CMSC 132: OBJECT-ORIENTED PROGRAMMING II

UML (Unified Modeling Language)

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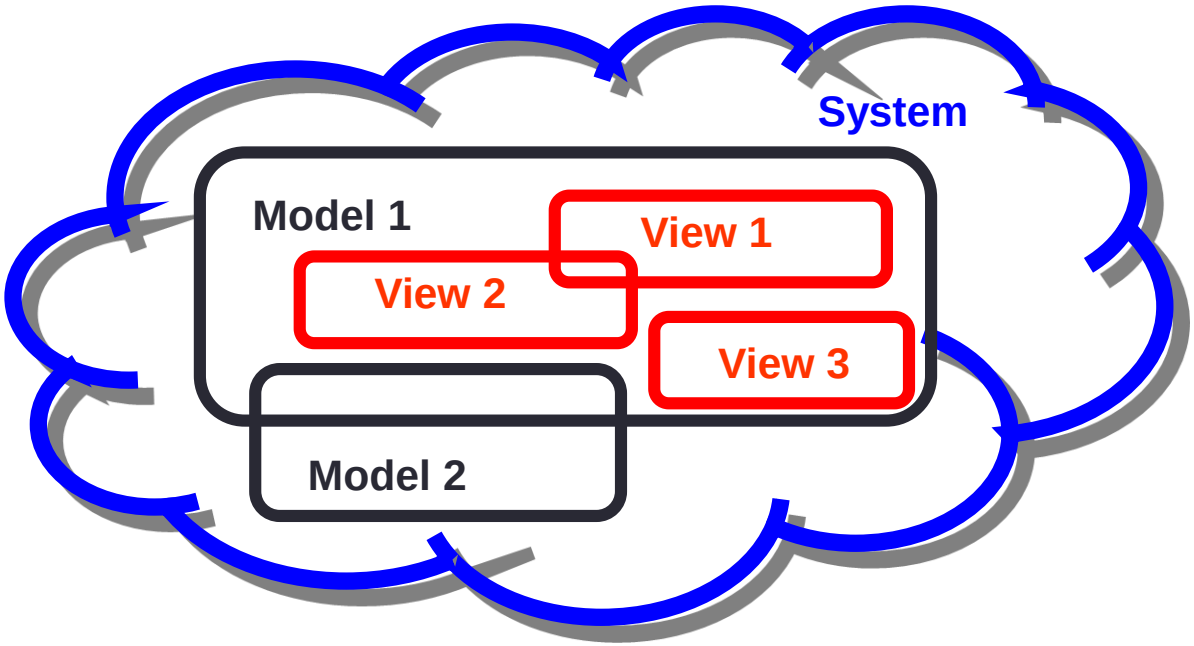
UML (Unified Modeling Language)

- UML is a modeling language for object-oriented software that allow us to specify, visualize, construct, and document systems
- Use UML to help
  - Visualize design of software
  - Provide abstract model of software
- UML provides a number of diagrams that
  - Describe a model of all or part of system
  - From a particular point of view
  - With varying level of abstraction

UML Diagrams

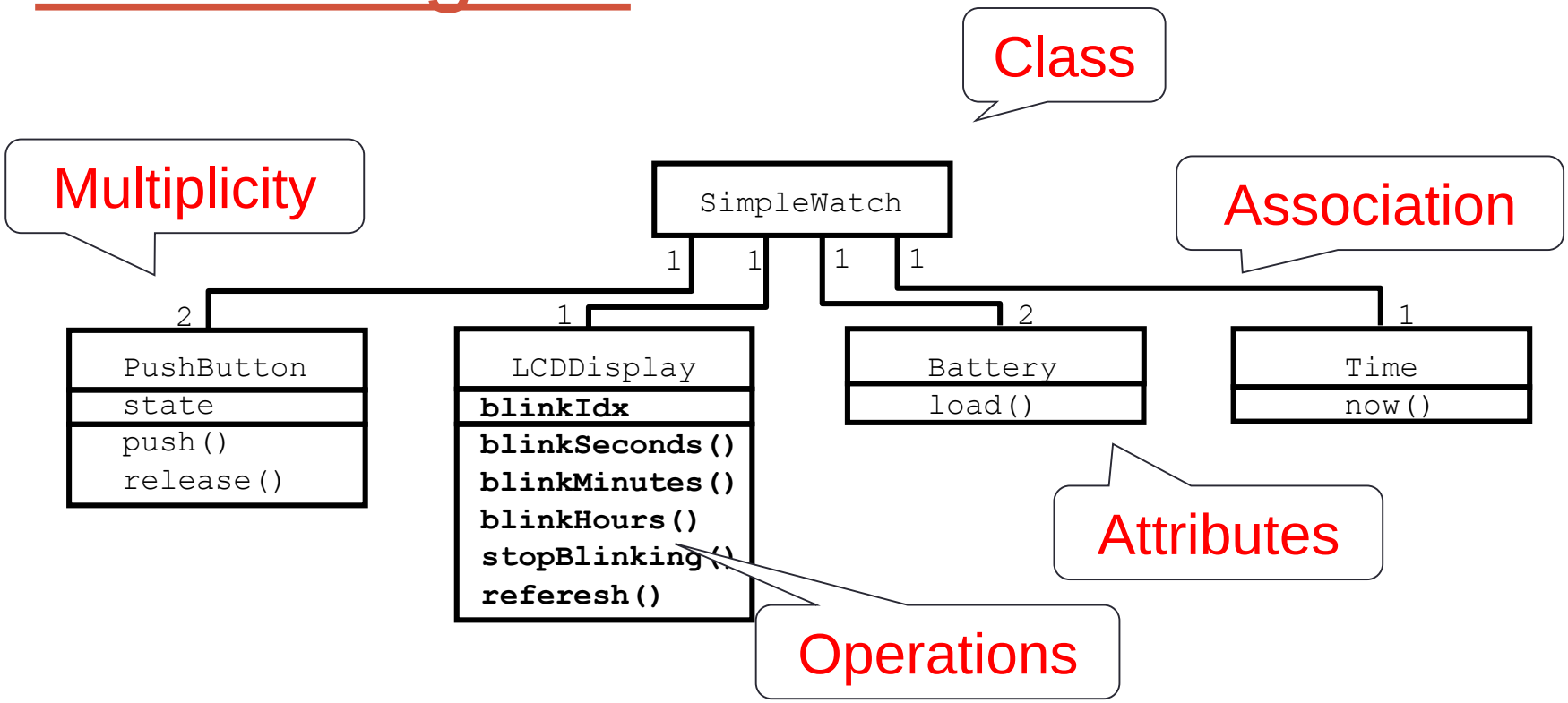
- UML provides a number of diagrams that
  - Describe a model of all or part of system
  - From a particular point of view
  - With varying level of abstraction
  - Using certain set of notations



Class Diagrams

- We want to use **class diagrams** to describe our designs
- **Class diagram**
  - Represents (static) structure of system
  - It displays
    - Information for class
    - Relationships between classes

