Activity Diagrams

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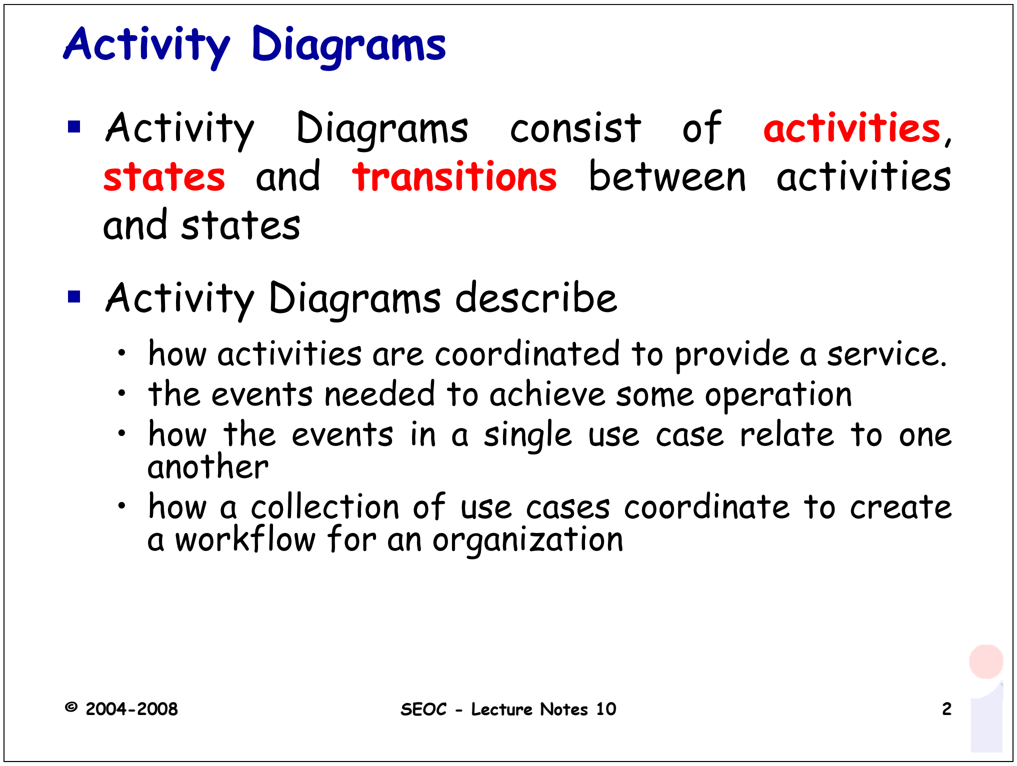


Activity Diagrams

- 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 organization

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 organization.

