Software Engineering I: Software Technology

WS 2008/09

Refresher Course UML I

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Outline for this Week

- **Tuesday (Today): Modeling Functions, Structure and Behavior**
  - Use case diagrams
  - Class diagrams
  - Sequence diagrams, State chart diagrams, Activity diagrams
- **Thursday: UML 2 updates**
  - Deployment diagrams
  - Stereotypes
  - Profiles
- **Friday: UML 2 Meta model**

Outline for today

- What is UML and why do we use it?
- Functional model
  - Use case diagram
- Object model
  - Class diagram
- Dynamic model
  - Sequence diagram
  - State chart diagram
  - Activity diagram

What is UML?

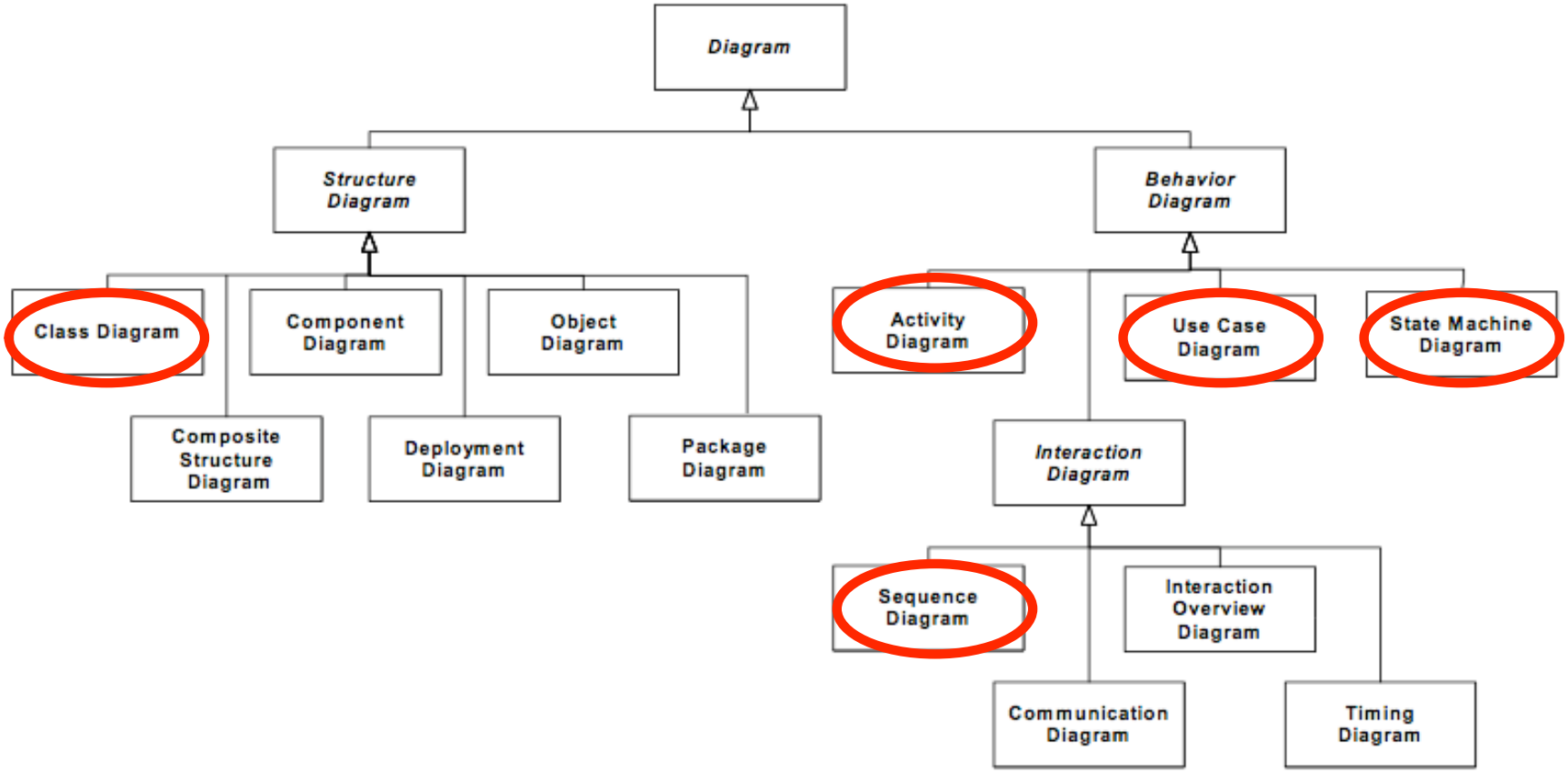
- UML (Unified Modeling Language)
  - Convergence of notations used in object-oriented methods
    - OMT (James Rumbaugh and colleagues)
    - Booch (Grady Booch)
    - OOSE (Ivar Jacobson)
- Current version 2.1.2
  - Information at the UML portal http://www.uml.org/
- Commercial CASE tools: Rational Rose (IBM), Together (Borland), Visual Architect (business processes, BCD)
- Open Source CASE tools: ArgoUML, StarUML, Umbrello
- Commercial as well as Open Source: PoseidonUML (Gentleware)

We use Models to describe Software Systems

- System model: Object model + functional model + dynamic model

- Object model: What is the structure of the system?
  - UML Notation: Class diagrams
- Functional model: What are the functions of the system?
  - UML Notation: Use case diagrams
- Dynamic model: How does the system react to external events?
  - UML Notation: Sequence, State chart and Activity diagrams

Another view on UML Diagrams



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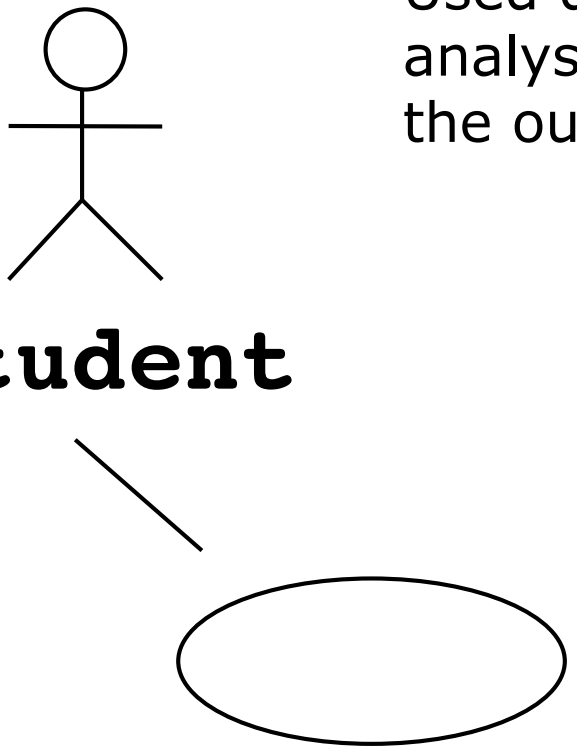
Use Case Diagrams: 3 Important Terms



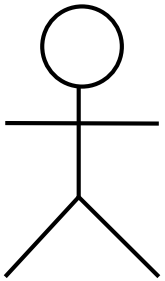
Used during requirements elicitation and analysis to represent behavior visible from the outside of the system

An ***actor*** represents a role, that is, a type of user of the system

A ***use case*** represents a class of functionality provided by the system

Use case model:
The set of all use cases that completely describe the functionality of the system.

Actor



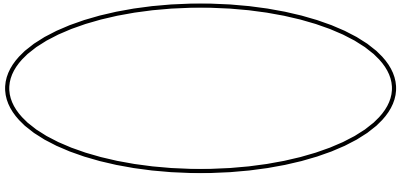
Student

- An actor is a model for an external entity which interacts with the system:
  - EndUser, Administrator
  - External system (Another system)
  - Physical environment (e.g. Weather)
- An actor has a unique name and an optional description
- Examples:
  - **Student**: A studying person
  - **Teaching Assistant**: Member of teaching staff who supports the instructor.
  - **Random Number generator**