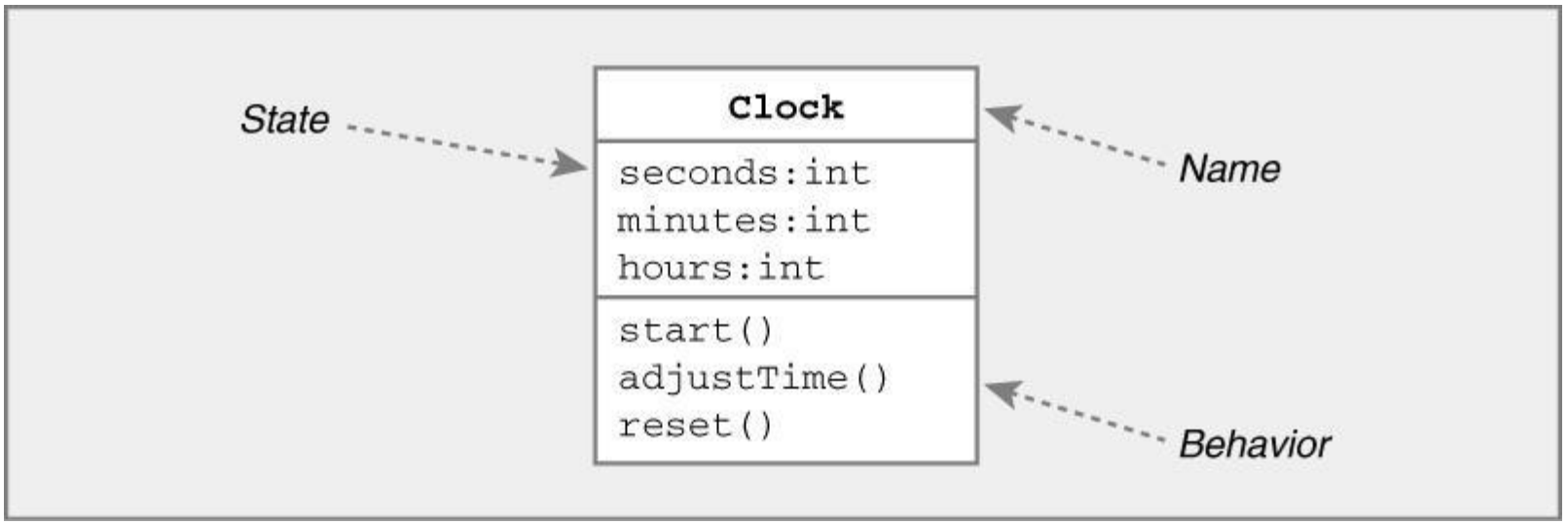
Class Diagram



Class diagrams represent structure of system

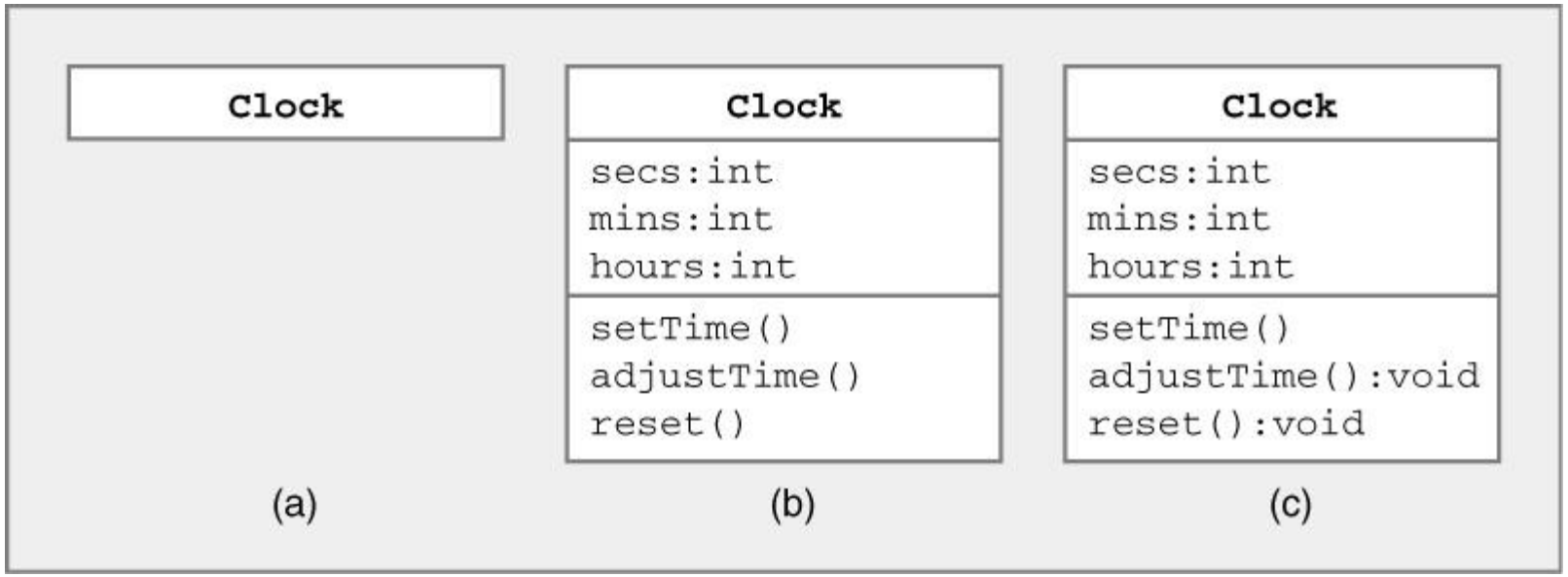
Class Diagrams

- Information for class contains
  - **Name**
  - **State**
  - **Behavior**



Class Diagram

- **Class name is required**
- **Other information optional**
  - State, behavior
  - Types, visibility…



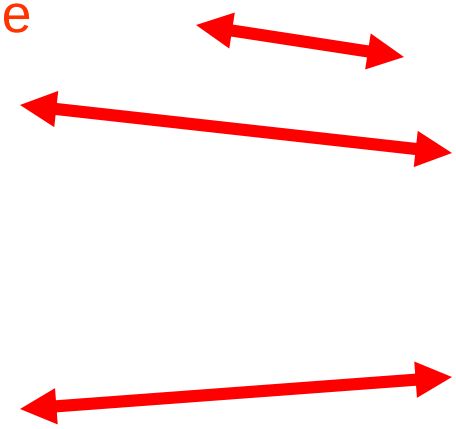
UML Class Diagrams ↔ Java Code

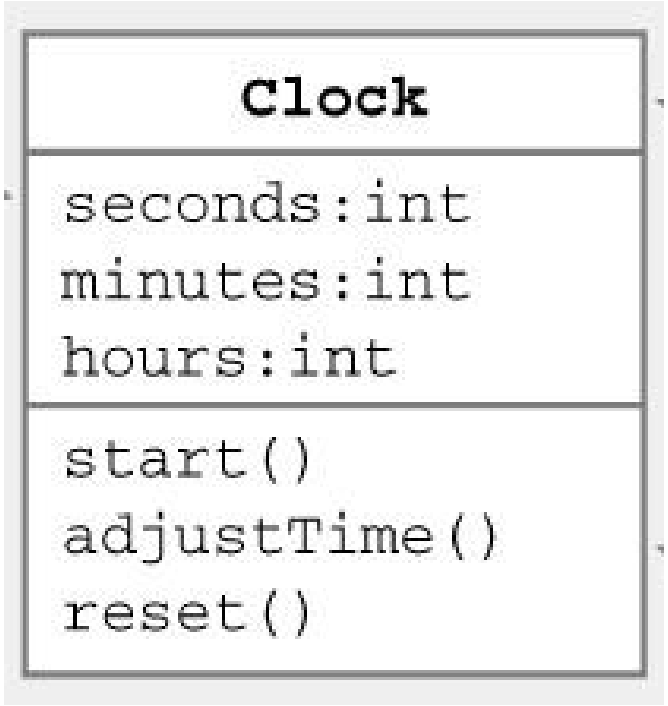
- Different representation of same information
  - Name, state, behavior of class
  - Relationships between classes
- Should be able to derive one from the other
- Motivation
  - **UML ⇒ Java**
    - Implement code based on design written in UML
  - **Java ⇒ UML**
    - Create UML to document design of existing code