Activity Diagrams

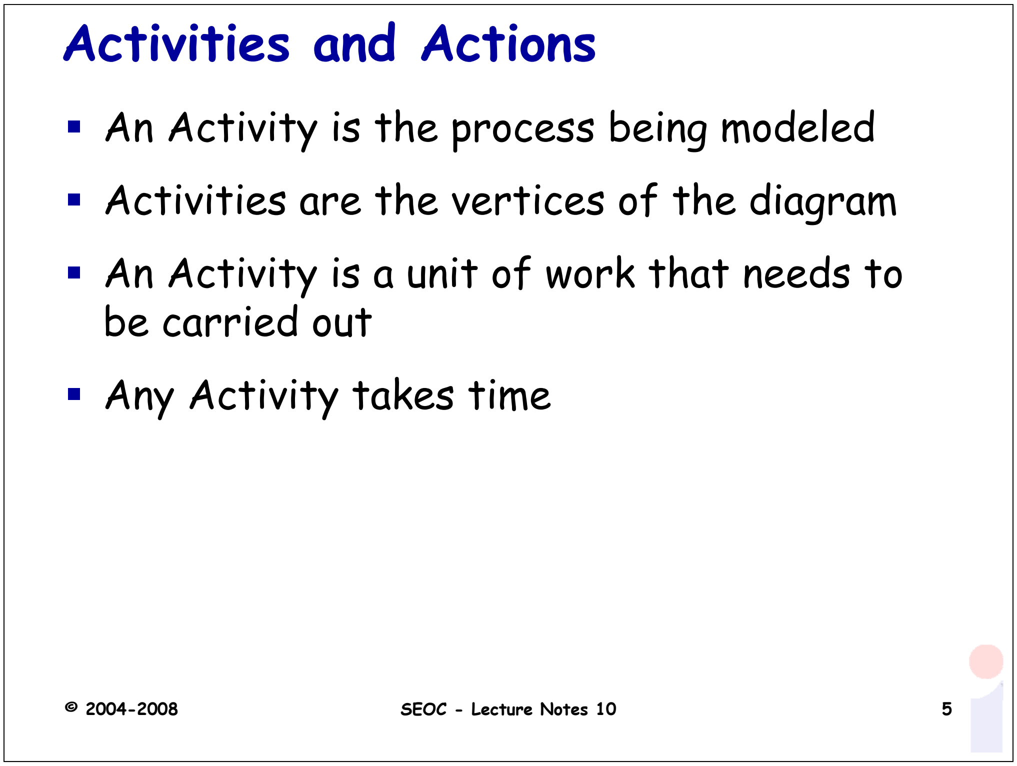
- focus on the flow of activities involved in a single process
- show how activities depend on one another
- capture activities that are made up of smaller actions.

Activity Diagrams' Rationale

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

Activity Diagram Basics

- 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



Activities and Actions

- An Activity is the process being modeled
- Activities are the vertices of the diagram
- An Activity is a unit of work that needs to be carried out
- Any Activity takes time

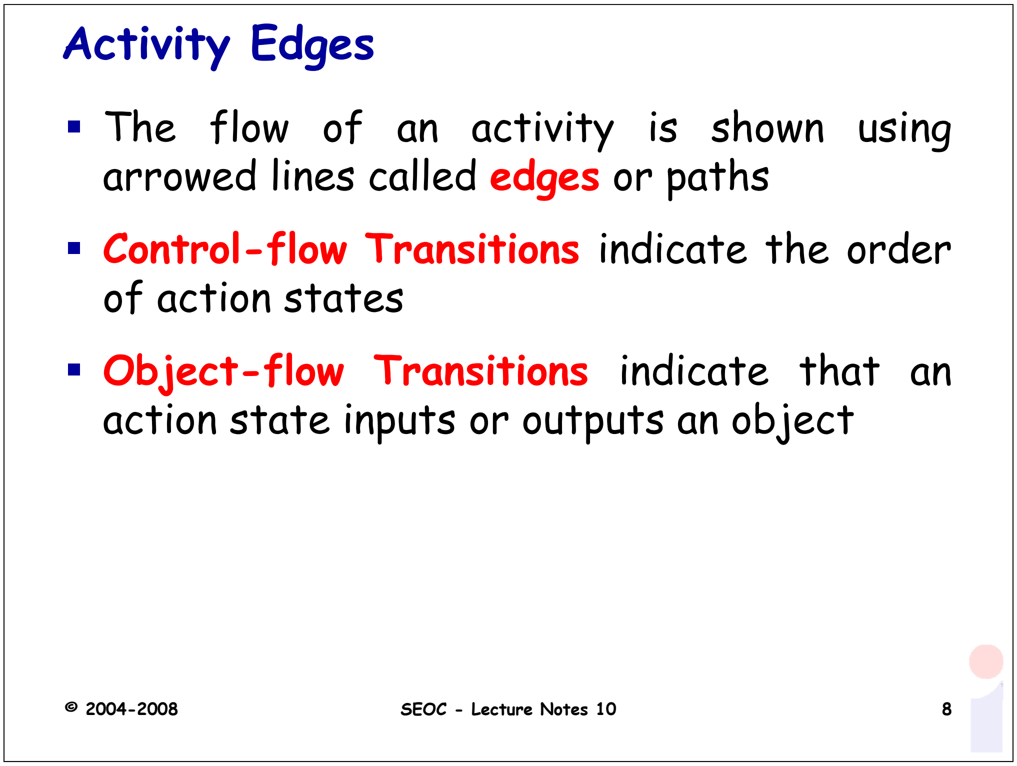
An activity is like a state where the criterion for leaving the state is the completion of the activity.

