Use Case Modelling

- So far, we have looked into the basic syntax...
- Factoring use cases ...
- Text description ...
- Design of Use Case model from a given text description ...

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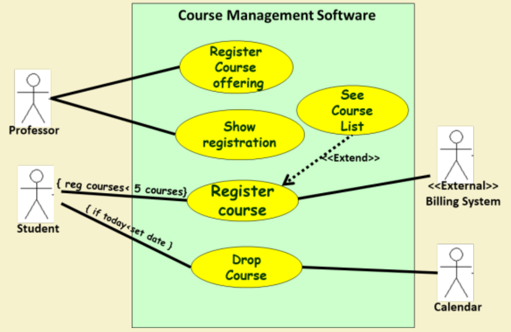
Style Notes (Ambler, 2005)

- Use case name should begin with a verb.
- While use cases do not explicitly imply timing:
  - Order use cases from top to bottom to imply timing -- it improves readability.
- **The primary actors should appear in the left.**
- Actors are associated with one or more use cases.
- Do not use arrows on the actor-use case relationship.
- **To initiate scheduled events include an actor called "calendar"**
- **Do not show actors interacting with each other.**
- <<include>> and <<extend>> should rarely nest more than 2 levels deep.



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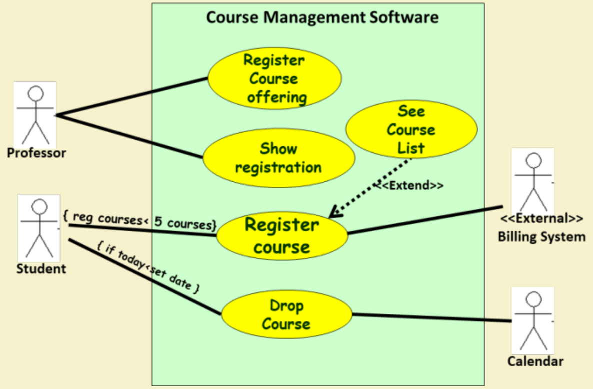
Effective Use Case Modelling

- Use cases should be named and organized from the perspective of the users.
- Use cases should start off simple and at as much higher view as possible.
  - Can be refined and detailed further.
- Use case diagrams represent functionality:
  - **Should focus on the "what" and not the "how".**



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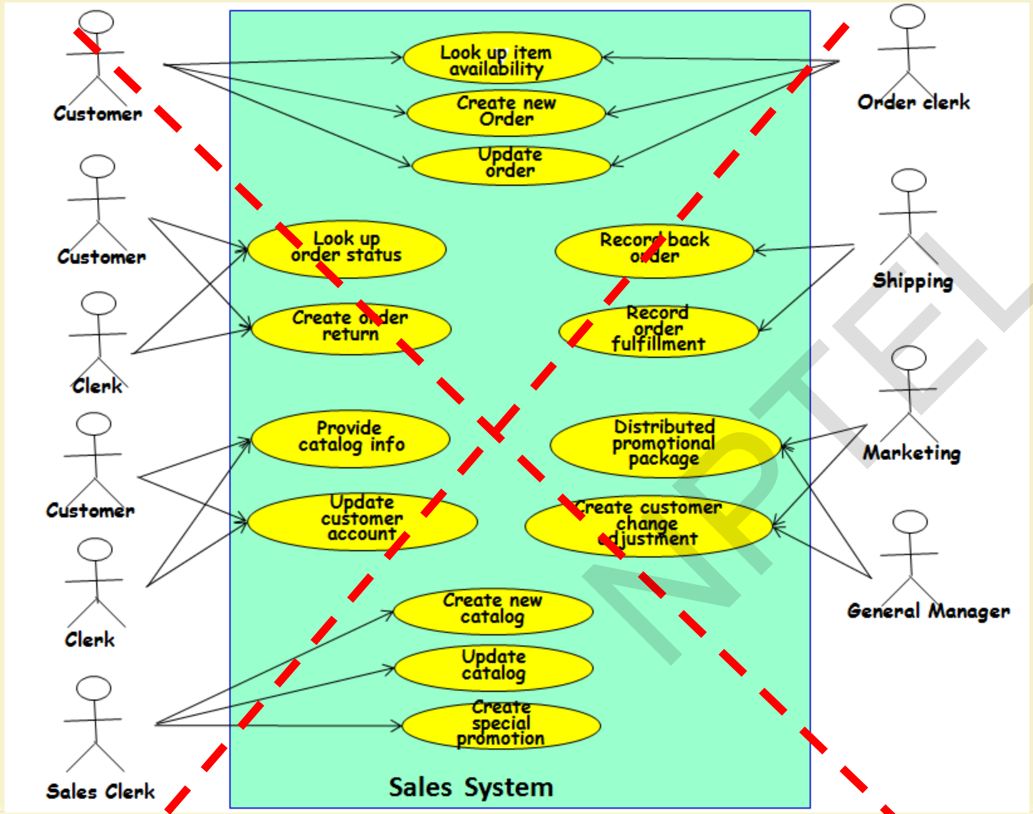

Is it OK?

Too many use cases at any level should be avoided!