Java → UML : Clock Example

- Java

```
class Clock { // name
  // state
  int seconds;
  int minutes;
  int hours;
  // behavior
  void start();
  void adjustTime();
  void reset();
}
```



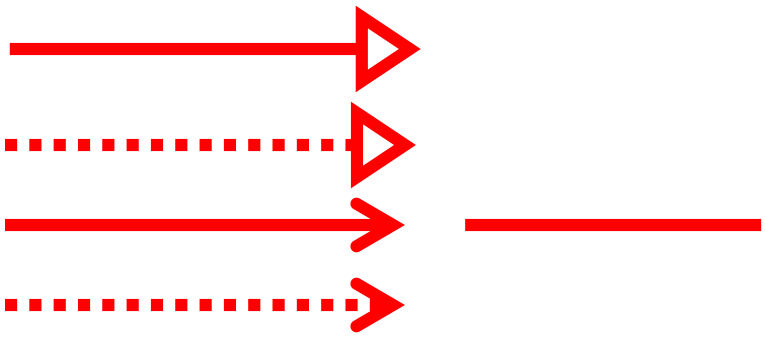


Java Code

Class Diagram

UML Class Diagram Notation

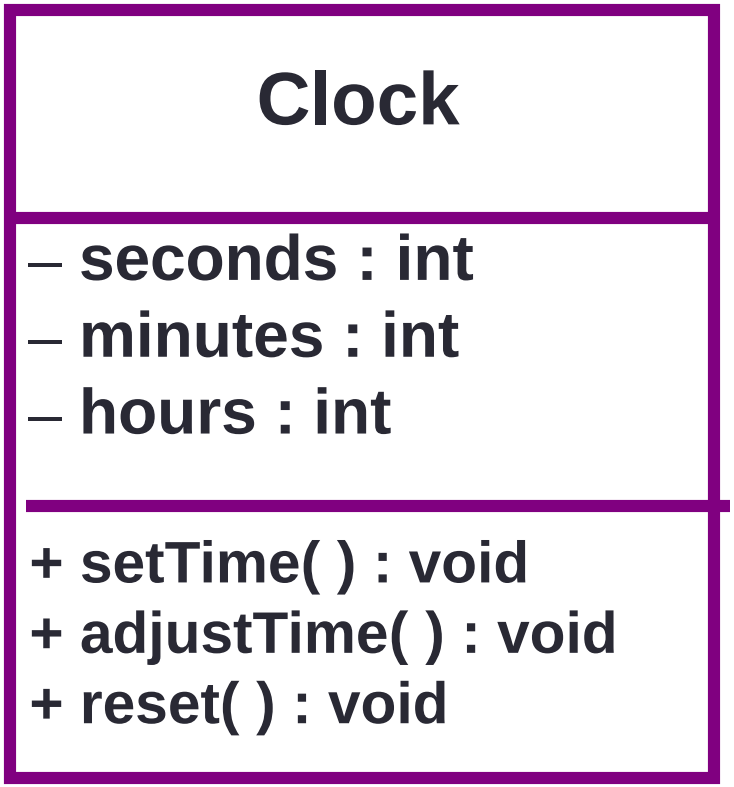
- Type ⇒ type name preceded by colon :
- Visibility ⇒ prefix symbol
  - + public
  - – private
  - # protected
  - ~ package
- Static ⇒ underline
- Types of relationships
  - Generalization
    - Inheritance
    - Implementation
  - Association
    - Dependency



Java → UML : Clock Example

- Java

```
class Clock { // name
  // state
  private int seconds;
  private int minutes;
  private int hours;
  // behavior
  public void setTime( );
  public void adjustTime(int value);
  public void reset( );
}
```



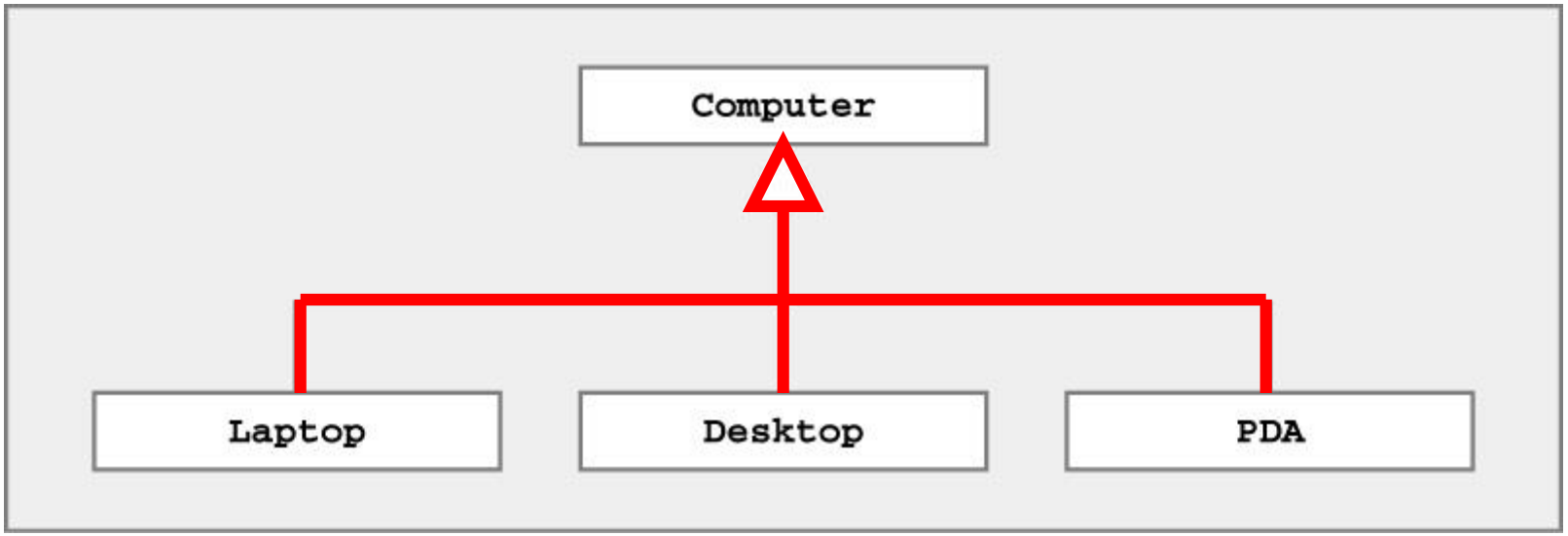
Java Code **Class Diagram**

Generalization

- Denotes inheritance between classes
  - Can view as “is a” relationship
- Example
  - Lecturer is a person (Lecturer extends Person class)
- Types of generalization
  - Subclass extends superclass
    - Solid line ending in (open) triangle
  - Class implements interface
    - Dotted line ending in (open) triangle