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
  - **On Entry -** as soon as the activity starts
  - **Do -** during lifetime of the activity
  - **On Event -** in response to an event
  - **On Exit -** just before the activity completes

Transitions or Activity Edges

- 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

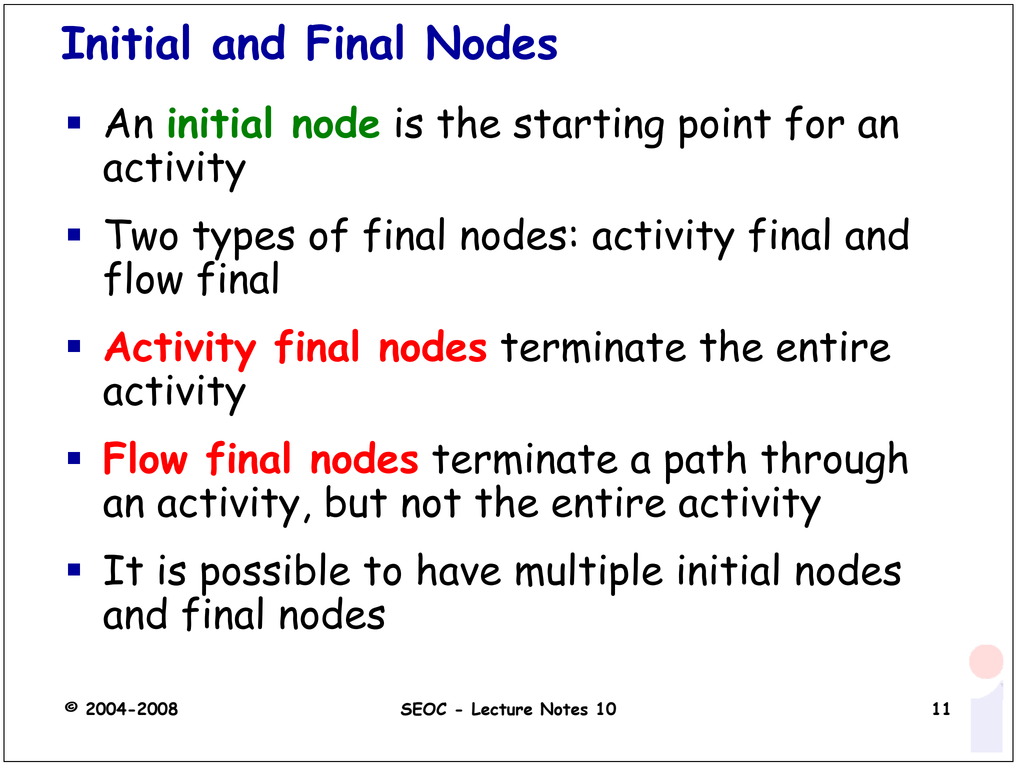
Time could be a factor in an activity. **Time events** are drawn with an hourglass symbol.