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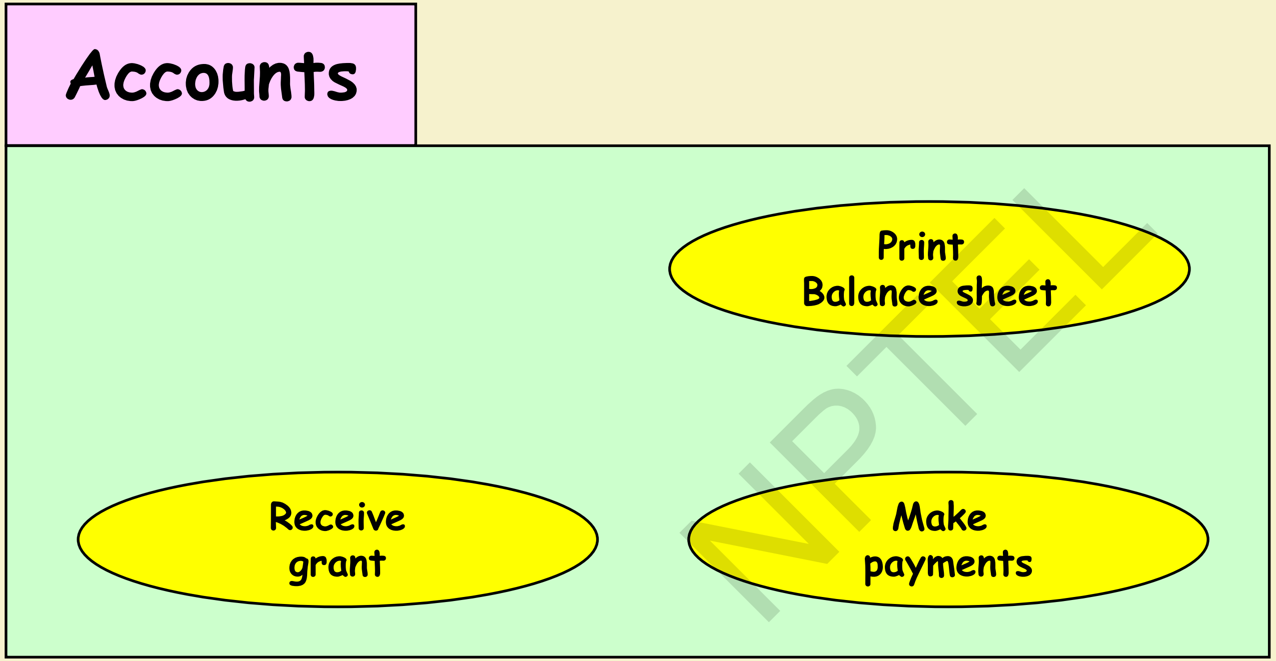
Use Case Packaging



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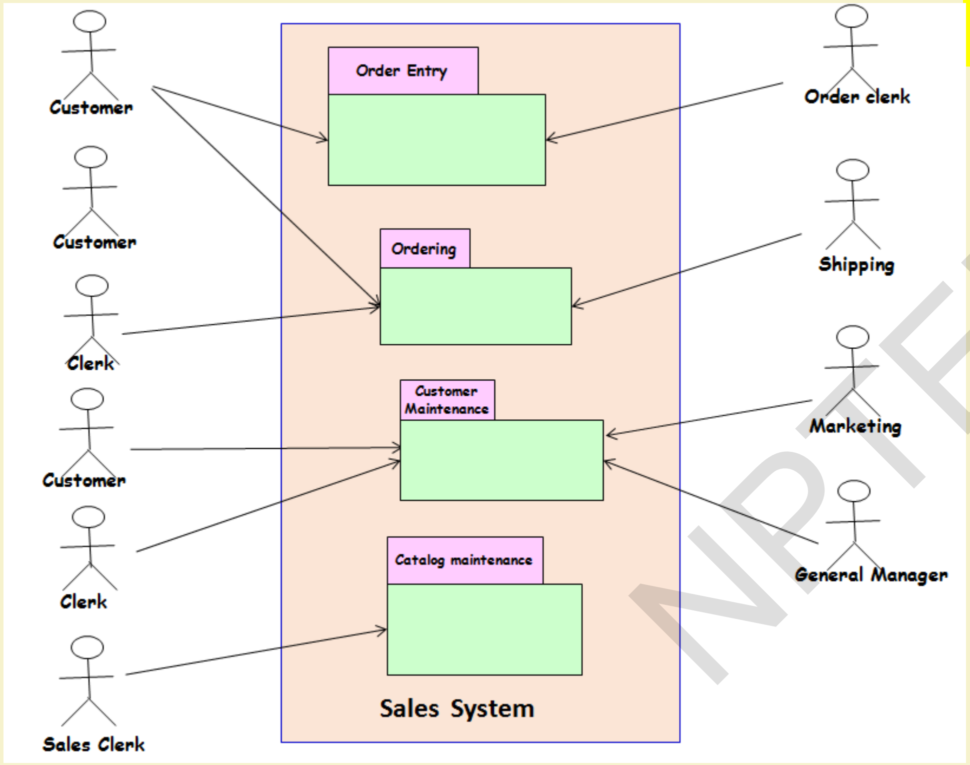
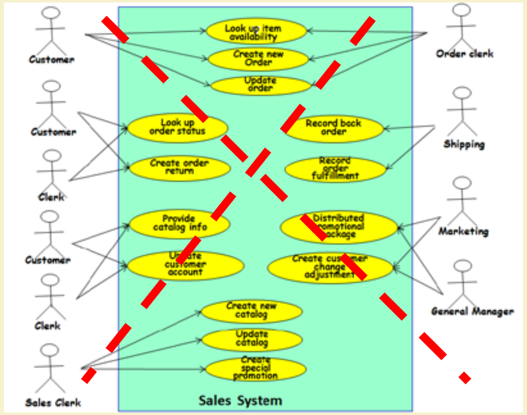
Which is more acceptable?