Generalization Example

- Inheritance



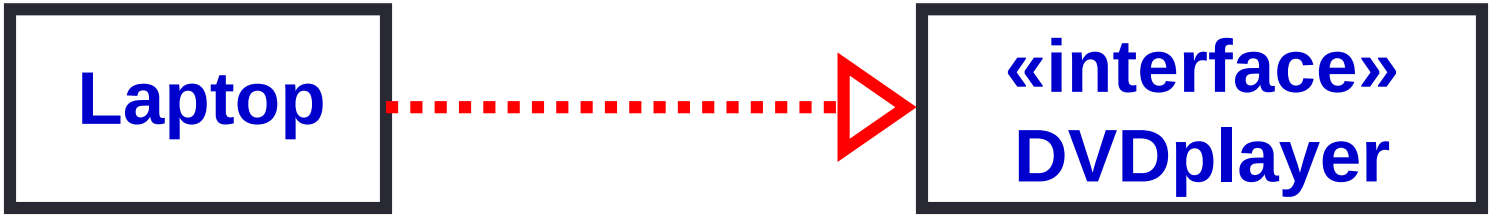
Laptop, Desktop, PDA inherit state & behavior from Computer

Generalization Example

- Abstract Classes are represented by italicizing the name

Abstract class Shape

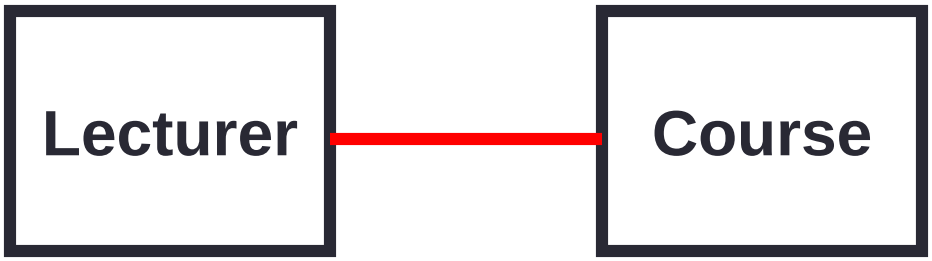
- Interfaces are prefaced with <<interface>>



Laptop implements DVDplayer interface

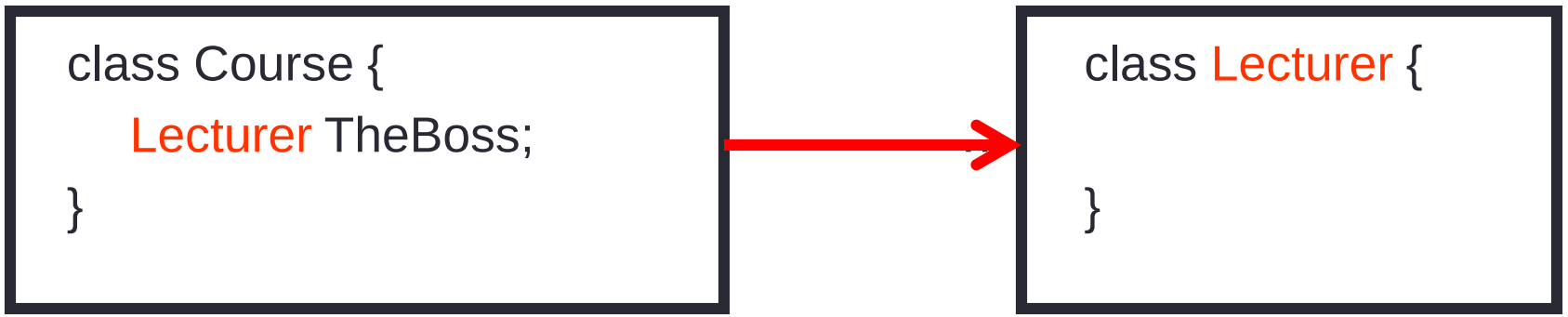
Association

- Denotes interaction between two classes
- Example
  - Lecturer teaches course
    - Indicates relationship between Lecturer & Course



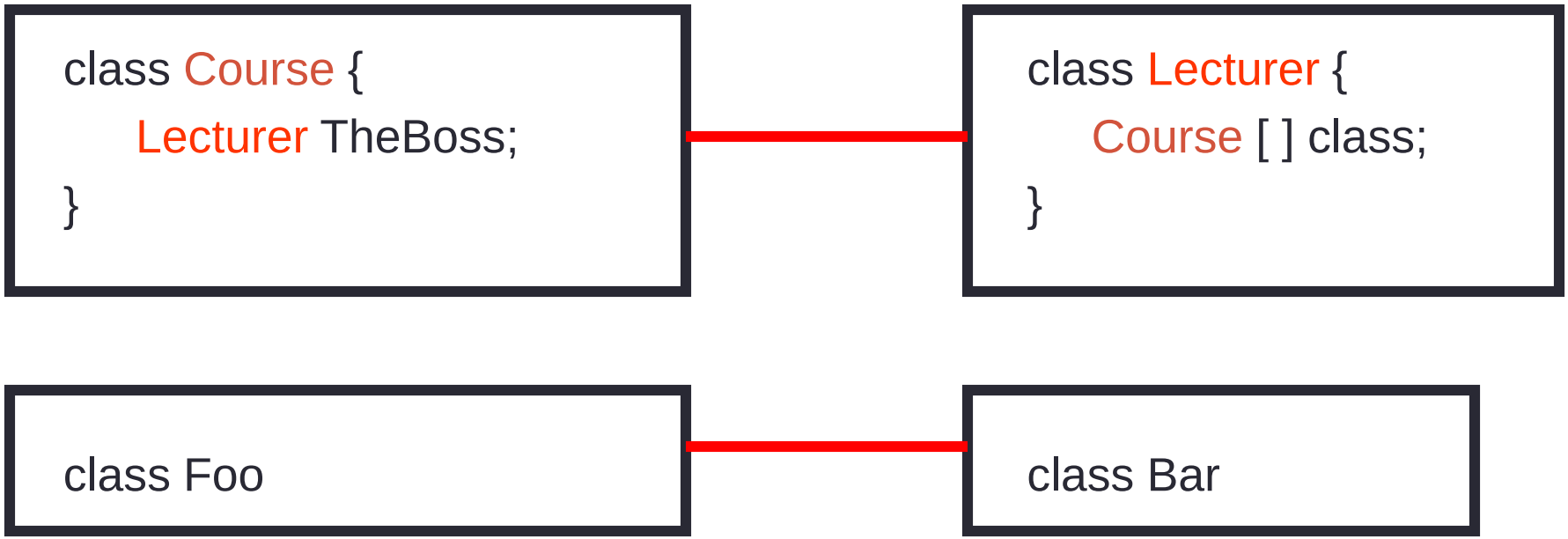
Association w/ Navigation

- Navigation information
  - Relationship between classes may be directional
    - Only class A can send messages to class B
  - Arrowhead indicates direction of relationship
- Example