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**

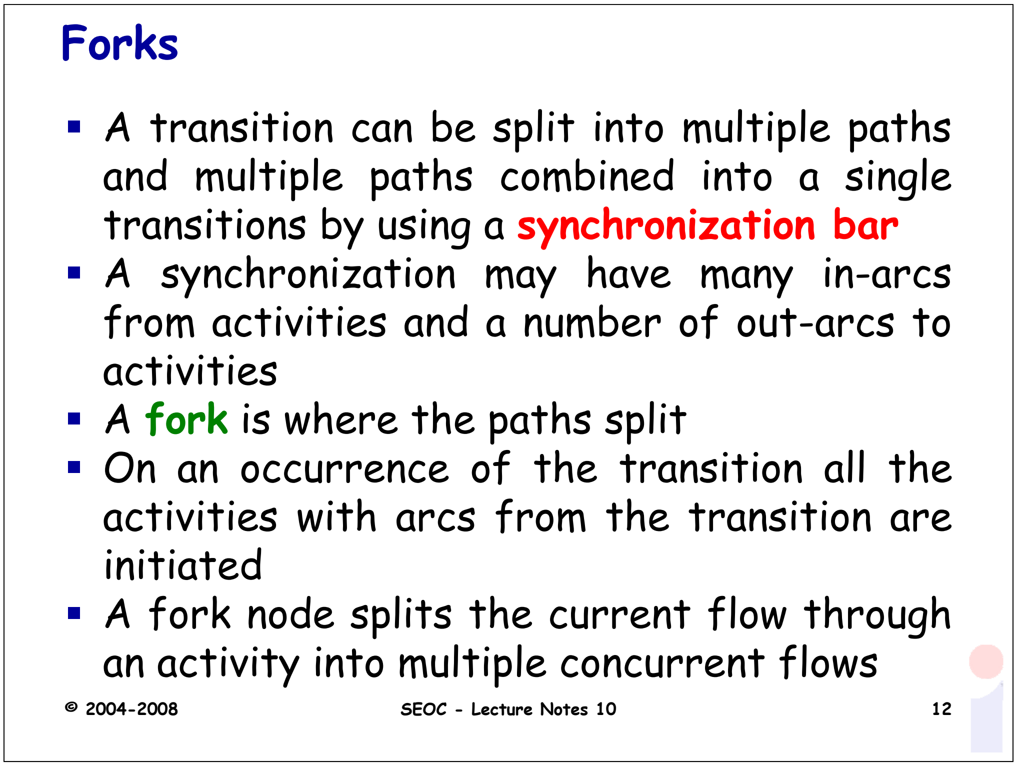
Activity Nodes

- 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



Initial and Final Nodes

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



Forks

- A transition can be split into multiple paths and multiple paths combined into a single transitions by using a **synchronization bar**
- A synchronization 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

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 synchronization of the completion of those activities with arcs into the transition
- A join synchronizes multiple flows of an activity back to a single flow of execution