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Quiz: Home Assignment System - Use Case Model

- HAS will be used by an instructor to:
  - Distribute homework assignments,
  - Review students' solutions,
  - Distribute suggested solution,
  - Assign a grade to each assignment.
- Students can:
  - Download assignments
  - Submit assignment solutions
- System:
  - Automatically reminds the students a day before an assignment is due.

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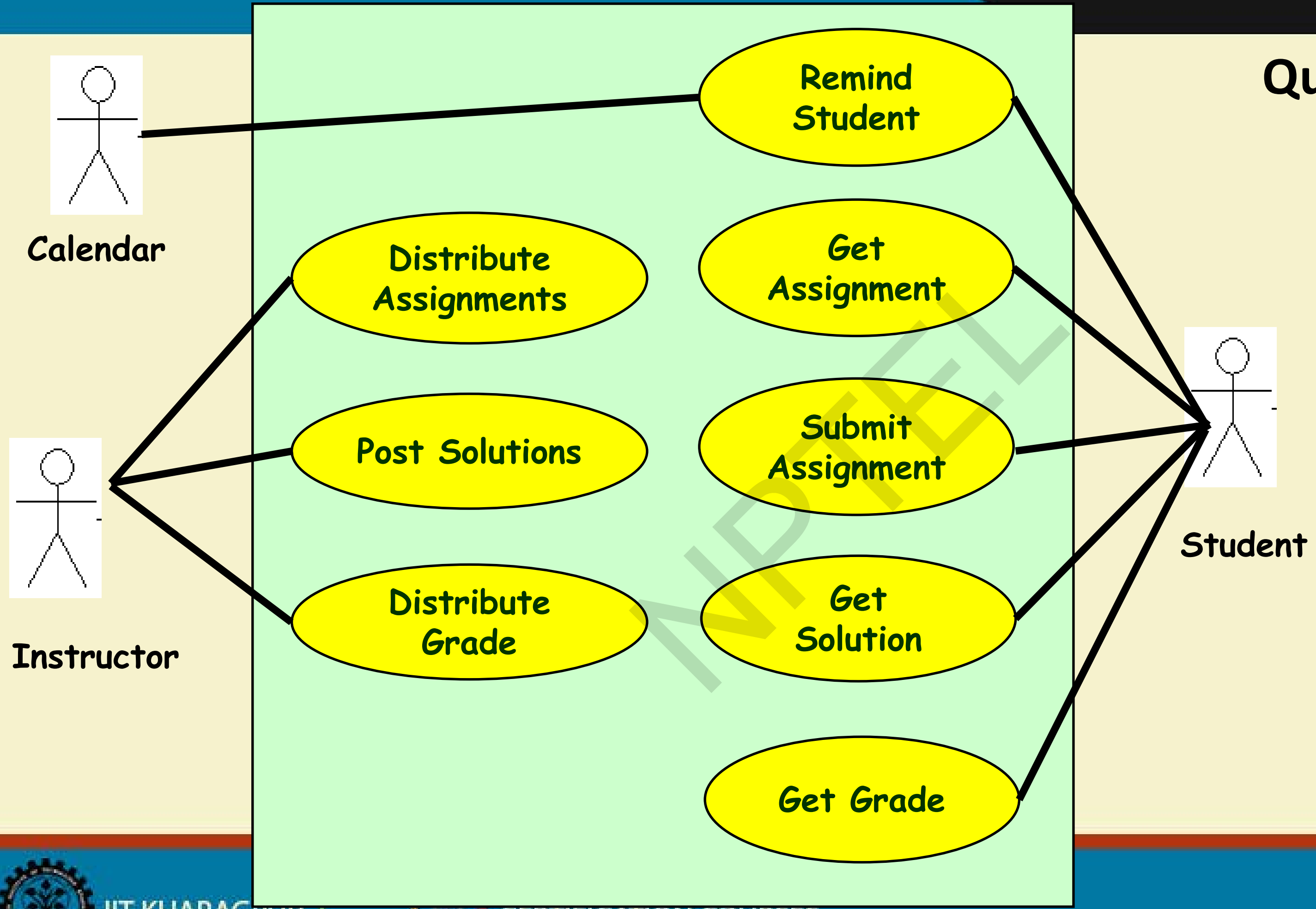
Quiz: Solution 1 (Inferior)



