UML Examples

Fawzi Emad
Chau-Wen Tseng

Department of Computer Science
University of Maryland, College Park

UML Class Diagrams

- Represent the (static) structure of the system

  **General** | **In Java**
  --- | ---
  Name | Name
  State | Variables
  Behavior | Methods

![Class Diagram Example](chart.png)
Relationships Between Classes

- **Association**
  - Permanent, structural, “has a”
  - Solid line (arrowhead optional)

- **Dependency**
  - Temporary, “uses a”
  - Dotted line with arrowhead

- **Generalization**
  - Inheritance, “is a”
  - Solid line with open (triangular) arrowhead

- **Implementation**
  - Dotted line with open (triangular) arrowhead

### Association

- Denotes permanent, structural relationship
- State of class A contains class B
- Represented by solid line (arrowhead optional)

```
<table>
<thead>
<tr>
<th>Car</th>
<th>Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>running:bool</td>
<td>curRPM:int</td>
</tr>
<tr>
<td>myEngine:Engine</td>
<td>running:bool</td>
</tr>
<tr>
<td>start()</td>
<td>accelerate()</td>
</tr>
<tr>
<td>lock()</td>
<td>decelerate()</td>
</tr>
<tr>
<td>accelerate()</td>
<td>stop()</td>
</tr>
</tbody>
</table>
```

Car and Engine classes know about each other
Associations w/ Navigation Information

- Can indicate direction of relationship
- Represented by solid line with arrowhead

Gas Pedal class knows about Engine class
Engine class doesn’t know about Gas Pedal class

Associations w/ Navigation Information

- Denotes “has-a” relationship between classes
- “Gas Pedal” has a “Engine”

State of Gas Pedal class contains instance of Engine class \(\Rightarrow\) can invoke its methods
Multiplicity of Associations

- Some relationships may be quantified
- Multiplicity denotes how many objects the source object can legitimately reference

**Notation**

- * $\Rightarrow$ 0, 1, or more
- 5 $\Rightarrow$ 5 exactly
- 5..8 $\Rightarrow$ between 5 and 8, inclusive
- 5..* $\Rightarrow$ 5 or more

---

**Many-to-one**

- Bank has many ATMs, ATM knows only 1 bank

**One-to-many**

- Inventory has many items, items know 1 inventory
Association – Aggregation

- Special case of association denotes a "consists of" hierarchy
  - Aggregate is the parent class
  - Components are the children class
- Represented by line ending in open diamond

\[ \text{Exhaust System} \]
\[ \begin{array}{ccc}
 & 1 & \\
Muffler & & Tailpipe \\
 & 0..2 & \\
\end{array} \]

Dependency

- Denotes dependence between classes
- Always directed (Class A depends on B)
- Represented by dotted line with arrowhead

\[ \text{A depends on B} \]
Dependency

- Caused by class methods
- Method in Class A temporarily "uses a" object of type Class B
- Change in Class B may affect class A

A uses object of class B

Dependency

- Dependence may be caused by
  - Local variable
  - Parameter
  - Return value

Example

```java
Class A {
    B Foo(B x) {
        B y = new();
        return y;
    }
}
```

Class B {
    ... 
    ... 
    ...
    }

Dependency Example

Class Driver depends on Class Car

Generalization

- Denotes inheritance between classes
- Can view as “is-a” relationship
- Represented by line ending in (open) triangle

Laptop, Desktop, PDA inherit state & behavior from Computers
Implementation

- Denotes class implements Java interface
- Represented by dotted line ending in (open) triangle

UML Examples

- Read UML class diagram
- Try to understand relationships
- Examples
  - Pets & owners
  - Computer disk organization
  - Library books
  - Banking system
  - Home heating system
  - Printing system
Try to read & understand UML diagram

- 1 or more Pets associated with 1 PetOwner
UML Example – Computer System

Try to read & understand UML diagram

- 1 CPU associated with 0 or more Controllers
- 1-4 DiskDrives associated with 1 SCSIController
- SCSIController is a (specialized) Controller
Try to read & understand UML diagram

- 1 or more Book associated with 1 or more Pages
- Patron & Shelf temporarily use (depend on) Books
UML Example – Banking System

Try to read & understand UML diagram

- 1 Bank associated with 0 or more Accounts
- Checking, Savings, MoneyMarket are Accounts
Try to read & understand UML diagram

- Room has 1 Thermostat
- Each Thermostat associated with 0 or more Heaters
- ElectricHeater is a specialized Heater
- AubeTH101D is a specialized Thermostat
UML Example – Printing System

```
Registry
findQueue(): PrintQueue

PrintQueue
printJobs: List
myPrinter: Printer
myRegistry: Registry
newJob(): void
length(): int
getResource(): Resources

Printer
myResources: resources
curJob: Job
print(): void
busy(): boolean
on(): boolean

Job
```

1

*