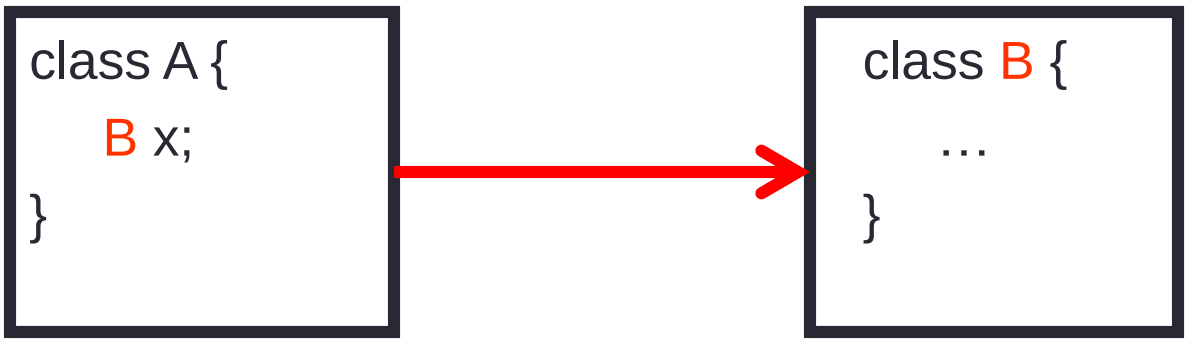
Association w/o Navigation

- Undirected edge
  - Relationship between classes may be bi-directional
  - Direction of relationship may be unknown
- Examples



Permanent Association

- Permanent / structural association
  - Class A contains reference to class B in data field
  - Can view as "has a" relationship
  - Also referred to as composition
- Example



A has a B

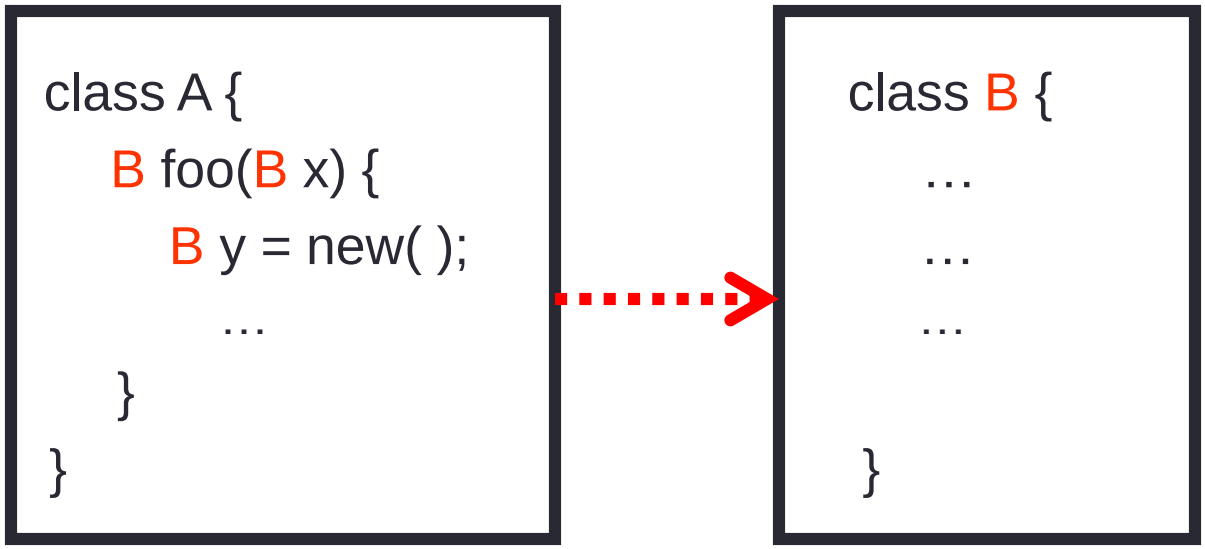
Temporary Association (Dependency)

- A transitory relationship between classes
  - Always directed (class A depends on B)
  - Indicates change in class B may affect class A
  - Can view as "uses a" relationship
  - Represented by dotted line with arrowhead
- Example