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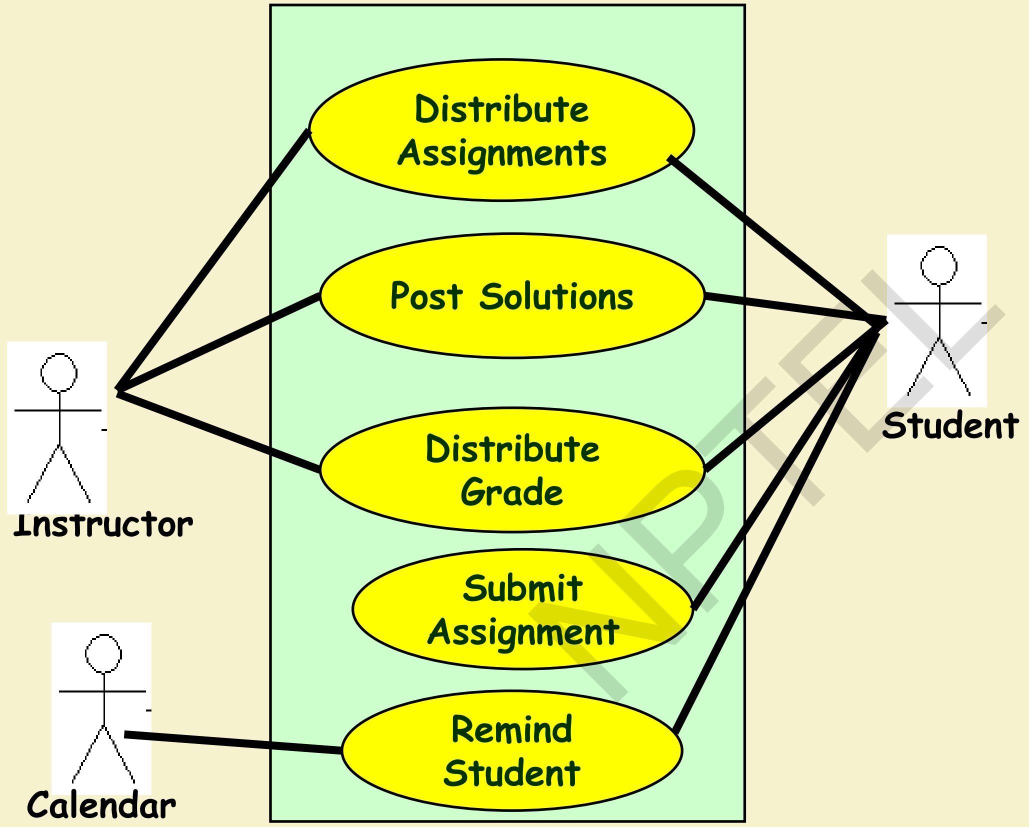
Quiz: Alternate (Better) Solution



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Class Diagram

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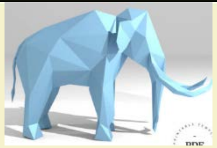
Class: A Fundamental Object-Oriented Concept

- Template for object creation:
  - Instantiated into objects



- Examples: Employees, Books, etc.
- Sometimes not intended to produce instances:
  - **Abstract classes**

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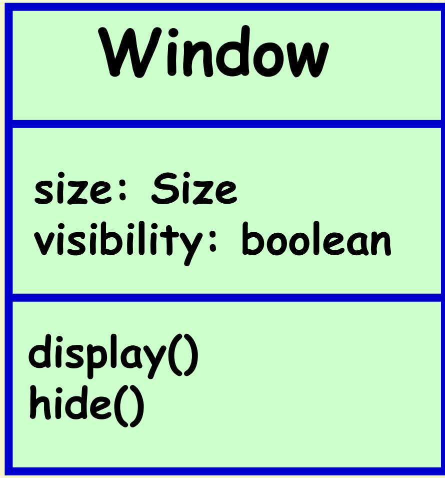
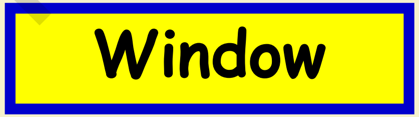
- Entities with common features are made into a class.
- Represented as solid outline rectangle with compartments.
- Compartments for **name, attributes, and operations.**
- Attribute and operation compartments are optional ... used depending on the purpose of a diagram.

Class Diagram





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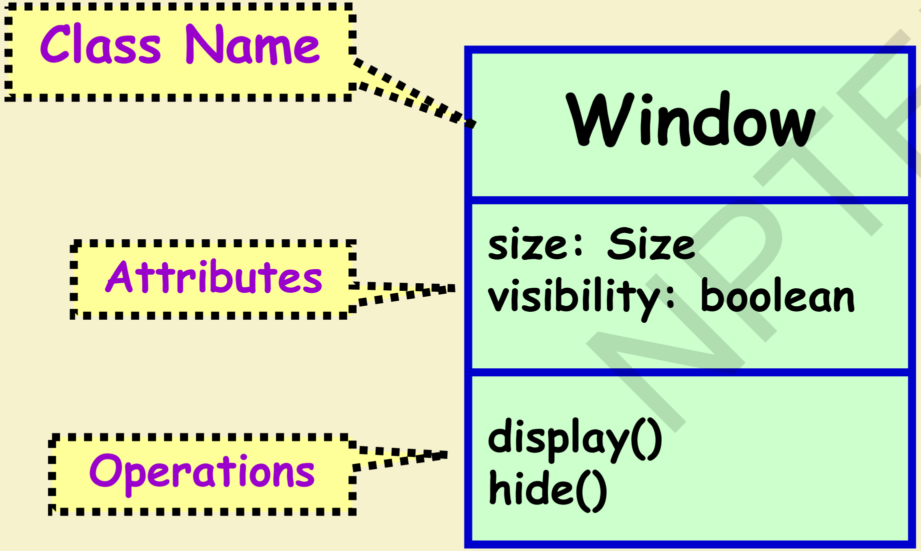
UML Class Representation

- A class represents a set of objects having similar attributes, operations, relationships and behavior.