Optional Description

Name

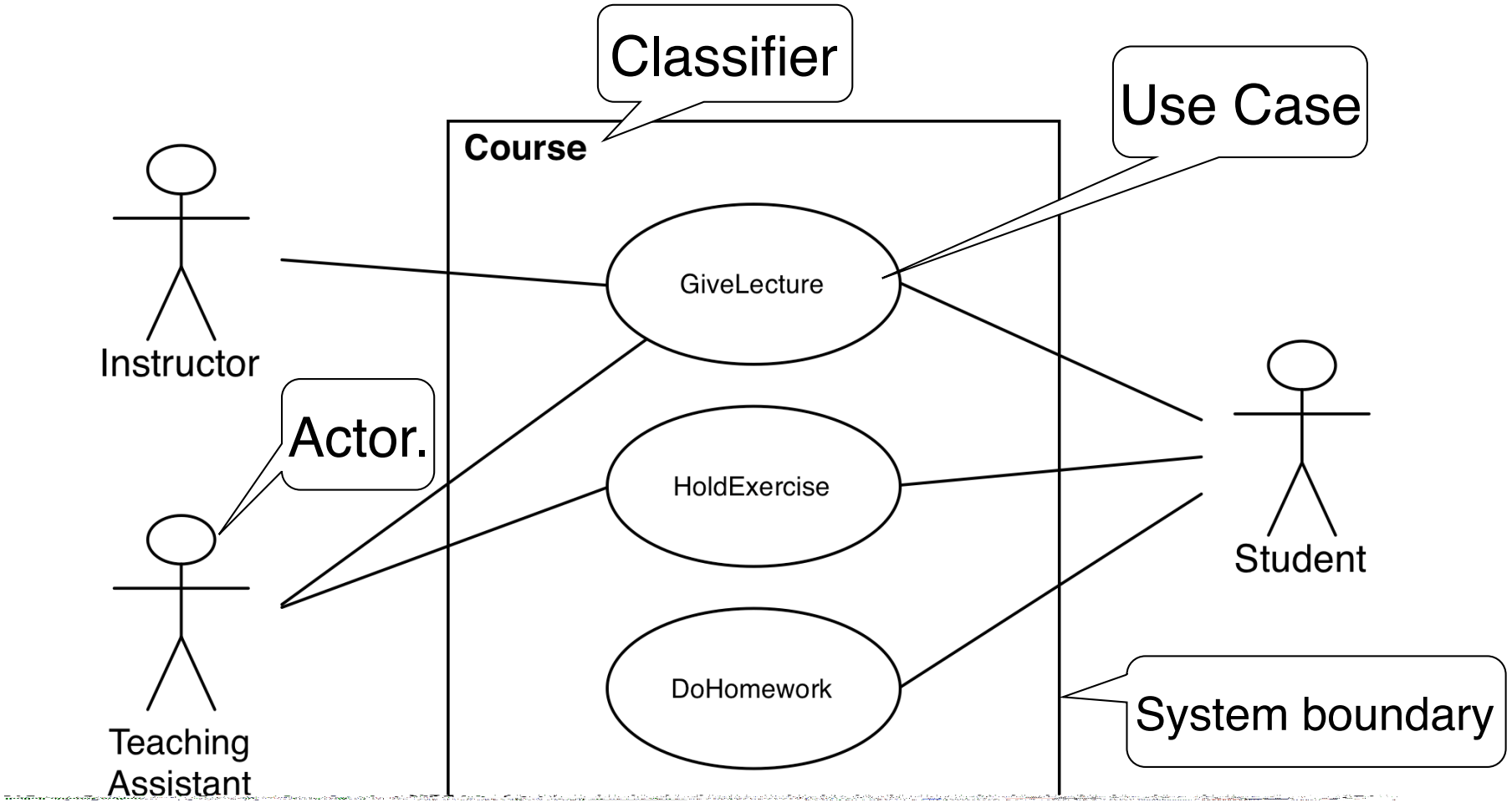
Use Case



DoHomework

- A use case represents a class of functionality provided by the system
- Use cases can be described textually, with a focus on the event flow between actor and system
- The textual use case description consists of 6 parts:
  1. Unique name
  2. Participating actors
  3. Entry conditions
  4. Exit conditions
  5. Flow of events
  6. Special requirements.

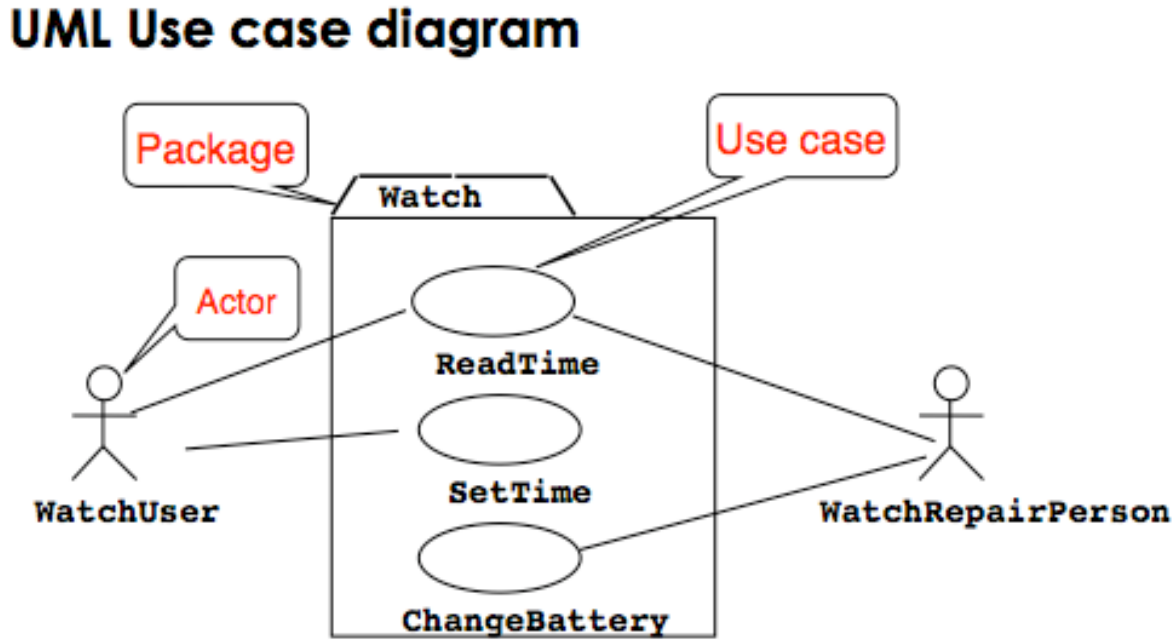
Use Case Model



Use case diagrams represent the functionality of the system from user's point of view

Historical Remark

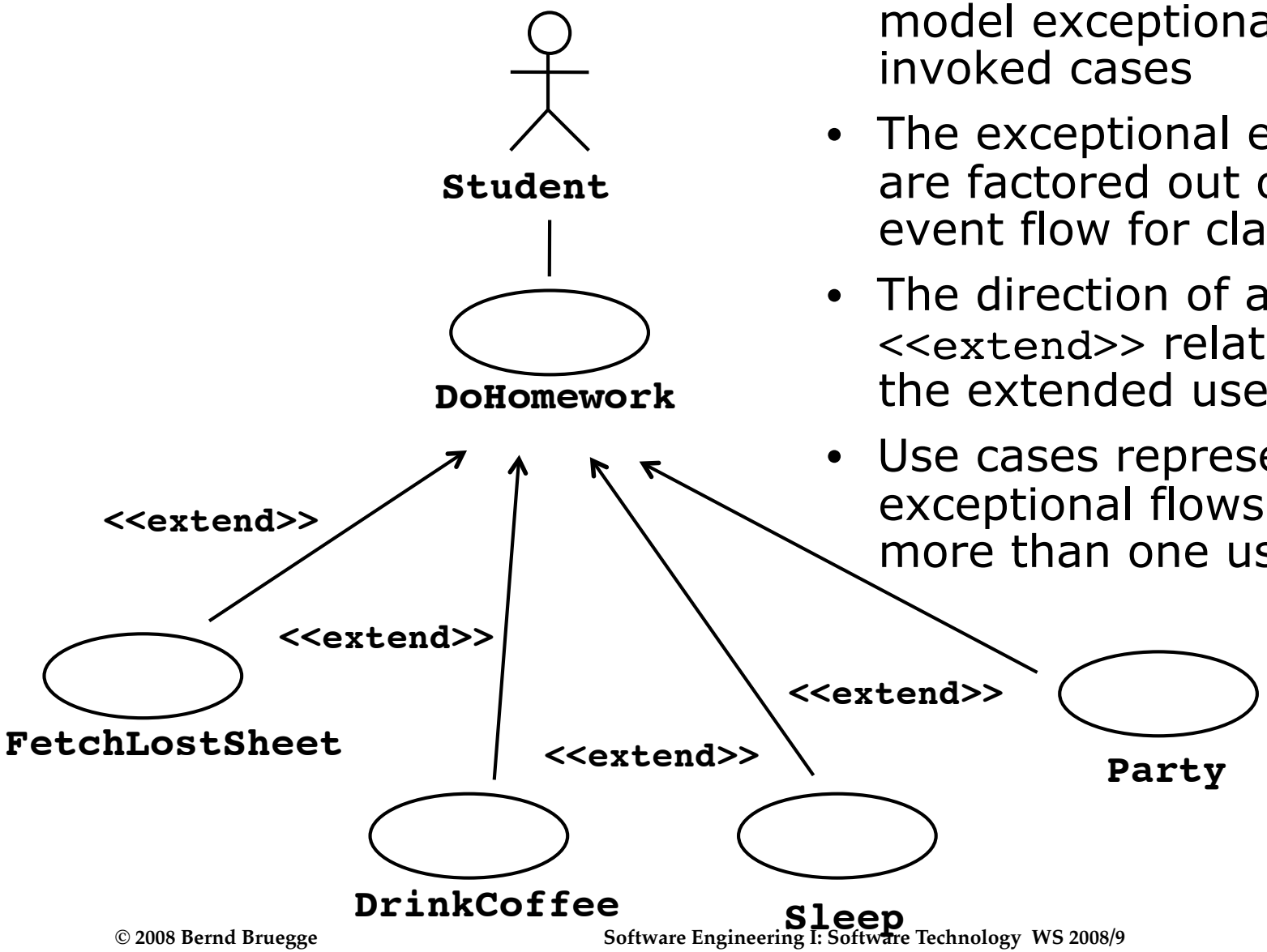
- UML 1: Package Notation
- UML 2: Classifier Notation