A depends on B

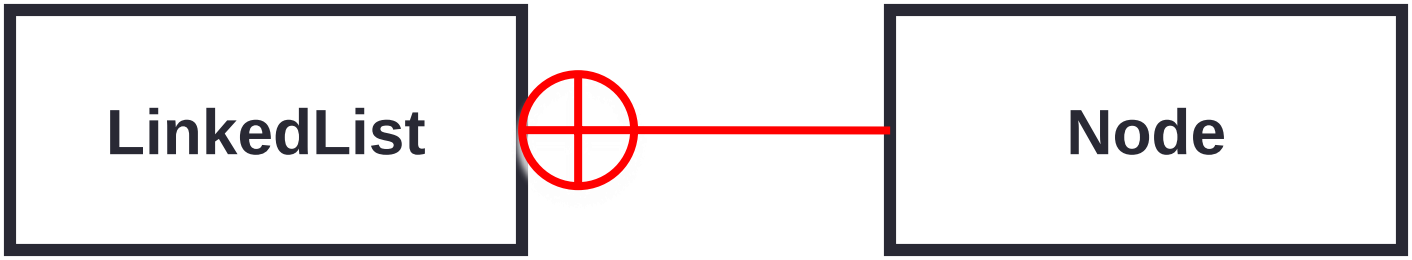
Dependency

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



Inner/Nested Classes

- Anchor (cross inside a circle) associated with enclosing class

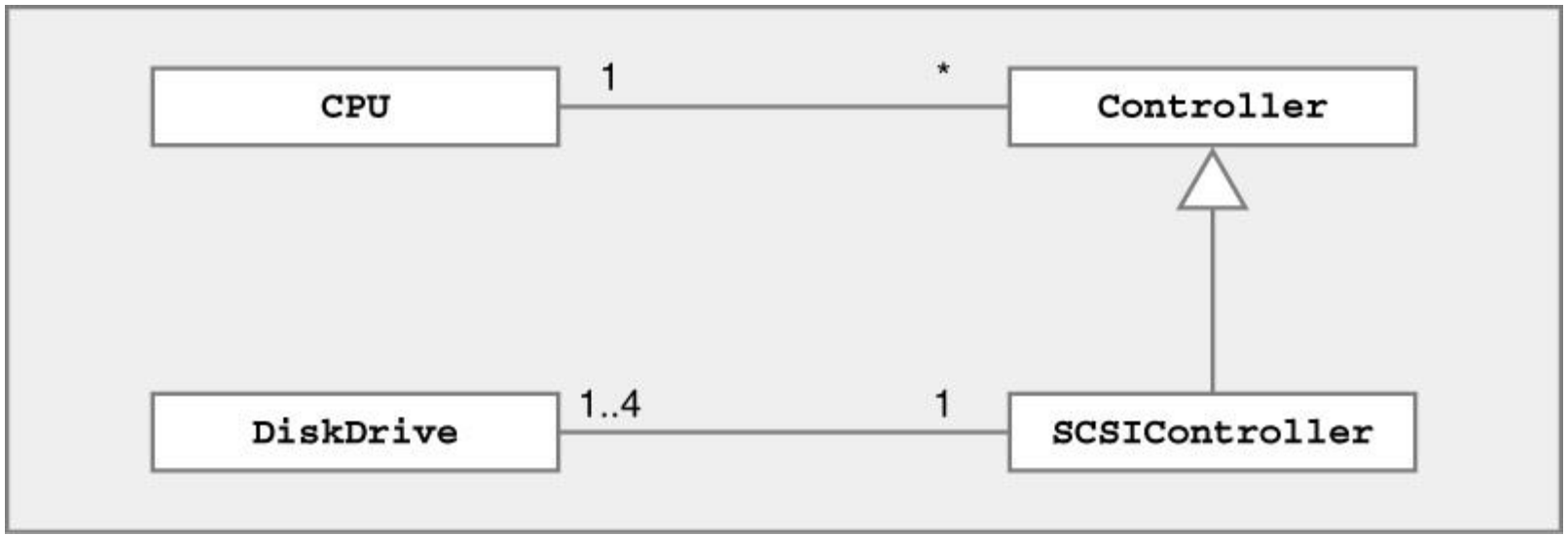


UML Examples

- Read UML class diagram
  - Try to understand relationships
  - Practice converting to / from Java code
- Examples
  - Computer disk organization
  - Banking system
  - Home heating system
  - Printing system