Decision and Merge Points

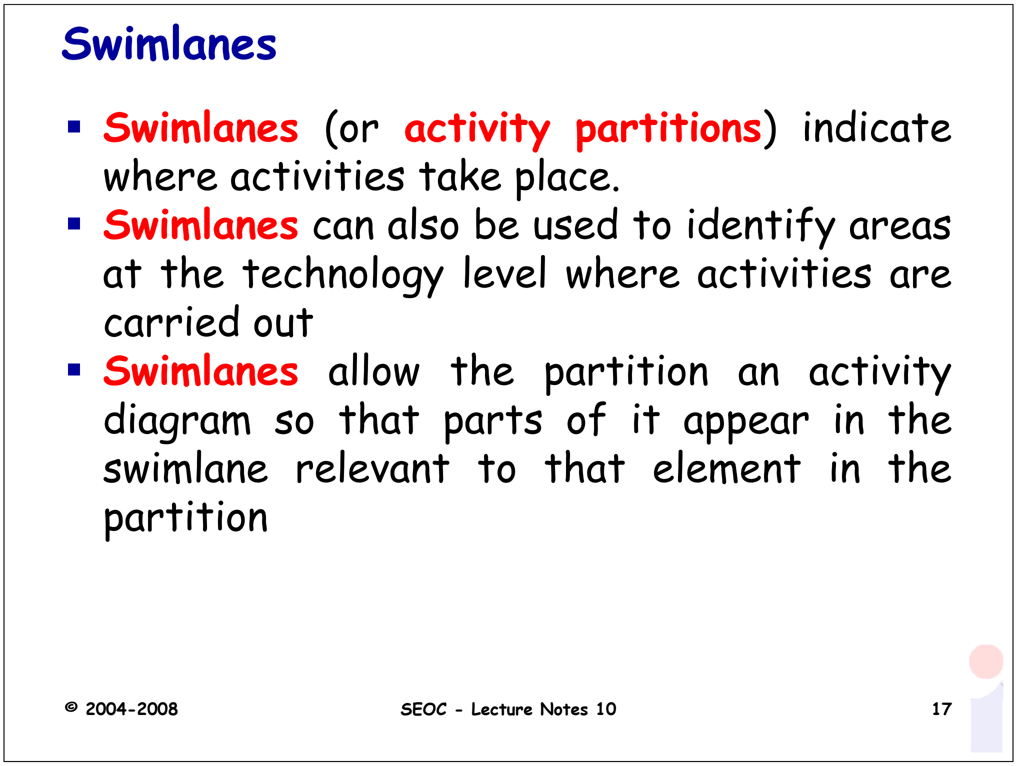
- A **Decision Point** shows where the exit transition from a state or activity may branch in alternative directions depending on a **condition**
- A Decision involves selecting one control-flow transition out of many control-flow transitions based on a condition
- Each branched edge contains a **guard condition**
- **Guard Expressions** (inside []) label the transitions coming out of a branch
- A merge brings together alternate flows into a single output flow – note that it does not synchronize 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
- **Mal-formed diagrams**: it is possible to form ill-formed diagrams that require multiple activations of activities or can allow deadlock