Uses Cases can be related

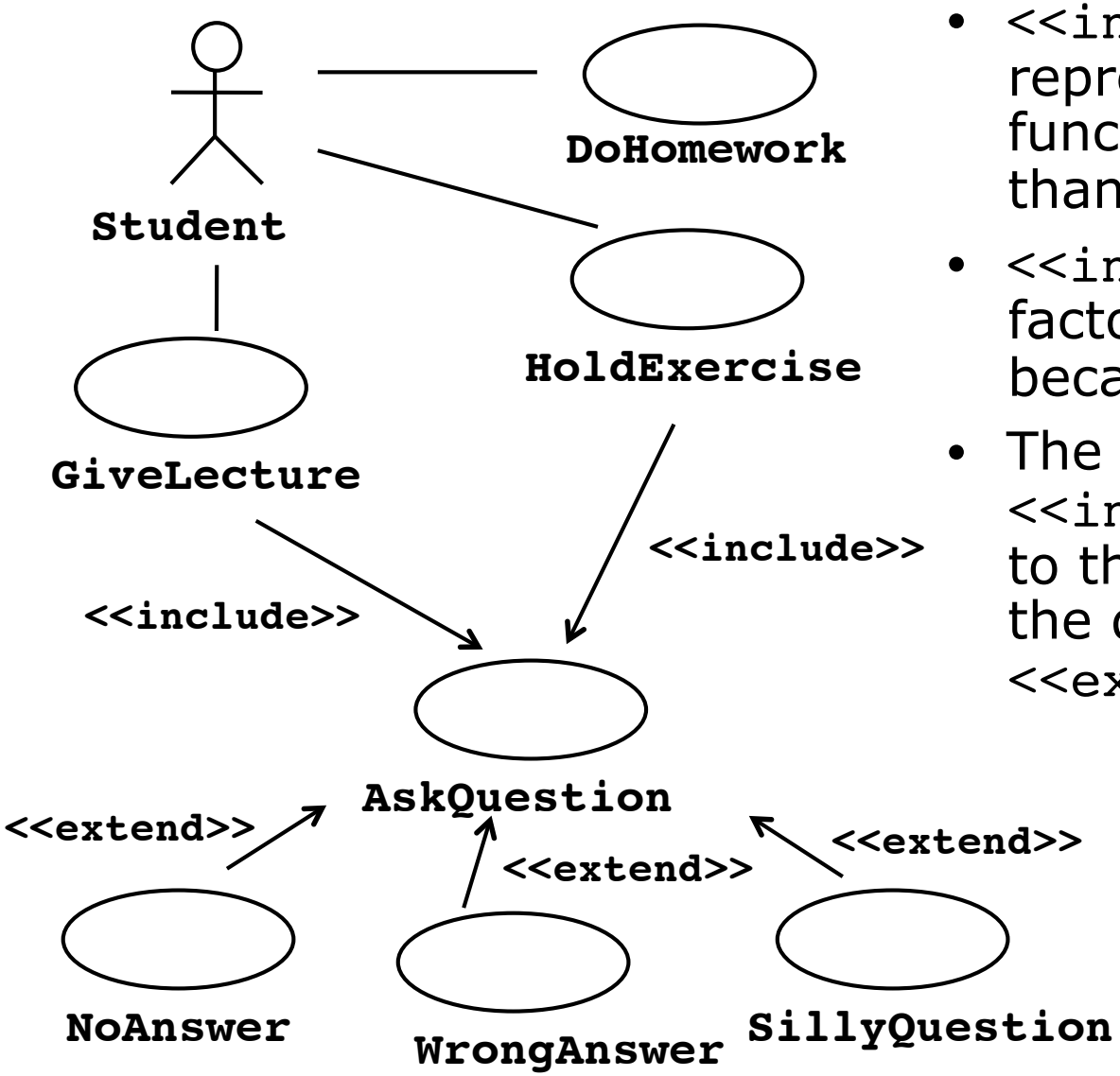
- Extend Relationship
  - To represent seldom invoked use cases or exceptional functionality
- Include Relationship
  - To represent functional behavior common to more than one use case.

The <<*extend*>> Relationship



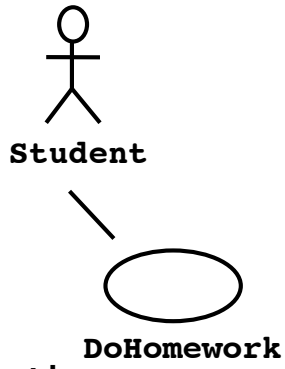
- <<extend>> relationships model exceptional or seldom invoked cases
- The exceptional event flows are factored out of the main event flow for clarity
- The direction of an <<extend>> relationship is to the extended use case
- Use cases representing exceptional flows can extend more than one use case.

The <<*include*>> Relationship



- <<include>> relationship represents common functionality needed in more than one use case
- <<include>> behavior is factored out for reuse, not because it is an exception
- The direction of a <<include>> relationship is to the using use case (unlike the direction of the <<extend>> relationship).

Textual Use Case Description Example



1. Name: `DoHomework`

2. Participating actor:
`Student`

3. Entry condition:

- `Student` received exercise sheet
- `Student` is in good health

4. Exit condition:

- `Student` delivered solution

5. Flow of events:

1. `Student` fetches the exercise sheet
2. `Student` reads through the assignments
3. `Student` processes the assignments and types the solution in his Computer.
4. `Student` prints out the solution
5. `Student` delivers the solution in the following exercise

6. Special requirements:

None.

Where are we now?

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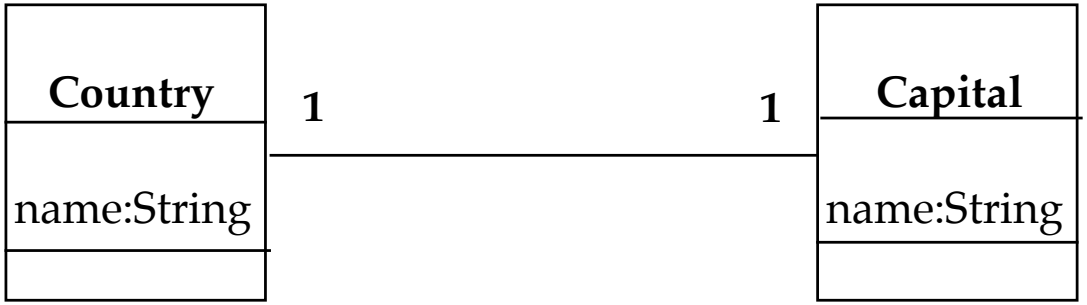
1-to-1 and 1-to-many Associations