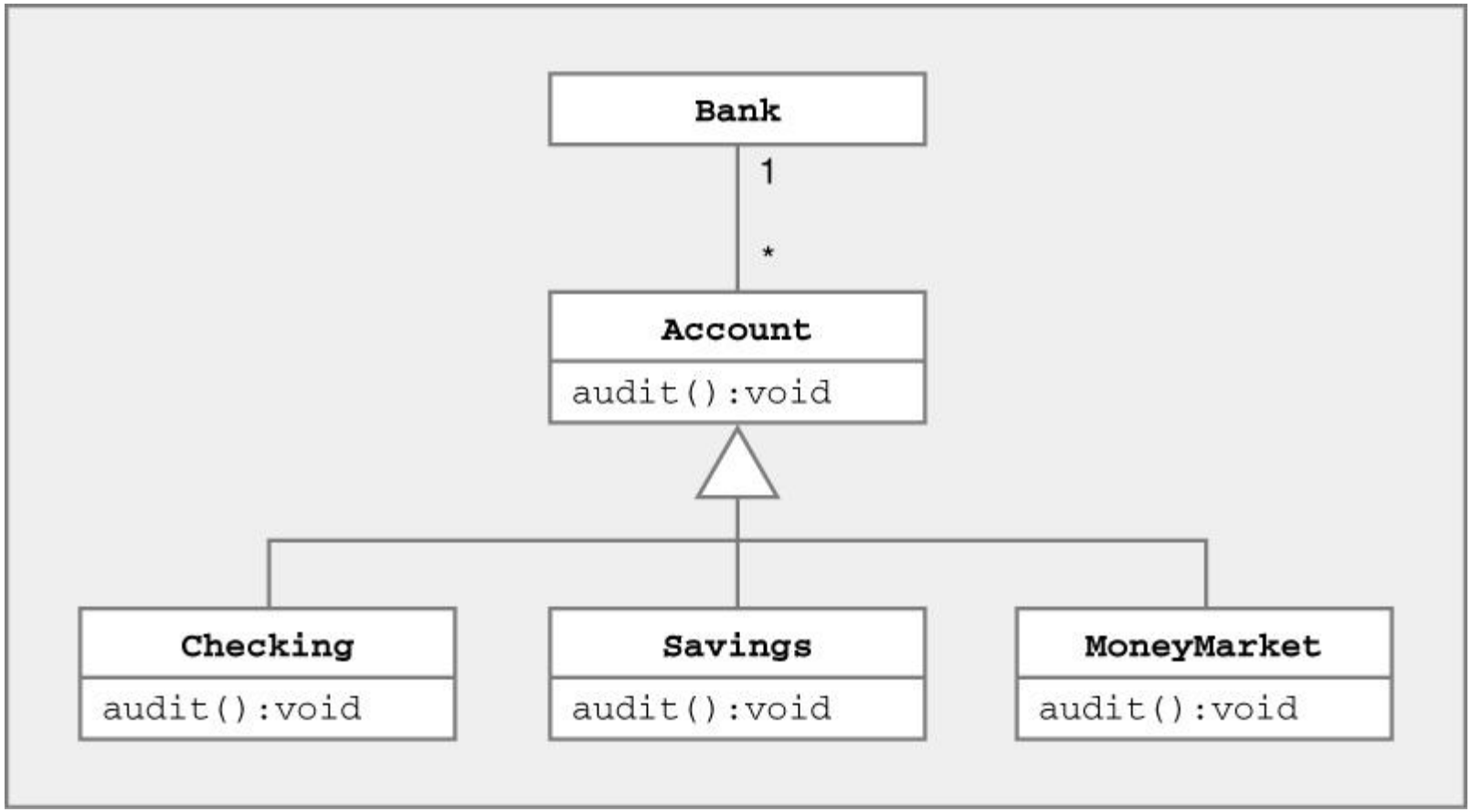
UML Example – Computer System

- Try to read & understand UML diagram



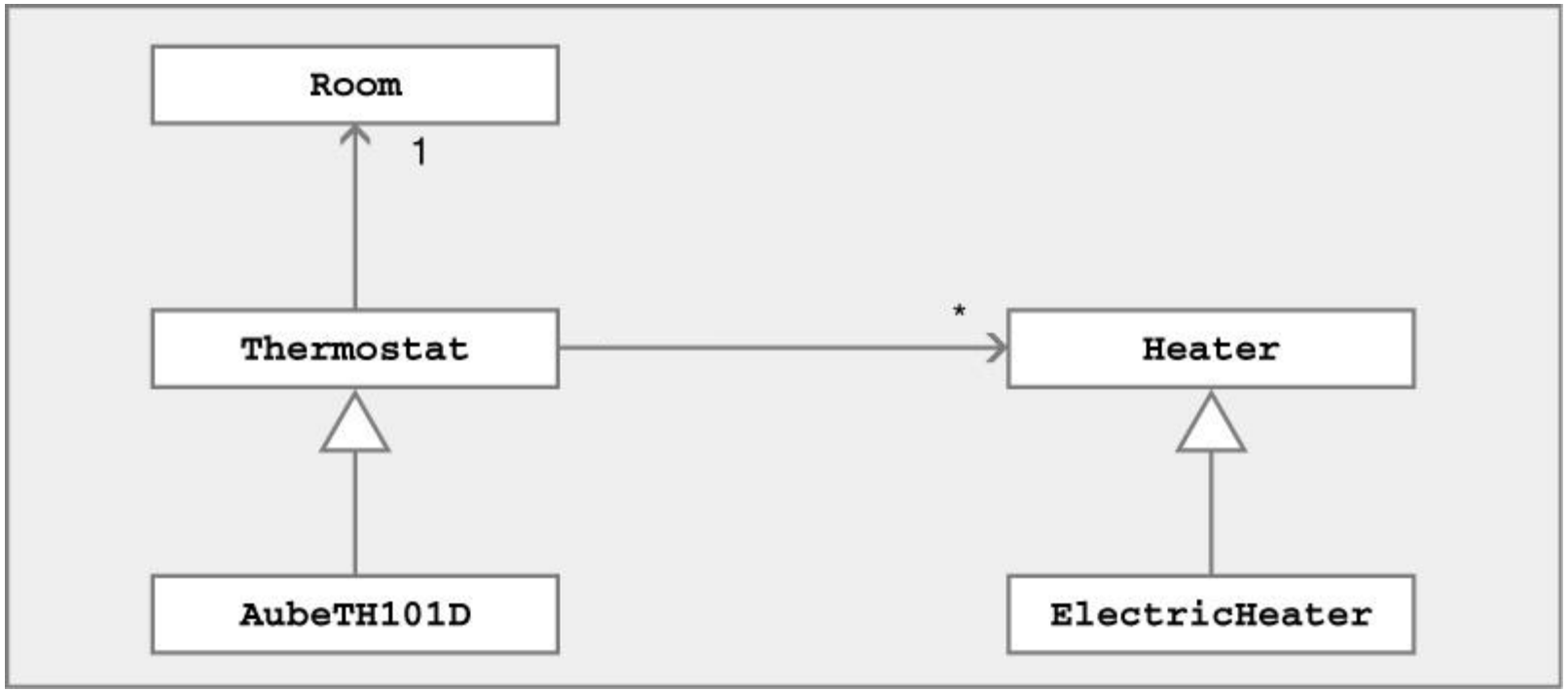
- **CPU is associated with Controllers**
- **DiskDrive is associated with SCSIController**
- **SCSIController is a (type of) Controller**

UML Example – Banking System



- **Bank associated with Accounts**
- **Checking, Savings, MoneyMarket are type of Accounts**

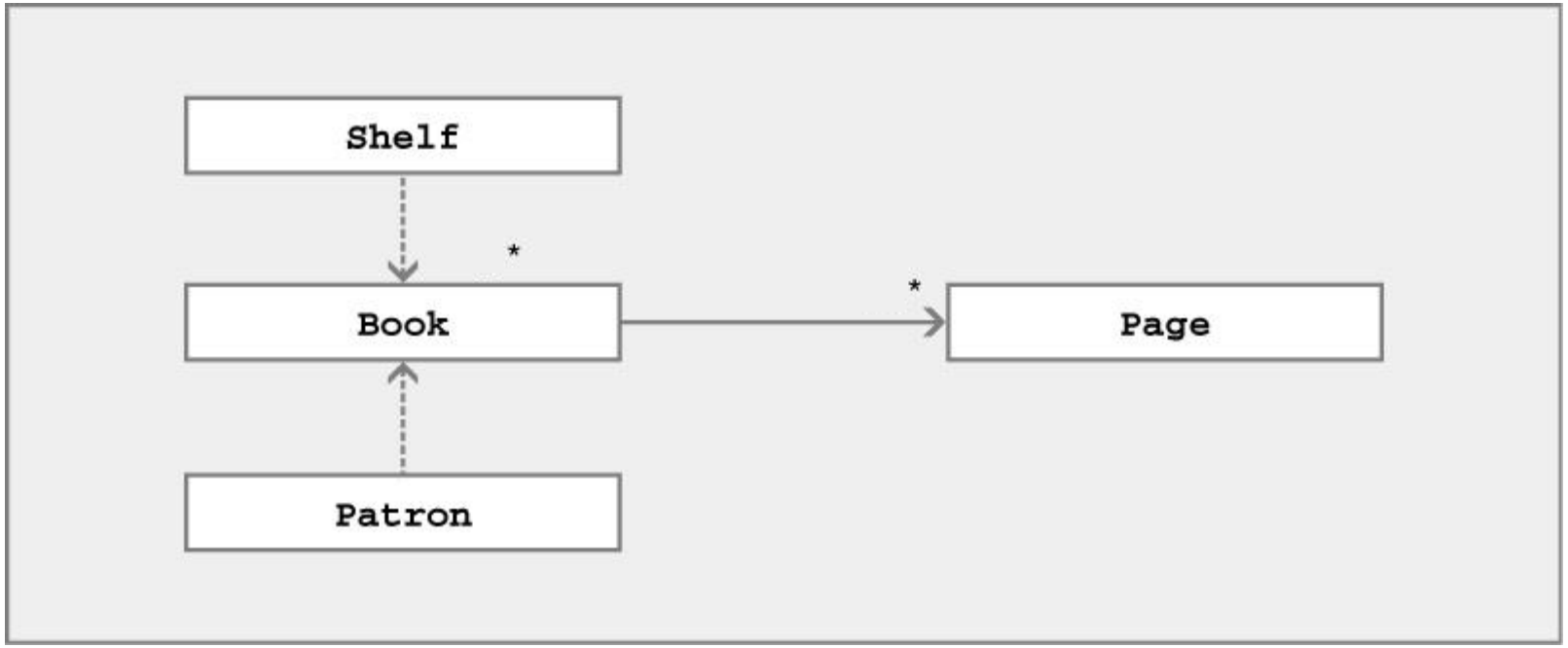
UML Example – Home Heating System



- **Thermostat associated with (has a) Room**
- **Thermostat associated with (has a) Heater**
- **ElectricHeater is a specialized Heater**
- **AubeTH101D is a specialized Thermostat**

UML Example – Library System

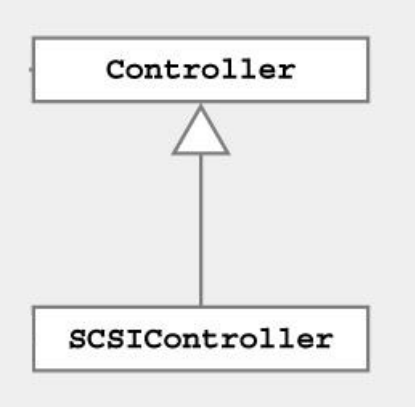
- Try to read & understand UML diagram



- **Books are associated with (has some) Pages**
- **Patron & Shelf depend on (temporarily use) Books**