A class can implicitly have a few association attributes

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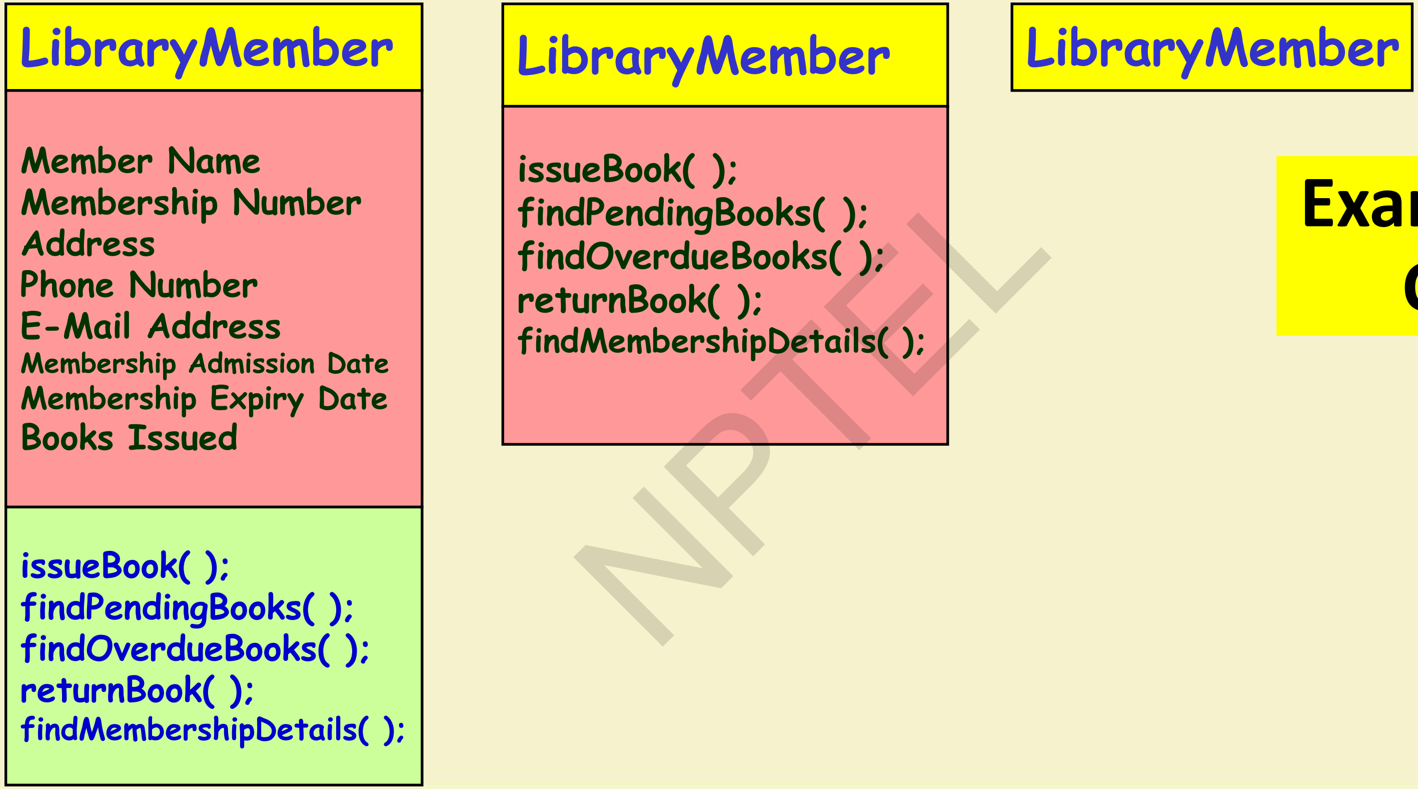
Different representations of the LibraryMember class



Example UML Classes

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Class Attribute Examples

Java Syntax	UML Syntax
Date birthday	Birthday:Date
Public int duration = 100	+duration:int = 100
Private Student students[0..MAX_Size]	-Students[0..MAX_Size]:Student

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Visibility Syntax in UML

Visibilty	Java Syntax	UML Syntax
public	public	+
protected	protected	#
package		~
private	private	-

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Methods vs. Messages

- Methods are the operations supported by an object:
  - Means for manipulating the data of an object.
  - Invoked by sending a message (method call).
  - **Examples:** calculate_salary(), issue-book(), getMemberDetails(), etc.

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Method Examples

Java Syntax	UML Syntax
void move(int dx, int dy)	~move(int dx,int dy)
public int getSize()	+int getSize()

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Are Methods and Messages Synonyms?

- No
- Message was the original concept in object-orientation…
- Methods are the later simplifications…
- Sometimes used as synonyms

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Are Methods and Operations Synonyms?

- No
- An operation can be implemented by multiple methods.
  - Known as polymorphism
  - In the absence of polymorphism-–the two terms are used as synonyms.

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What are the Different Types of Relationships Among Classes?

- Four types:
  - **Inheritance**
  - **Association**
  - **Aggregation/Composition**
  - **Dependency**

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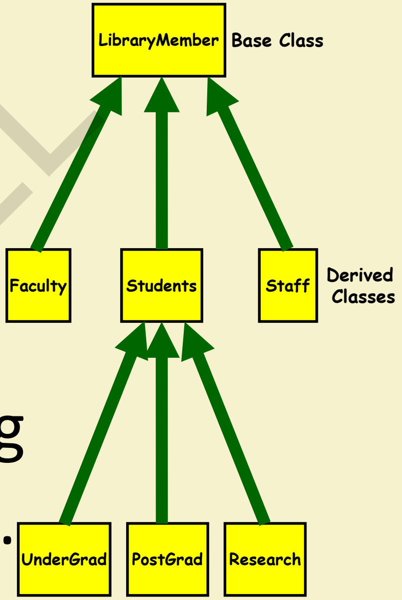
Inheritance

- Allows to define a new class (derived class) by extending an existing class (base class).
  - –Represents generalization-specialization relation.
  - –Allows redefinition of the existing methods (method overriding).