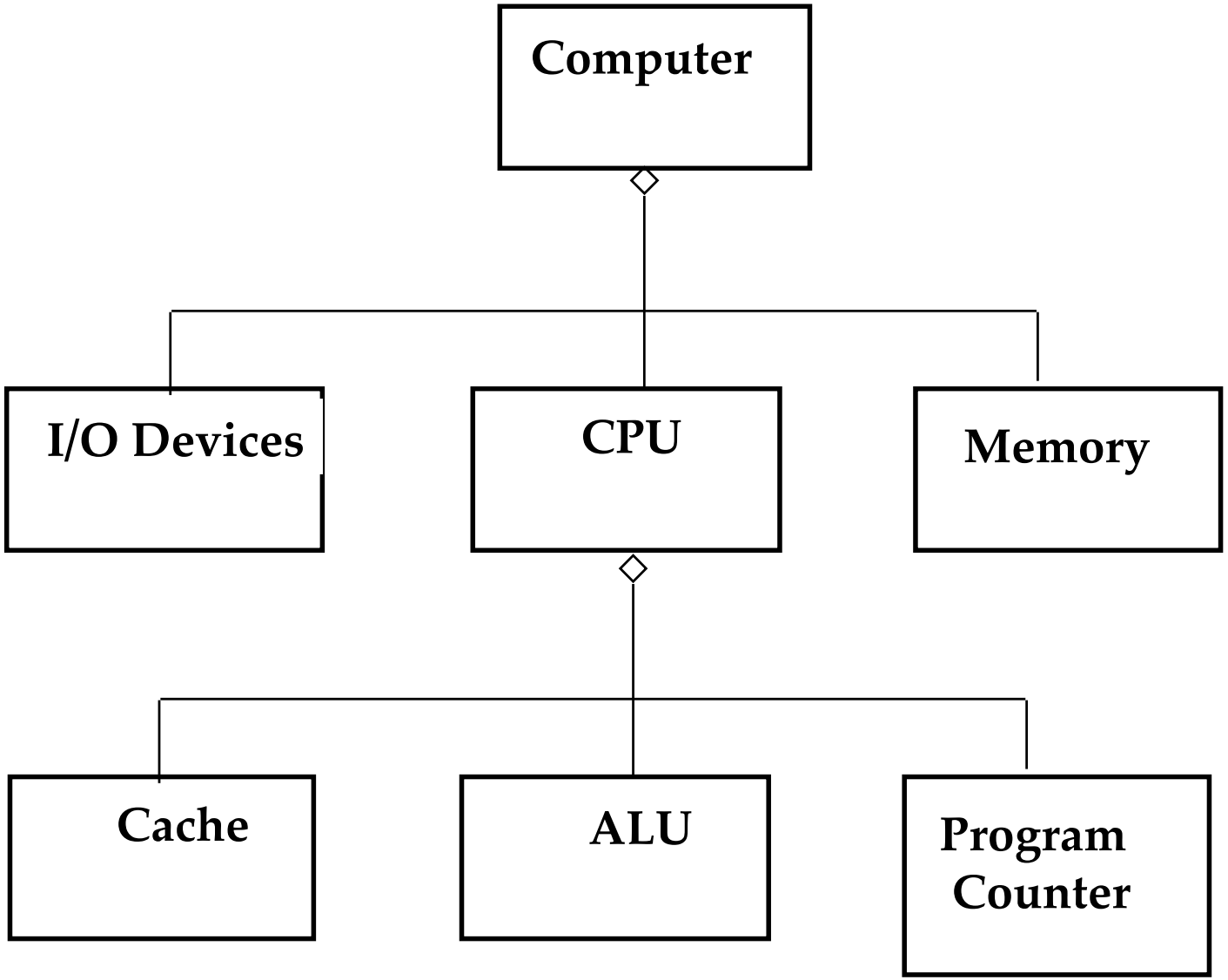
1-to-1 association

1-to-many association

Many-to-many Associations

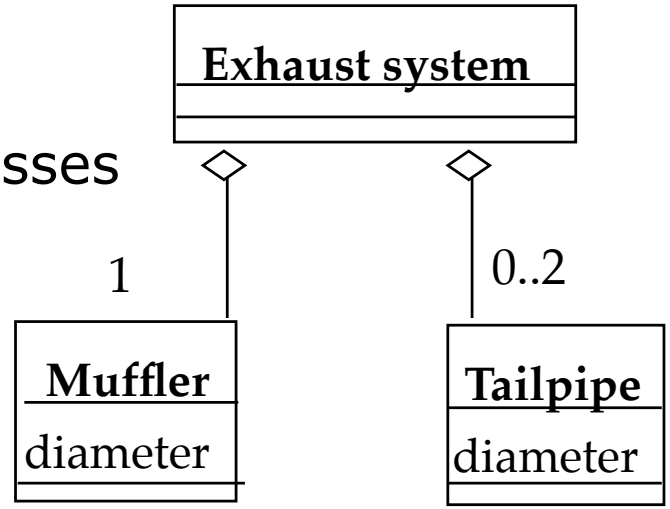
- A stock exchange lists many companies.
- Each company is identified by a ticker symbol

Part-of Hierarchy (Aggregation)

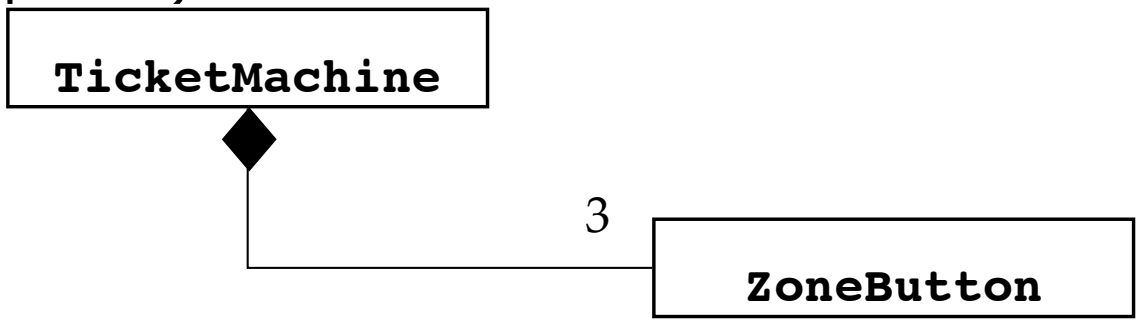


Aggregation

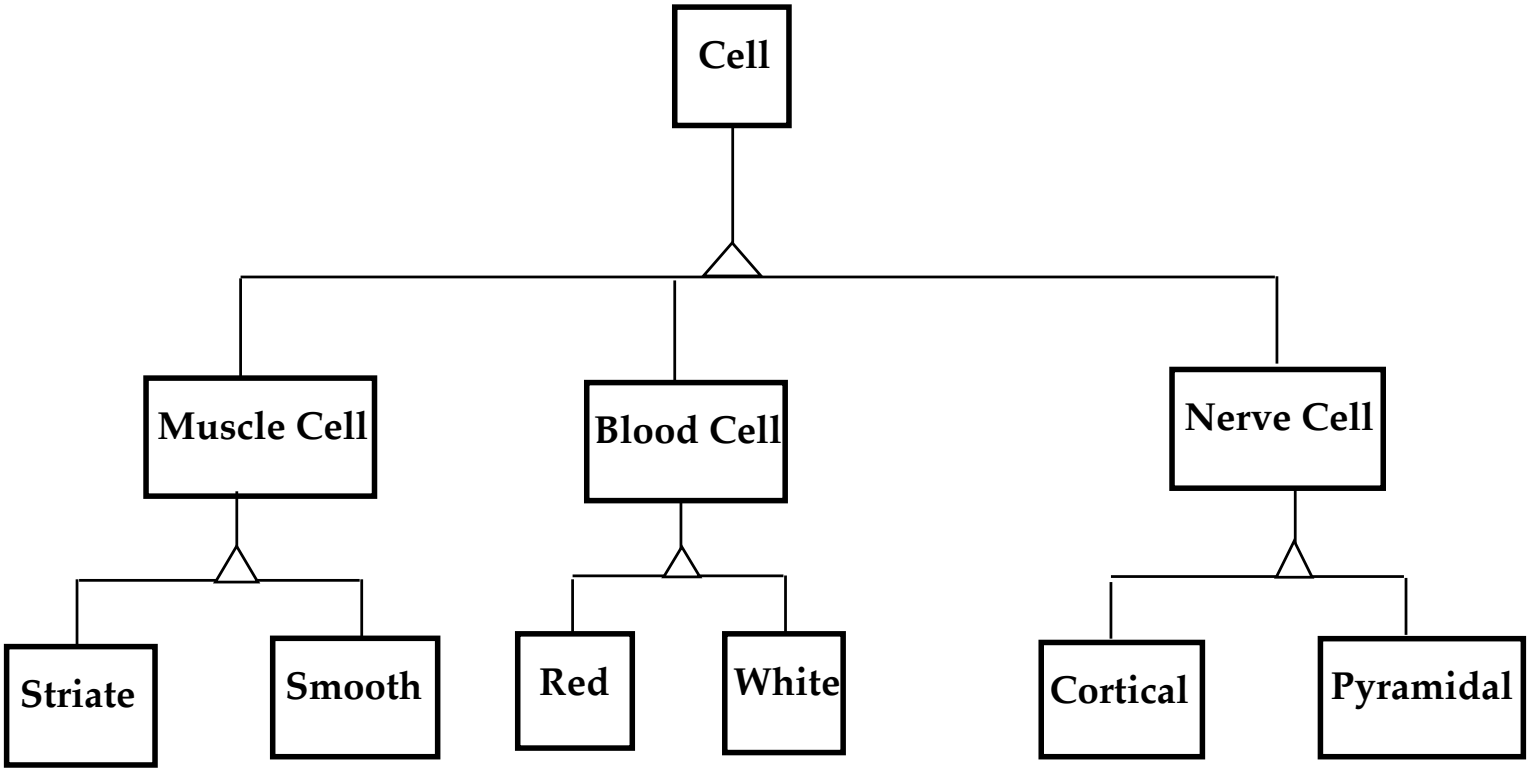
- An *aggregation* is a special case of association denoting a "consists-of" hierarchy
- The *aggregate* is the parent class, the components are the children classes



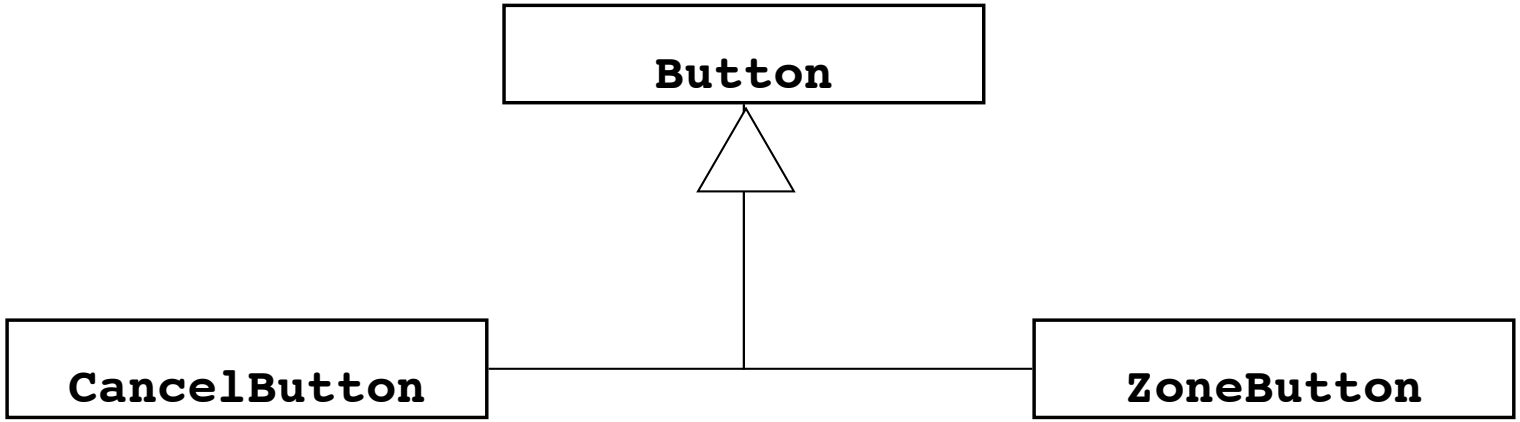
A solid diamond denotes *composition*: A strong form of aggregation where the *life time of the component instances* is controlled by the aggregate ("the whole controls/ destroys the parts")



Is-Kind-of Hierarchy (Taxonomy)

