Chapter 2, lecture 1, Modeling with UML
Overview: modeling with UML

- What is modeling?
- What is UML?
- Use case diagrams
- Class diagrams
- Sequence diagrams
What is modeling?

♦ Modeling consists of building an abstraction of reality.
♦ Abstractions are simplifications because:
  ♦ They ignore irrelevant details and
  ♦ They only represent the relevant details.
♦ What is relevant or irrelevant depends on the purpose of the model.
Example: street map
Why model software?

Software is getting increasingly more complex
  - Windows XP > 40 mio lines of code
  - A single programmer cannot manage this amount of code in its entirety.

Code is not easily understandable by developers who did not write it

We need simpler representations for complex systems
  - Modeling is a mean for dealing with complexity
**Systems, Models and Views**

- A **model** is an abstraction describing a subset of a system
- A **view** depicts selected aspects of a model
- A **notation** is a set of graphical or textual rules for depicting views
- Views and models of a single system may overlap each other

Examples:
- System: Aircraft
- Models: Flight simulator, scale model
- Views: All blueprints, electrical wiring, fuel system
**Systems, Models and Views**

- **System**
  - **Model 1**
    - **View 1**
    - **View 2**
    - **View 3**
  - **Model 2**

- **Views**
  - **View 1**
  - **View 2**
  - **View 3**

- **Models**
  - **Model 1**
  - **Model 2**

- **Systems**
  - **Aircraft**
  - **Flightsimulator**
  - **Blueprints**
  - **Scale Model**
  - **Electrical Wiring**
Models, Views and Systems (UML)
Concepts and Phenomena

Phenomenon

- An object in the world of a domain as you perceive it
- *Example:* The lecture you are attending
- *Example:* My black watch

Concept

- Describes the properties of phenomena that are common.
- *Example:* Lectures on software engineering
- *Example:* Black watches

Concept is a 3-tuple:

- Name (To distinguish it from other concepts)
- Purpose (Properties that determine if a phenomenon is a member of a concept)
- Members (The set of phenomena which are part of the concept)
Concepts and phenomena

<table>
<thead>
<tr>
<th>Name</th>
<th>Purpose</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock</td>
<td>A device that measures time.</td>
<td>Clock, Timer, Sandglass</td>
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- Abstraction
  - Classification of phenomena into concepts
- Modeling
  - Development of abstractions to answer specific questions about a set of phenomena while ignoring irrelevant details.
Concepts in software: Type and Instance

♦ Type:
  - An abstraction in the context of programming languages
  - Name: int, Purpose: integral number, Members: 0, −1, 1, 2, −2, . . .

♦ Instance:
  - Member of a specific type
  - The type of a variable represents all possible instances the variable can take

The following relationships are similar:
  - “type” ←→ “instance”
  - “concept” ←→ “phenomenon”
Abstract Data Types & Classes

♦ Abstract data type
  ♦ Special type whose implementation is hidden from the rest of the system.

♦ Class:
  ♦ An abstraction in the context of object-oriented languages

♦ Like an abstract data type, a class encapsulates both state (variables) and behavior (methods)
  ♦ Class Vector

♦ Unlike abstract data types, classes can be defined in terms of other classes using inheritance
Application and Solution Domain

♦ Application Domain (Requirements Analysis):
  ♦ The environment in which the system is operating

♦ Solution Domain (System Design, Object Design):
  ♦ The available technologies to build the system
Object-oriented modeling

Application Domain

Application Domain Model

TrafficControl

Aircraft

FlightPlan

TrafficController

Airport

Solution Domain

System Model

UML Package

SummaryDisplay

MapDisplay

FlightPlanDatabase

TrafficControl
What is UML?

♦ UML (Unified Modeling Language)
  ♦ An emerging standard for modeling object-oriented software.
  ♦ Resulted from the convergence of notations from three leading object-oriented methods:
    ♦ OMT (James Rumbaugh)
    ♦ OOSE (Ivar Jacobson)
    ♦ Booch (Grady Booch)

♦ Supported by several CASE tools
  ♦ Rational ROSE
  ♦ TogetherJ
**UML: First Pass**

- You can model 80% of most problems by using about 20% UML
- We teach you those 20%
UML First Pass

- Use case Diagrams
  - Describe the functional behavior of the system as seen by the user.
- Class diagrams
  - Describe the static structure of the system: Objects, Attributes, Associations
- Sequence diagrams
  - Describe the dynamic behavior between actors and the system and between objects of the system
- Statechart diagrams
  - Describe the dynamic behavior of an individual object (essentially a finite state automaton)
- Activity Diagrams
  - Model the dynamic behavior of a system, in particular the workflow (essentially a flowchart)
Use case diagrams represent the functionality of the system from user’s point of view
UML first pass: Class diagrams

Class diagrams represent the structure of the system.
UML first pass: Sequence diagram

Sequence diagrams represent the behavior as interactions
UML first pass: Statechart diagrams for objects with interesting dynamic behavior

Statechart diagrams represent behavior as states and transitions. Each state is connected to other states by transitions triggered by specific events. The initial state is where the object starts, and a final state indicates a completed state transition.
UML Summary

♦ UML provides a wide variety of notations for representing many aspects of software development
  ♦ Powerful, but complex language
  ♦ Can be misused to generate unreadable models
  ♦ Can be misunderstood when using too many exotic features

♦ For now we concentrate on a few notations:
  ♦ Functional model: Use case diagram
  ♦ Object model: class diagram
  ♦ Dynamic model: sequence diagrams, statechart and activity diagrams