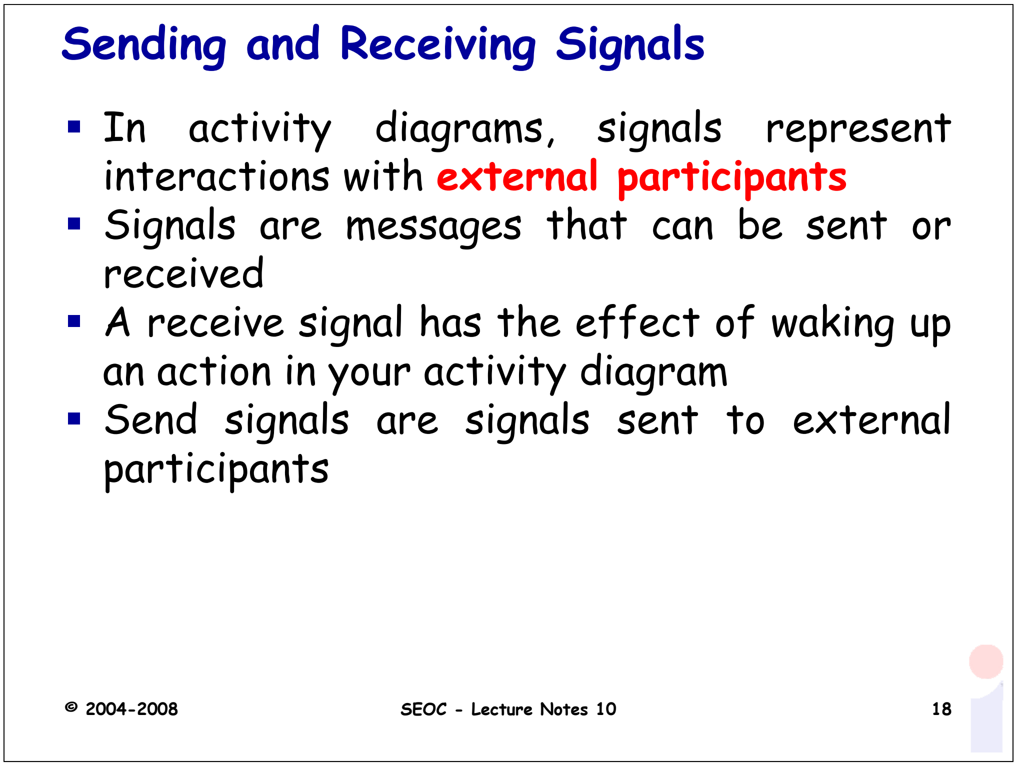


Swimlanes

- **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

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



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

Note that combining send and receive signals results in behavior 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.

Advanced Activity Modeling

- **Connectors**
- UML 2.0 provides supports for modeling **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 queuing 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

Activity Diagrams for Business Modeling

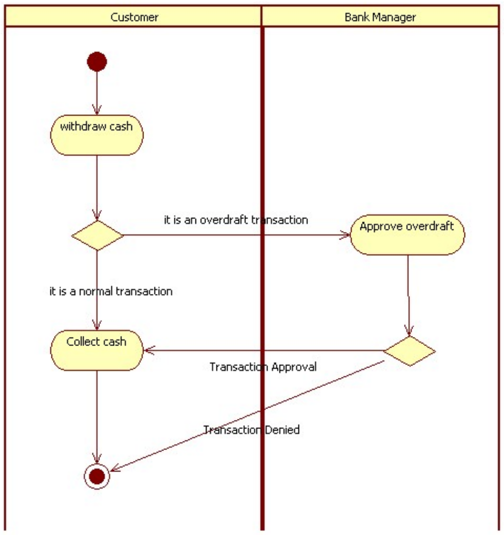
1. Finding **business actors** and **use cases**
2. Identifying key **scenarios** of business use cases
3. Combining the scenarios to produce comprehensive workflows described using **activity diagrams**
4. Where appropriate, mapping activities to business areas and recording this using **swimlines**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

How to construct Activity Diagrams

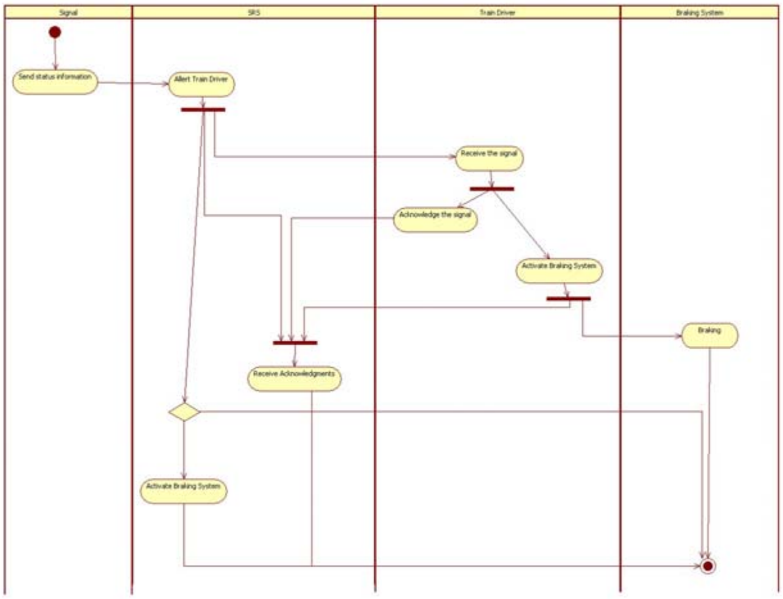
Activity Diagrams for Use Case Modeling

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 behavior is triggered by a workflow, adding **object flows** to the diagrams
5. Where workflows cross technology boundaries, using **swimlines** to map the activities
6. Refining complicated high level activities similarly, **nested activity diagrams**

An Example of Activity Diagram



An Example of Activity Diagram



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