UML → Java : Computer System

- UML

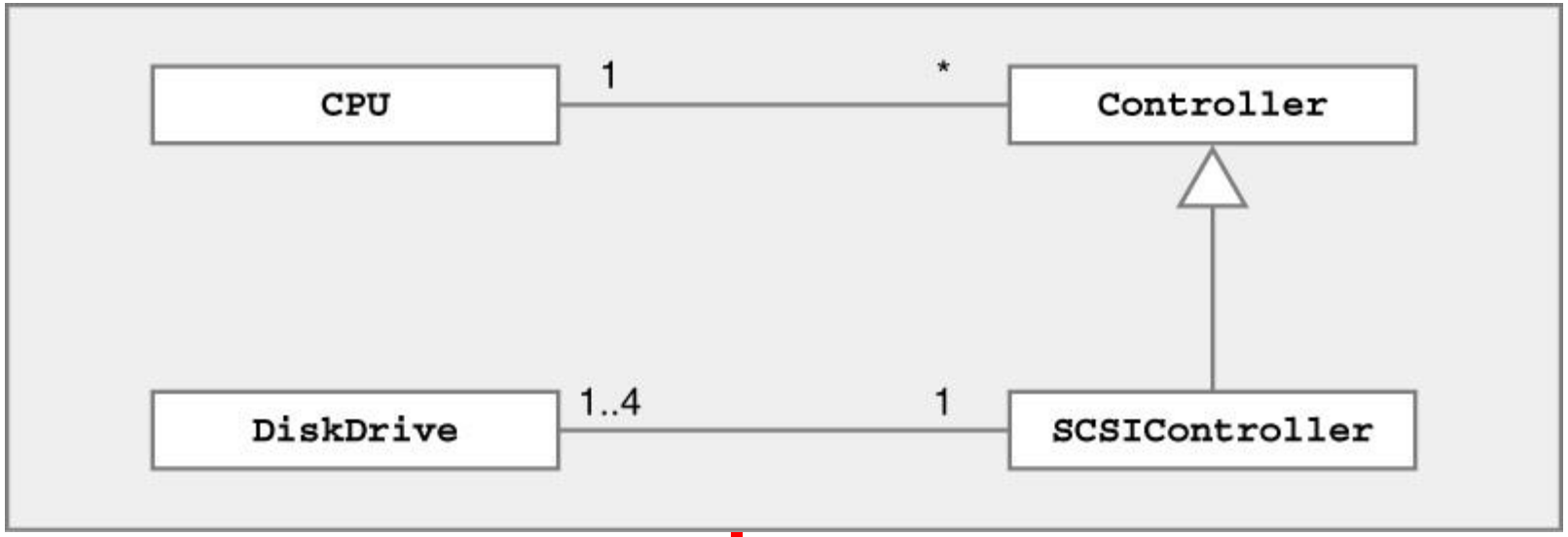


- Java

```
class Controller {
}
class SCSIController extends Controller {
}
```

UML → Java : Computer System

- UML

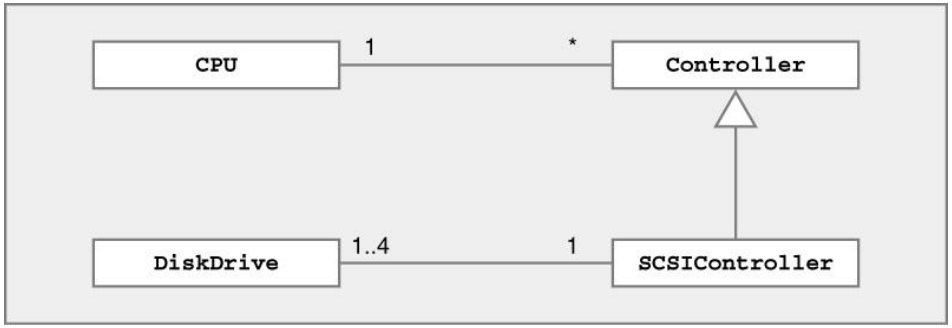


- Java
  - Design code using all available information in UML…

UML → Java : Computer System

- Java

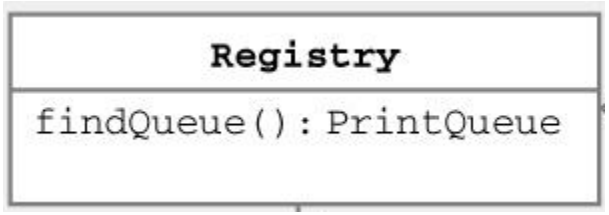
```
class CPU {
   Controller myCtlrs[ ];
}
class Controller {
   CPU myCPU;
}
class SCSIController extends Controller {
   DiskDrive myDrive[4];
}
Class DiskDrive {
    SCSIController mySCSI;
}
```

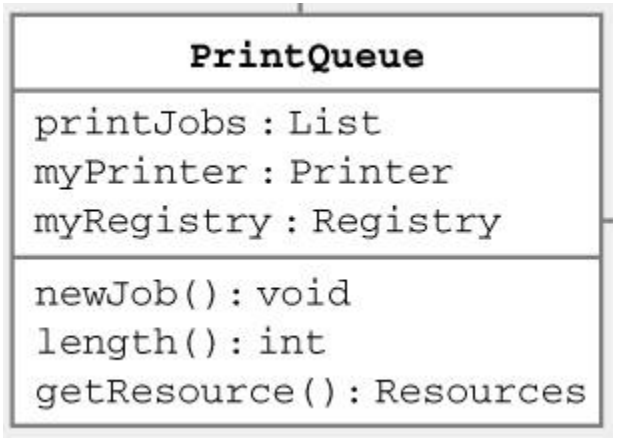


Java → UML : Printing System

- Java

```
class Registry {
   PrintQueue findQueue();
}
class PrintQueue {
   List printJobs;
   Printer myPrinter;
   Registry myRegistry;
   void newJob();
   int length();
   Resources getResource();
}
```

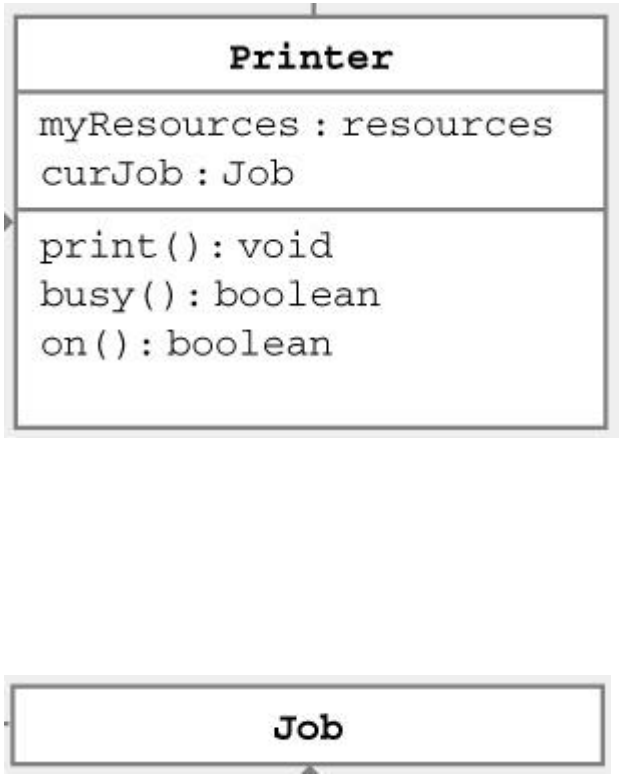




Java → UML : Printing System

- Java

```
Class Printer {
   Resources myResources;
   Job curJob;
   void print();
   boolean busy();
   boolean on();
}
class Job {
   Job(Registry r) {
         …
   }
}
```



Java → UML : Printing System

- Java
  - All together