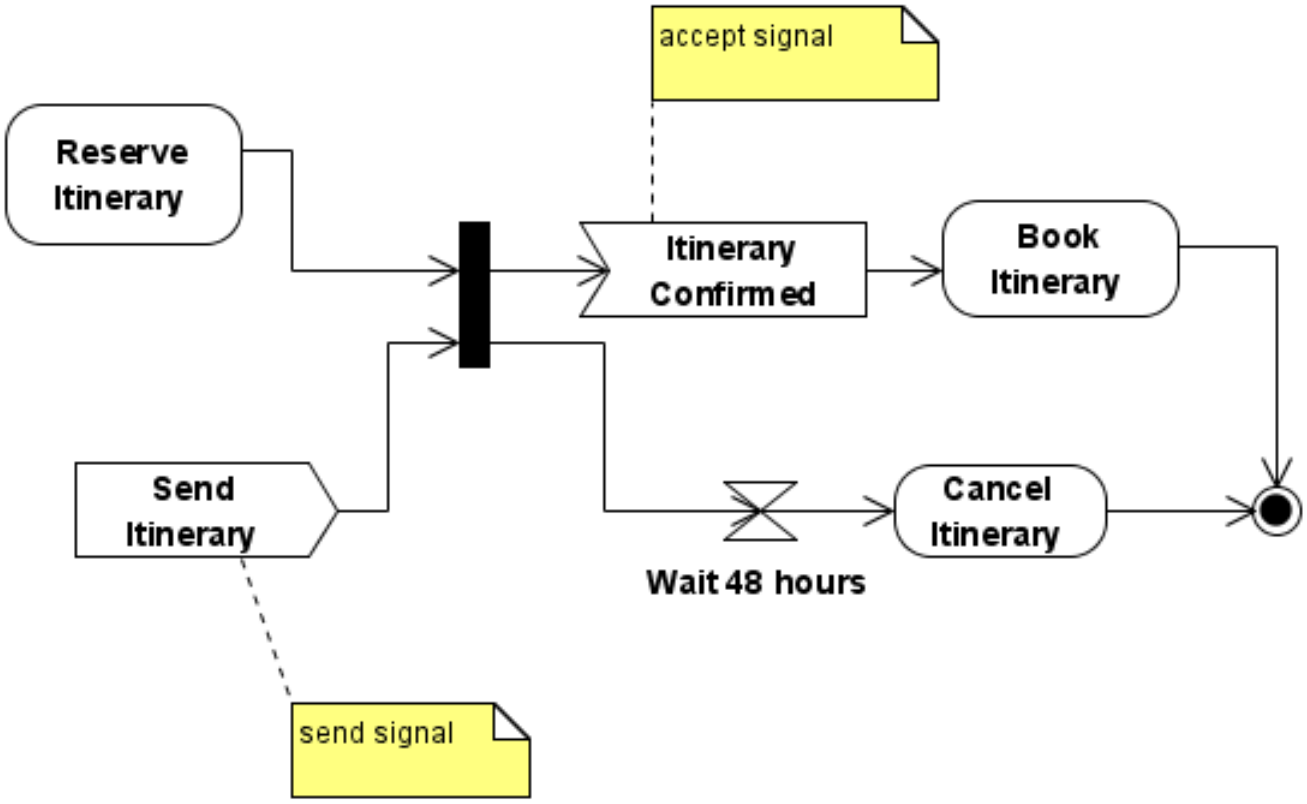
- Note that combining send and receive signals results in behaviour similar to synchronous call, or a call that waits for a response.

- It is common to combine send and receive signals in activity diagrams, because you often need a response to the signal you sent.

Signals on Activity Diagrams



Sending and Receiving Signals



Slide 22: Advanced Activity Modelling

- **Connectors**
- UML 2.0 provides supports for modelling **Exception Handling**
- It is possible to show that an action, or set of actions, executes over a collection of input data by placing the action in an **Expansion Region** (`<<parallel>>`, `<<iterative>>` or `<<stream>>`)
- UML 2.0 defines a construct to mode looping in activity diagrams – A **loop node** has three subregions: setup, body and test
- An action is said to be **streaming** if it can produce output while it is processing input
- **Interruptible activity region**
- UML 2.0 introduces a new type of activity node, called the **central buffer node**, that provides a place to specify queueing functionality for data passing between object nodes
- A **data store node** is a special type of central buffer node that copies all data that passes through it

How to construct Activity Diagrams

1. Finding system Actors, Classes and use cases
2. Identifying key scenarios of system use cases
3. Combining the scenarios to produce comprehensive workflows described using activity diagrams
4. Where significant object behaviour is triggered by a workflow, adding object flows to the diagrams
5. Where workflows cross technology boundaries, using swimlanes to map the activities
6. Refining complicated high level activities similarly, nested activity diagrams

How to construct Activity Diagrams

1. Finding business actors and use cases
2. Identifying key scenarios of business use cases
3. Combining the scenarios to produce comprehensive workflows described using activity diagrams
4. Where appropriate, mapping activities to business areas and recording this using swimlanes
5. Refining complicated high level activities similarly, nested activity diagrams

Readings

Required Readings

- UML course textbook, Chapter 11 on Activities

Summary

- Activity Diagrams are good for describing synchronization and concurrency between activities
- Activity diagrams are useful for capturing detailed activities, but they can also capture elements of the high level workflow the system is intended to support
- Partitioning can be helpful in investigating responsibilities for interactions and associations between objects and actors