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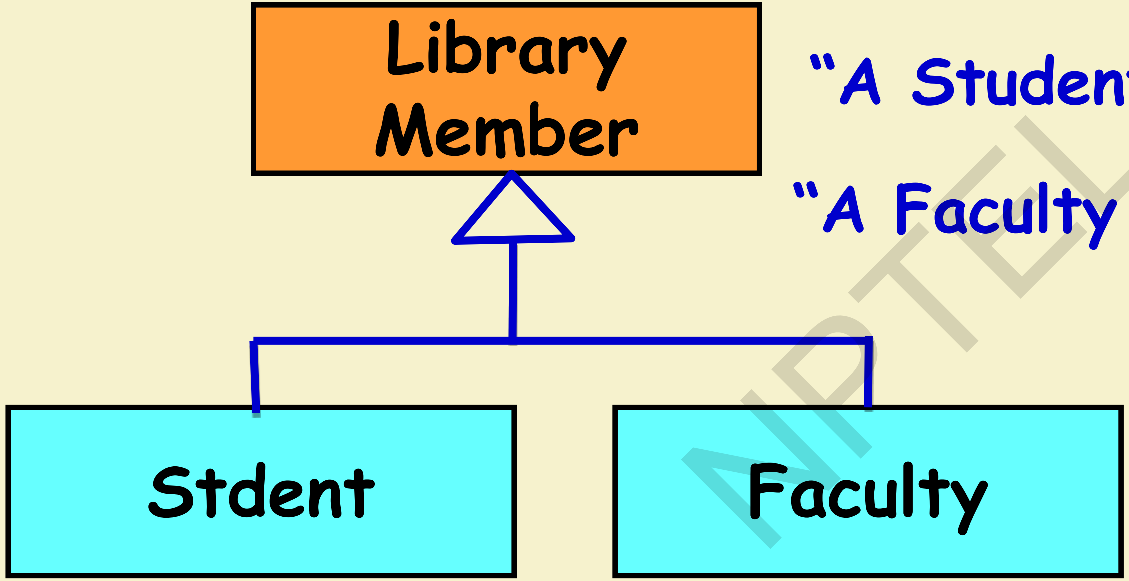
Inheritance One More Example



"A Student *ISA* Library Member"

"A Faculty *ISA* Library Member"

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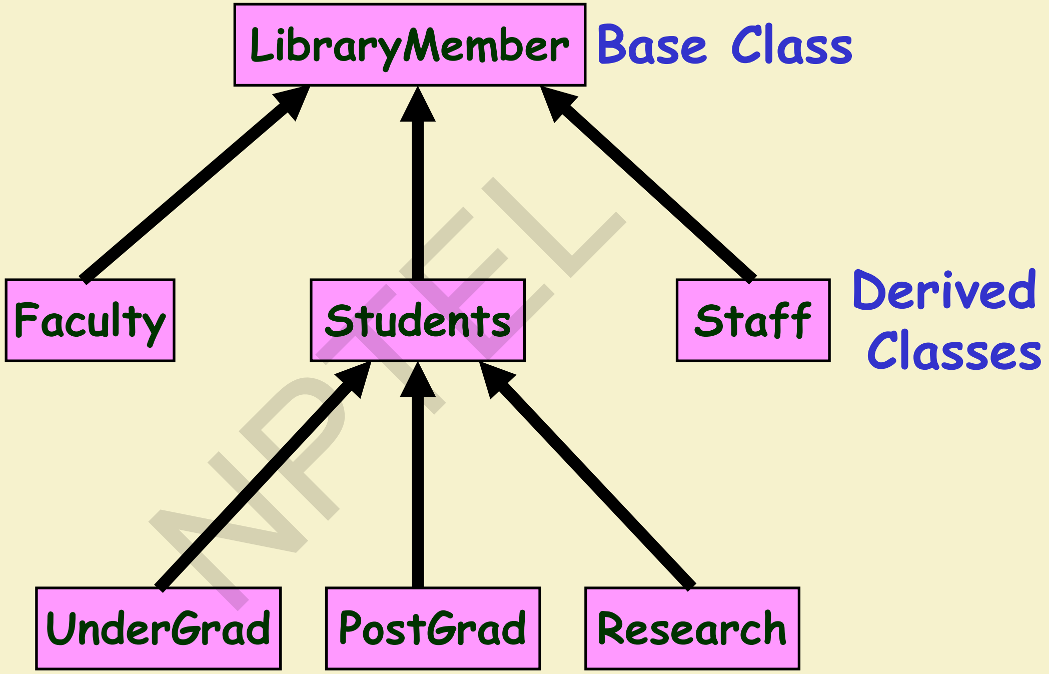
Inheritance: Semantics

- Lets a subclass inherit attributes and methods from a base class.