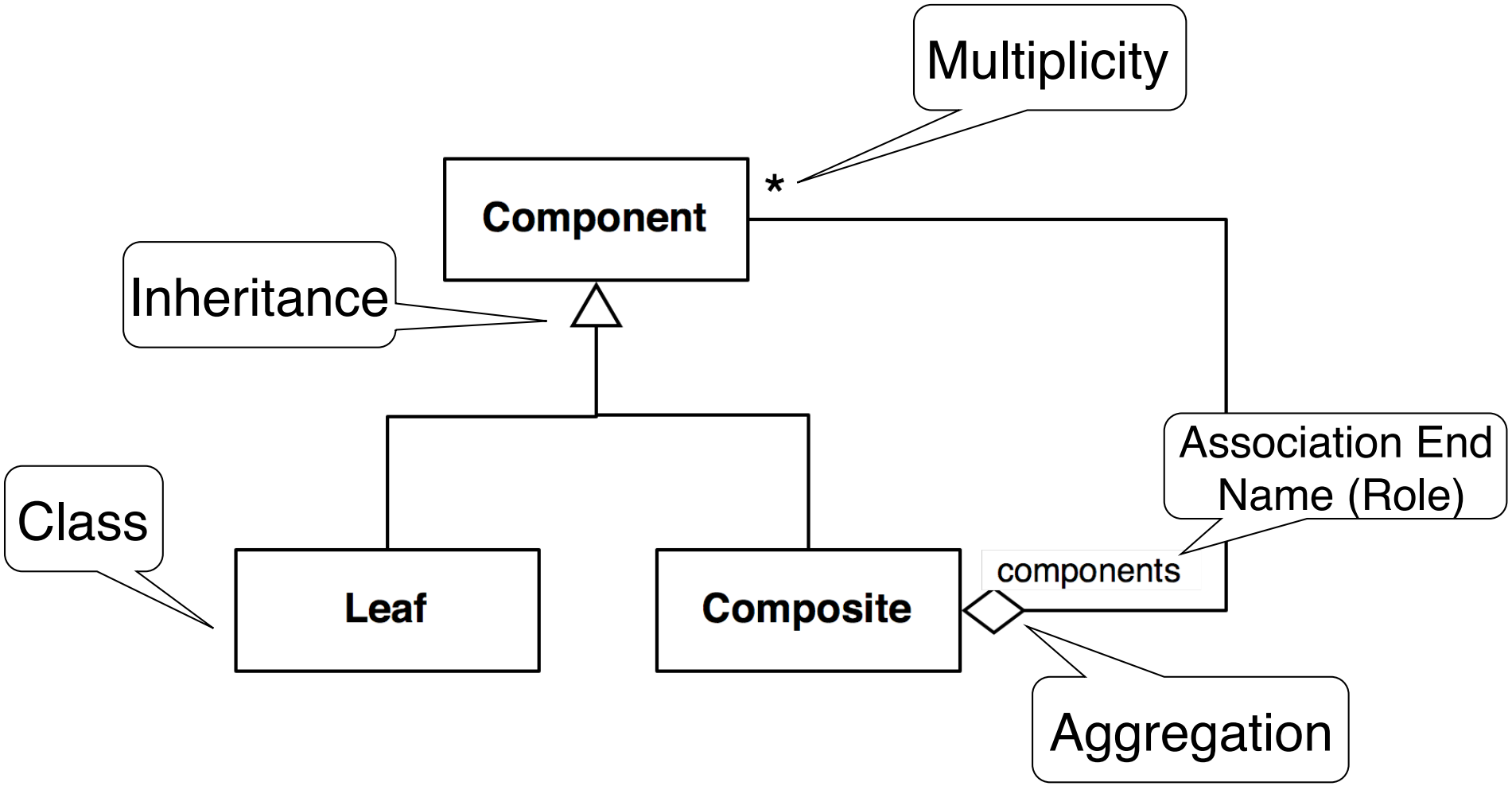


Inheritance



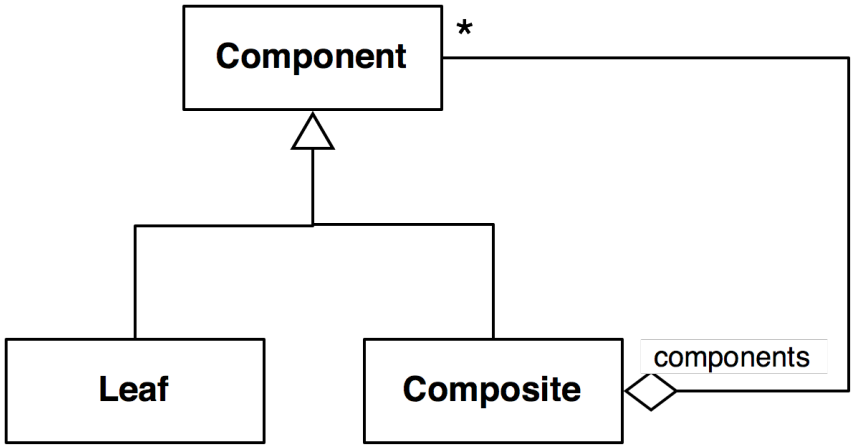
- *Inheritance* is another special case of an association denoting a "kind-of" hierarchy
- Inheritance simplifies the analysis model by introducing a taxonomy
- The **children classes** inherit the attributes and operations of the **parent class.**

Class diagram: Basic Notations



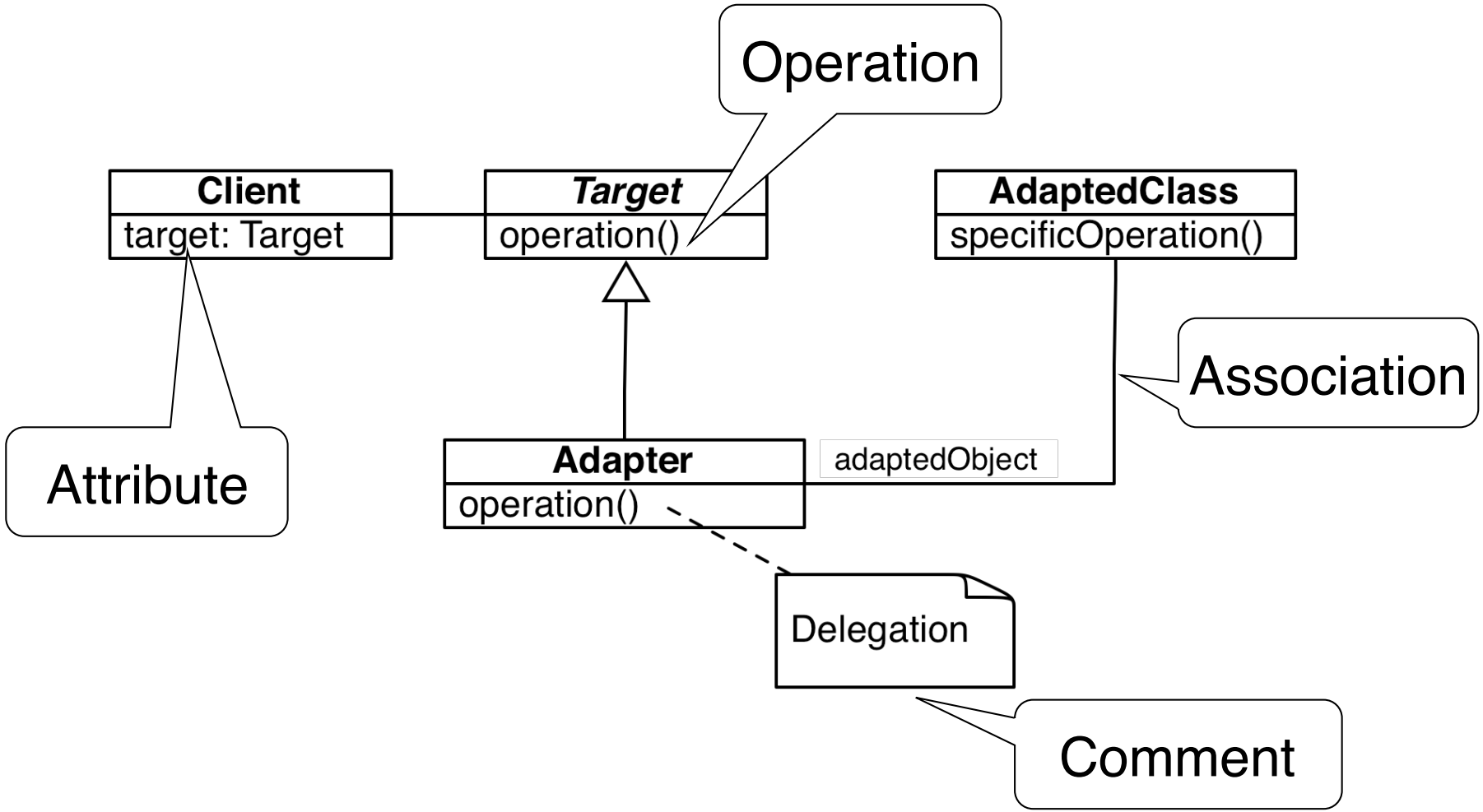
Class diagrams represent the structure of the system

Code Generation from UML to Java I

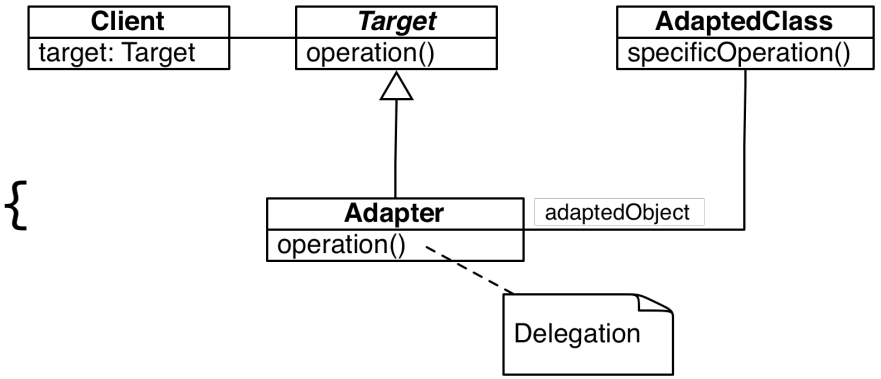



```
public class Component{  }

public class Leaf extends
  Component{  }

public class Composite
  extends Component{
  private
  Collection<Component>
  components;
  …
}
```

Class diagram: Basic Notations



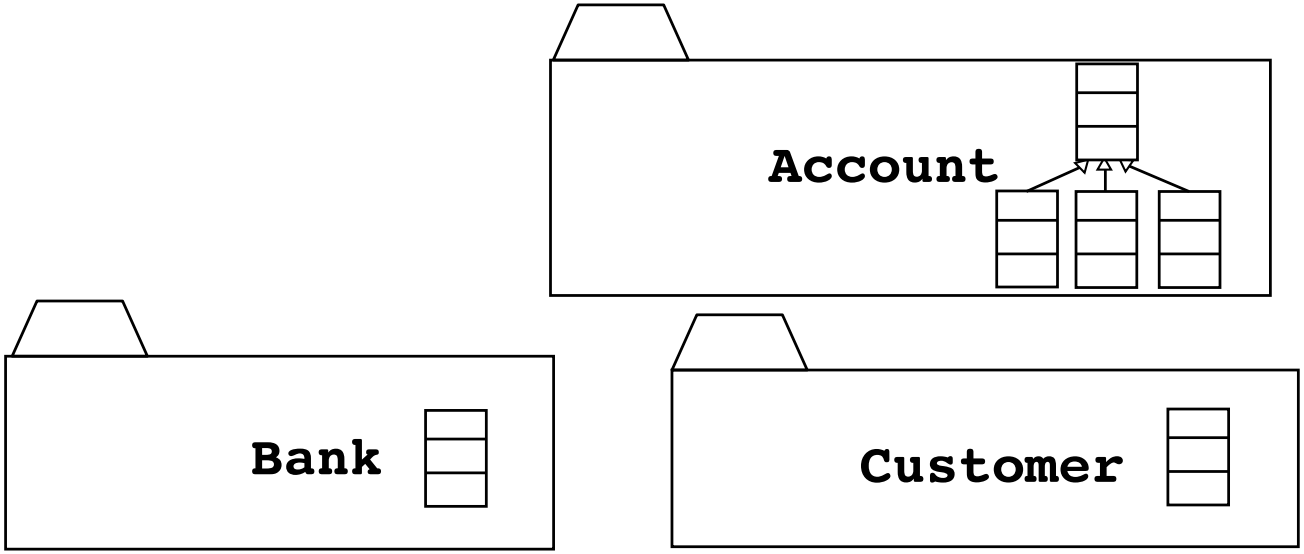
Code Generation from UML to Java II




```
public abstract class Target{
  public … operation(); }

public class Adapter extends Target {
  private AdaptedClass adaptedObject;
  public … operation(){
   adaptedObject.specificOperation();
  }
```

Excursion: Packages

- Packages help you to organize UML models to increase their readability
- We can use the UML package mechanism to organize classes into subsystems



- Any complex system can be decomposed into subsystems, where each subsystem is modeled as a package.

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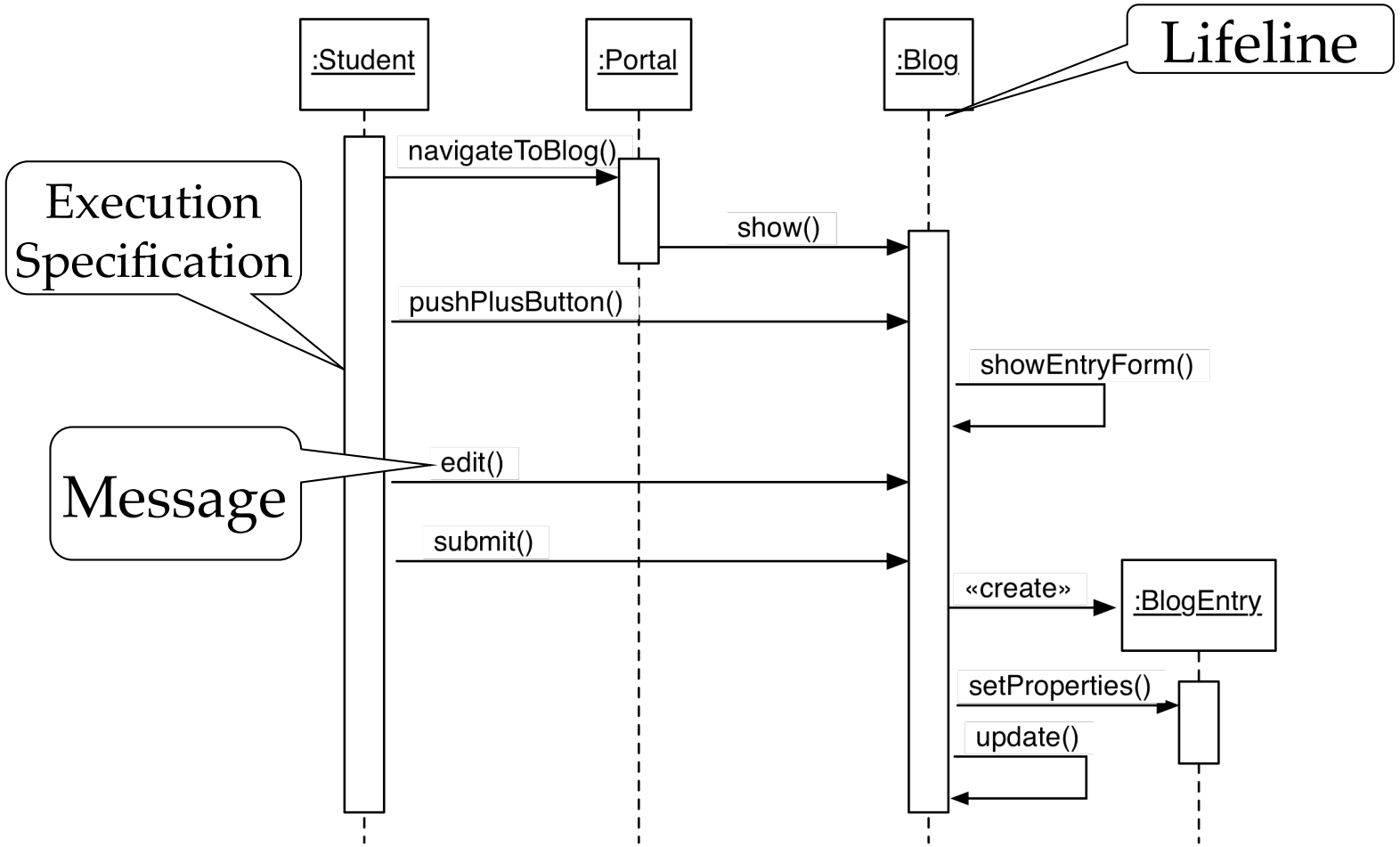
Example for the use of sequence diagrams

- Possibility to ask questions
- You have to be member of the sews08 group
- Post question as new blog entry

Sequence diagram: Basic Notations



Sequence diagrams represent the behavior of a system as messages ("interactions") between *different objects*.

Lifeline and Execution Specification

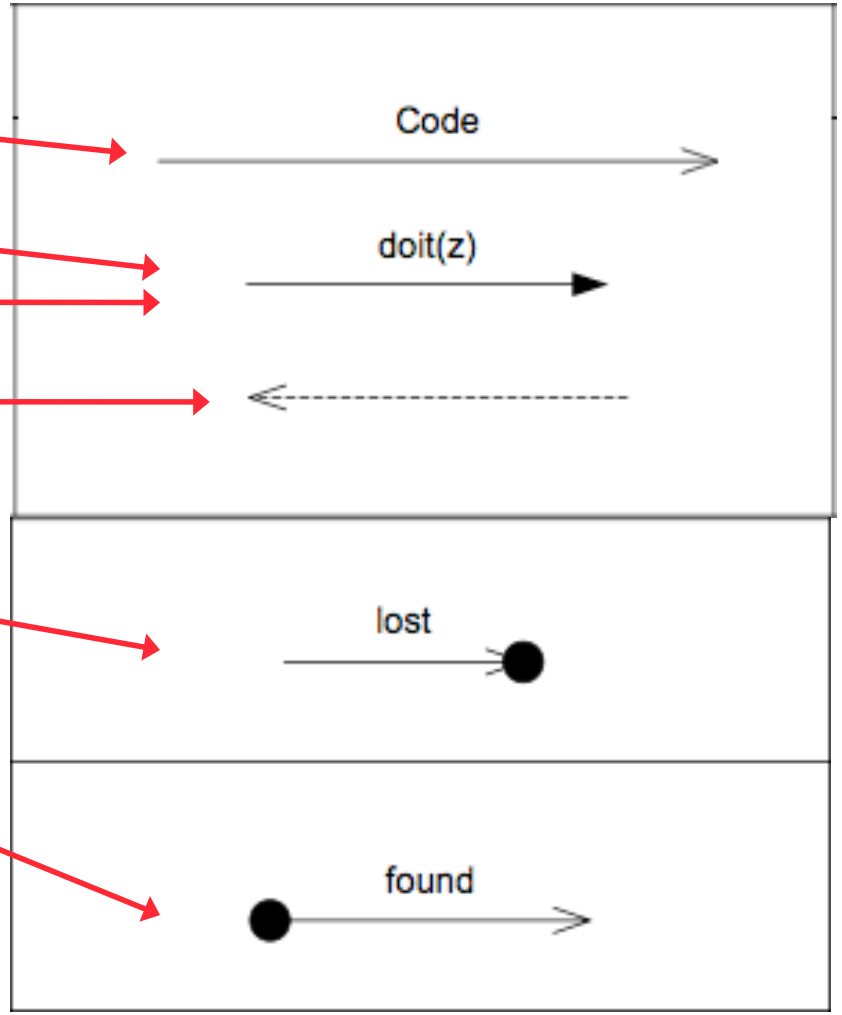
- A **lifeline** represents an individual participant (or object) in the interaction
- A lifeline is shown using a symbol that consists of a rectangle forming its "head" followed by a vertical line (which may be dashed) that represents the lifetime of the participant
- An **execution specification** specifies a behavior or interaction within the lifeline
- An execution specification is represented as a thin rectangle on the lifeline.