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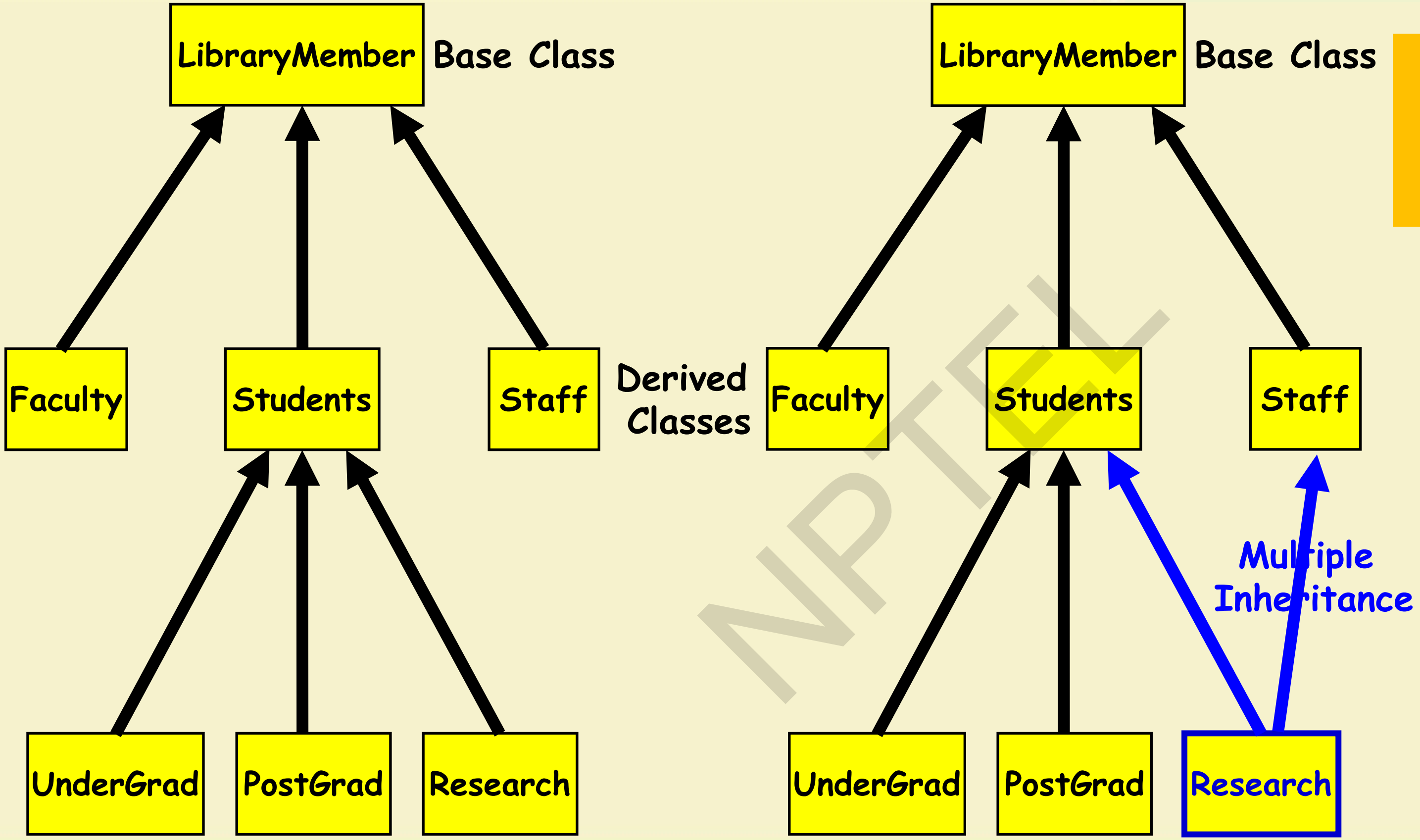
Multiple Inheritance



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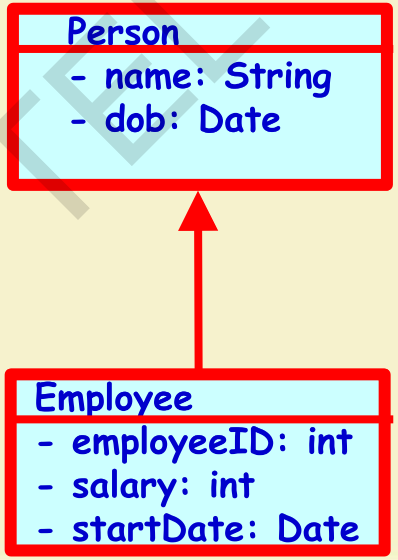
Inheritance Implementation in Java

- Inheritance is declared using the "extends" keyword
  - Even when no inheritance defined, the class implicitly extends a class called Object.

```
class Person{
   private String name;
   private Date dob;
   ...
}
```

```
class Employee extends Person{
   private int employeeID;
   private int salary;
   private Date startDate;
   ...
}
```

```
Employee anEmployee = new Employee();
```