Messages

- Define a particular communication between lifelines of an interaction
- Examples of communication
  - raising a signal
  - invoking an operation
  - creating or destroying an instance
- Specify (implicitly) sender and receiver
- are shown as a line from the sender to the receiver
- Form of line and arrowhead reflect message properties

Message Types

- Asynchronous
- Synchronous
- Call and Object creation
- Reply
- Lost
- Found



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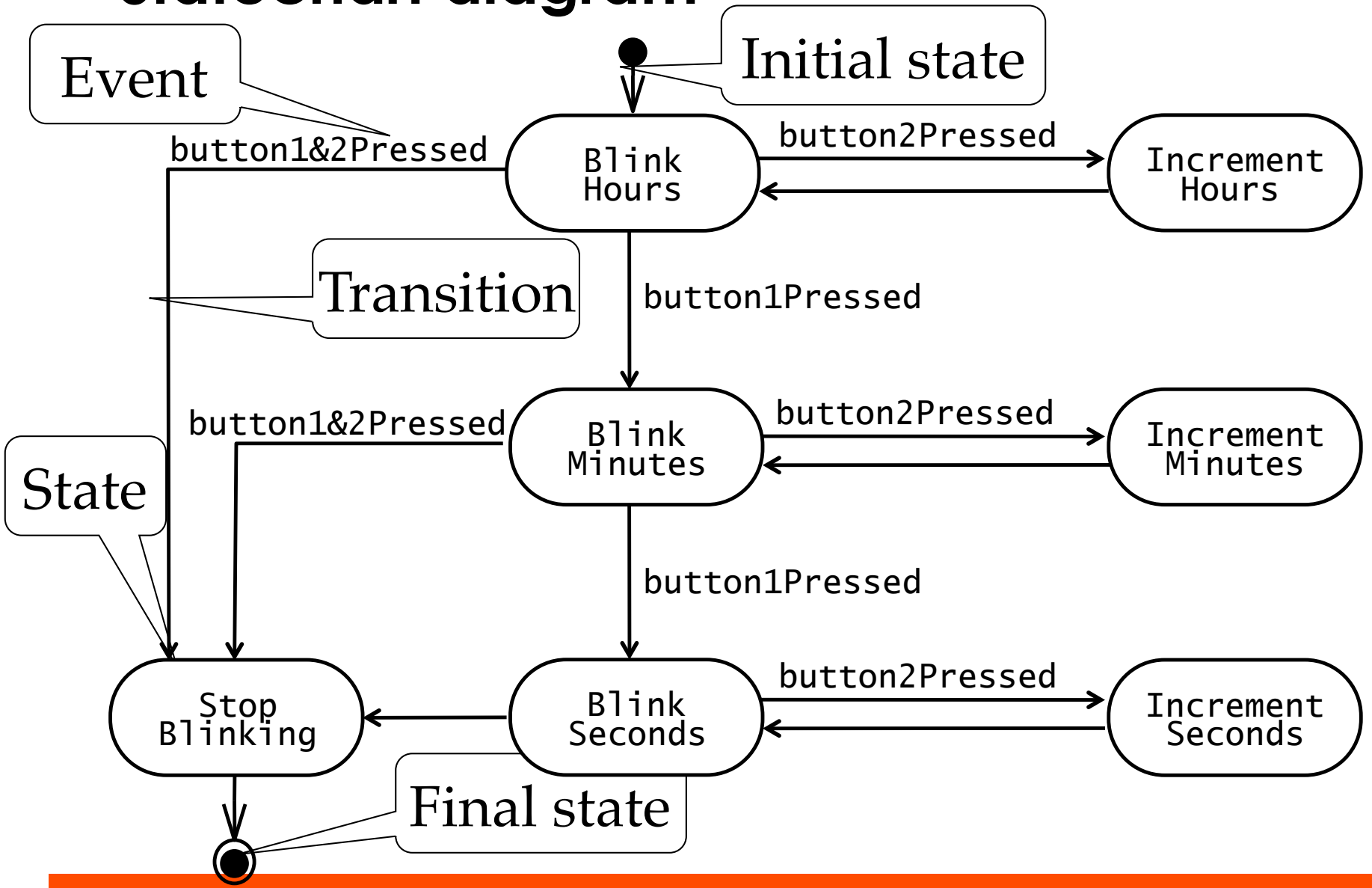
Statechart diagram

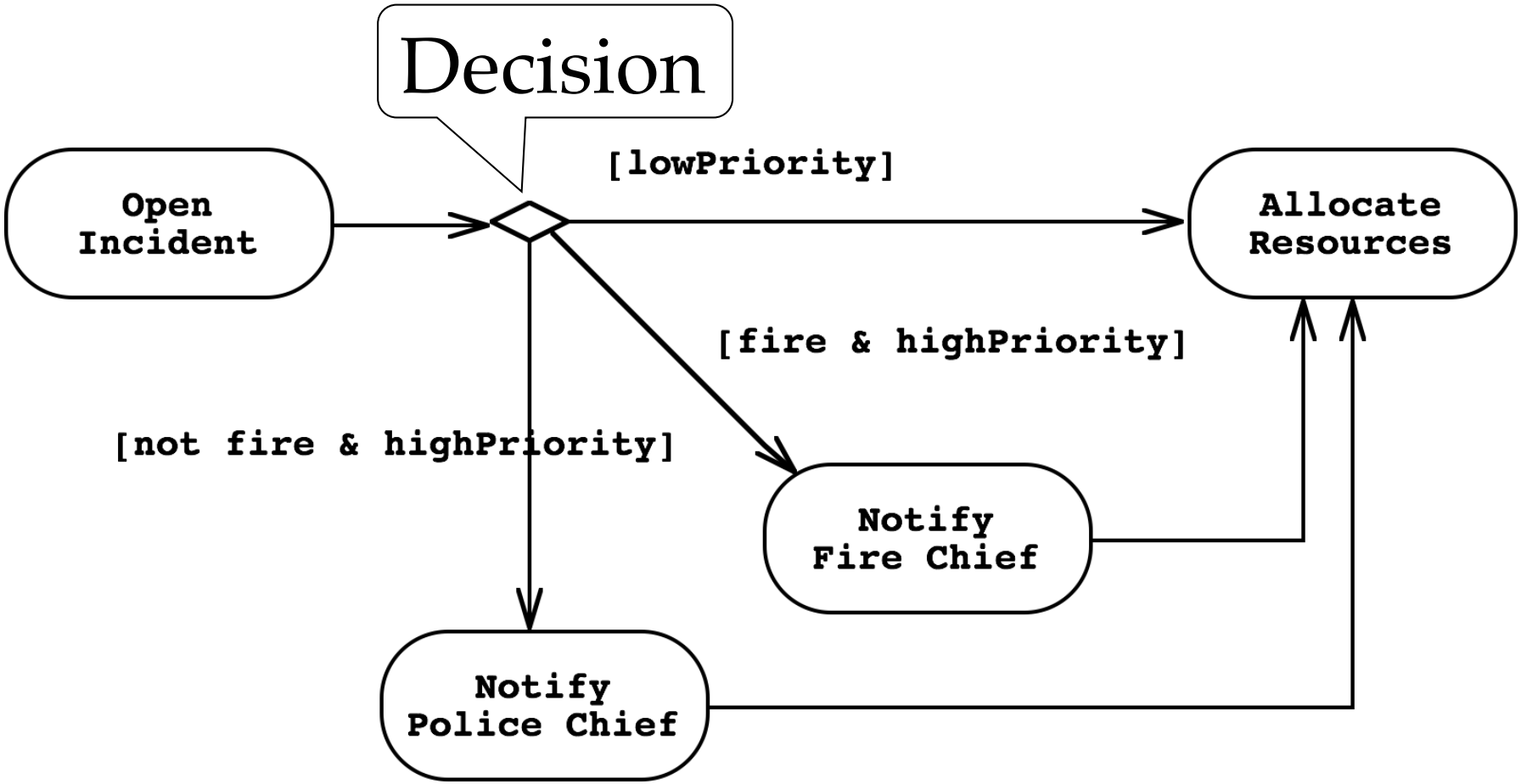


Represents behavior of *a single object* with interesting dynamic behavior.

Activity Diagrams

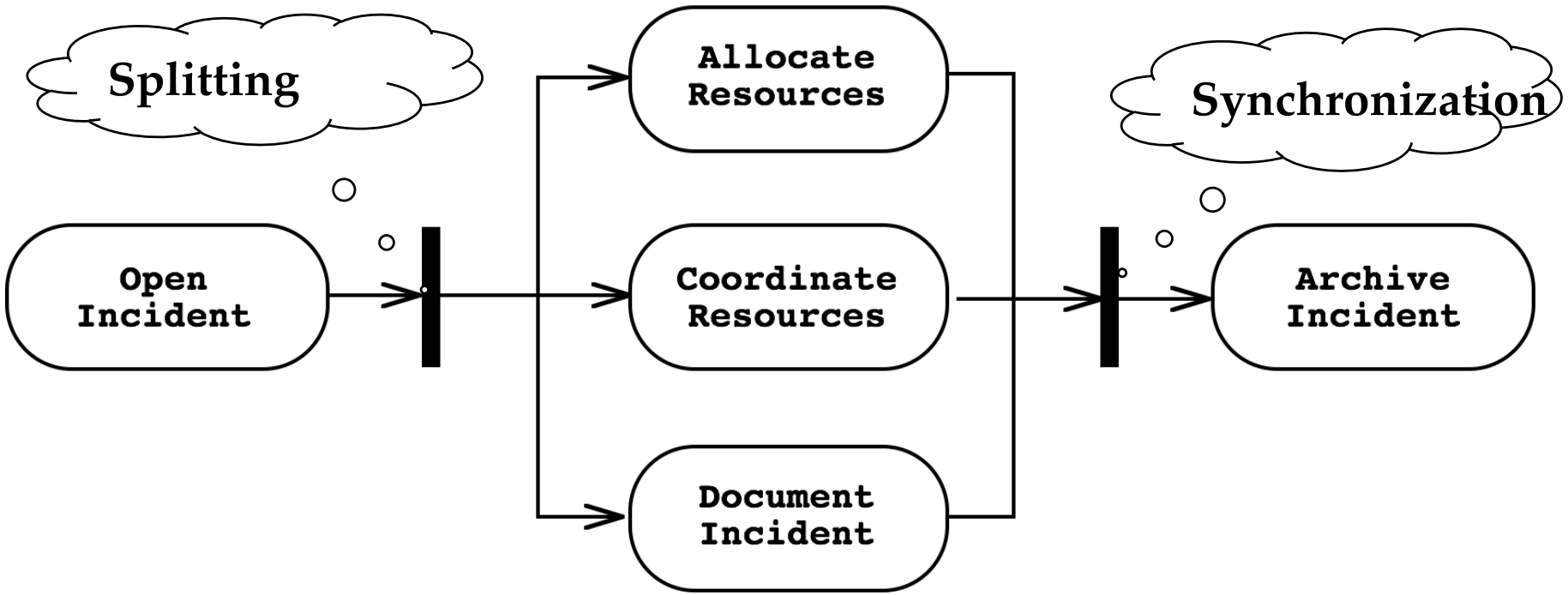
- An activity diagram is a special case of a state chart diagram
- The states are activities ("functions")
- An activity diagram is useful to depict the workflow in a system.

Activity Diagrams allow to model Decisions



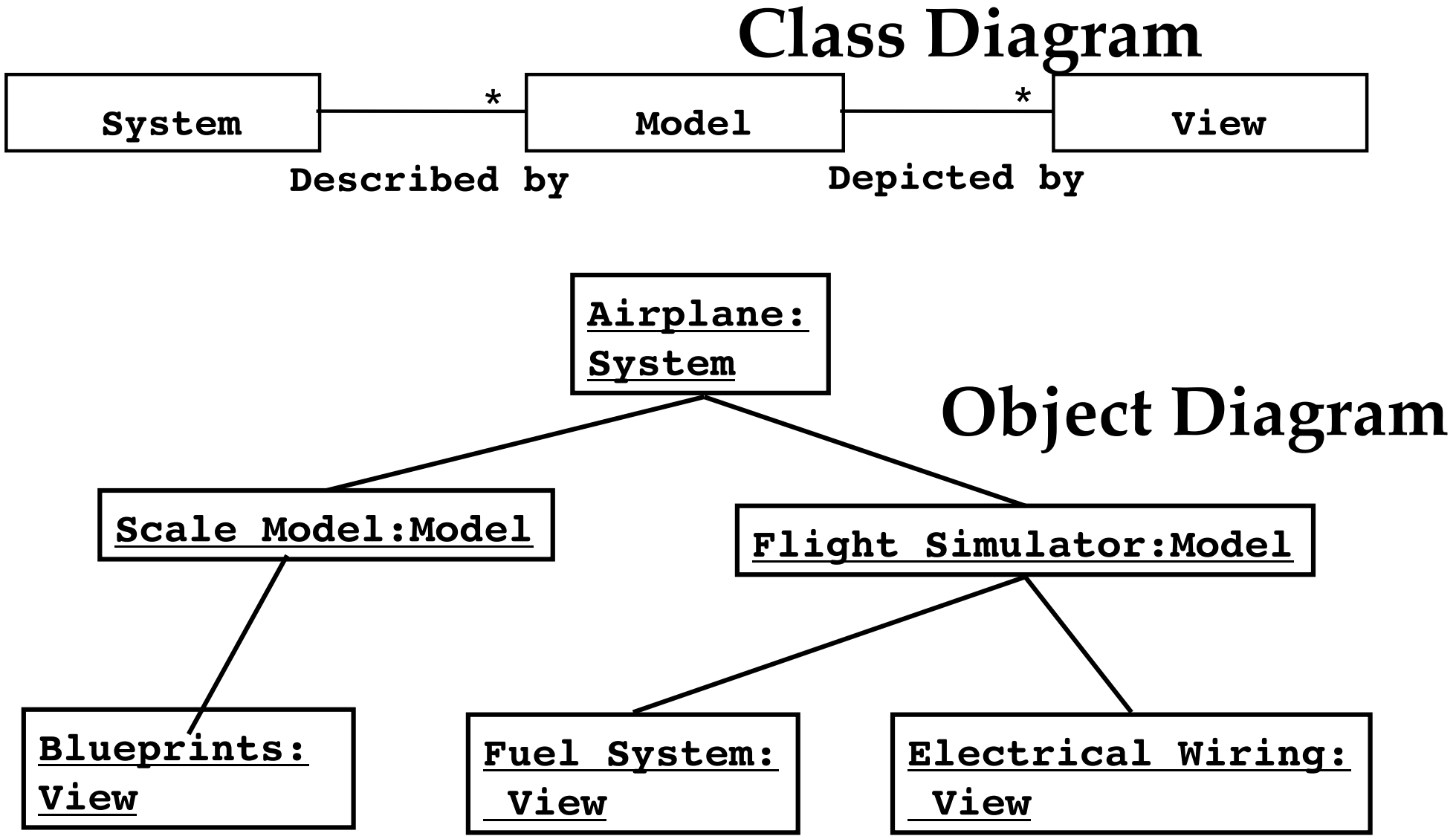
Activity Diagrams can model Concurrency

- Synchronization of multiple activities
- Splitting the flow of control into multiple threads



Backup Slides

Systems, Models and Views (UML Notation)



Model-driven Software Development

Reality: A stock exchange lists many companies. Each company is identified by a ticker symbol

Analysis results in analysis object model (UML Class diagram):

Implementation results in source code (Java):

```
public class StockExchange {
    public m_Company = new Vector();
  };
public class Company  {
  public int m_tickerSymbol;
  public Vector m_StockExchange = new Vector();
};
```

Model-Driven Development

1. Build a platform-independent model of an applications functionality and behavior
   a) Describe model in modeling notation (UML)
   b) Convert model into platform-specific model
2. Generate executable from platform-specific model

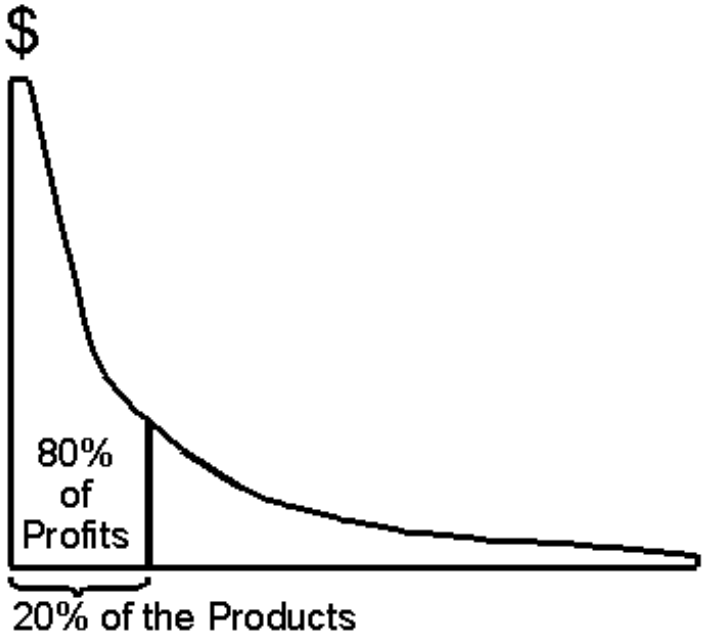
Advantages:

- Code is generated from model ("mostly")
- Portability and interoperability

- Model Driven Architecture effort:
  - http://www.omg.org/mda/
- OMG: Object Management Group

UML: First Pass

- You can solve 80% of the modeling problems by using 20 % UML
- We teach you those 20%
- 80-20 rule: Pareto principle



Vilfredo Pareto, 1848-1923
Introduced the concept of Pareto Efficiency,
Founder of the field of microeconomics.