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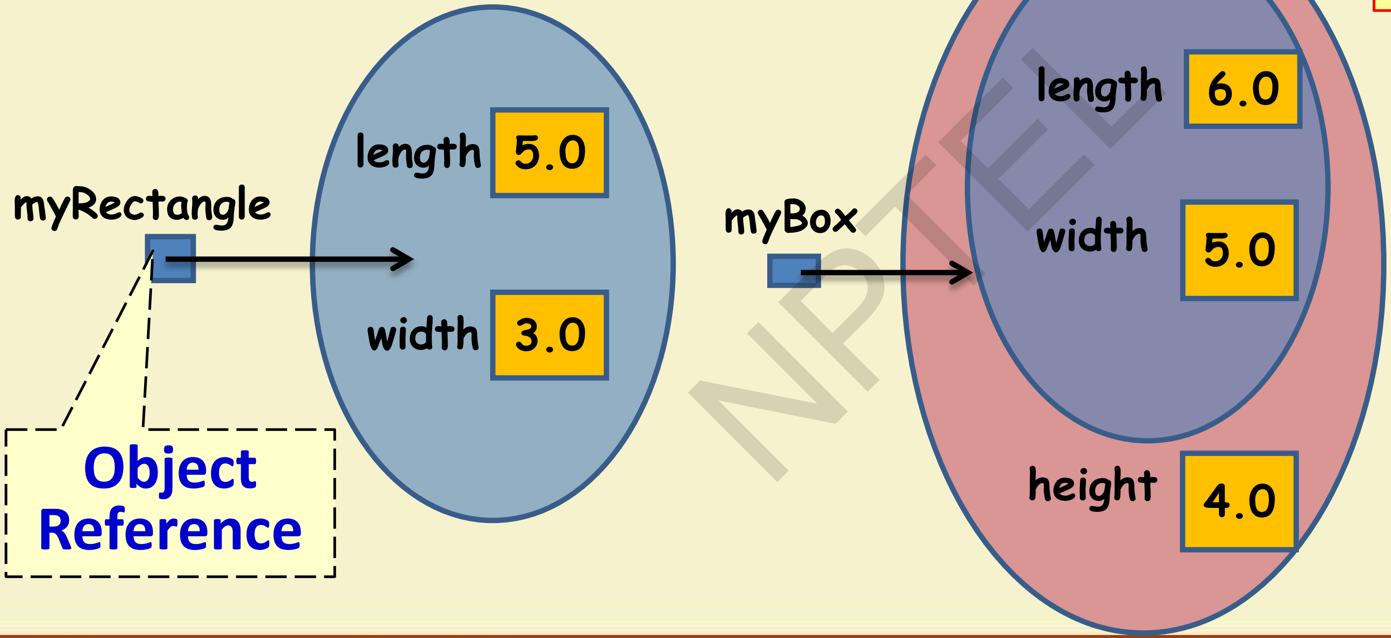
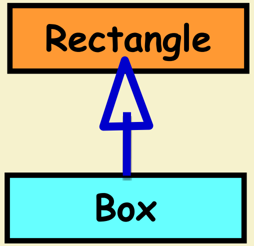
```
Rectangle myRectangle = new Rectangle(5, 3);
Box myBox = new Box(6, 5, 4);
```

Objects myRectangle and myBox





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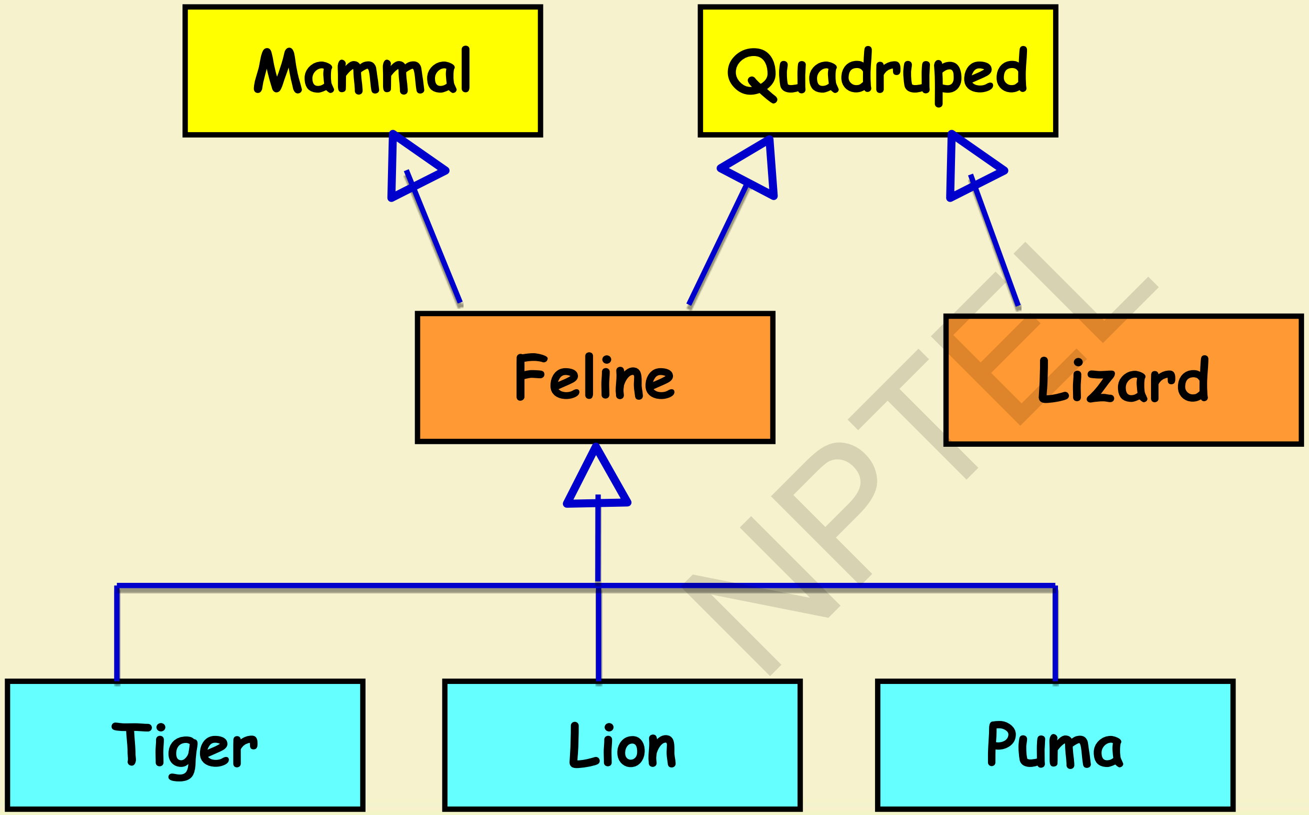
More Generalization Examples...



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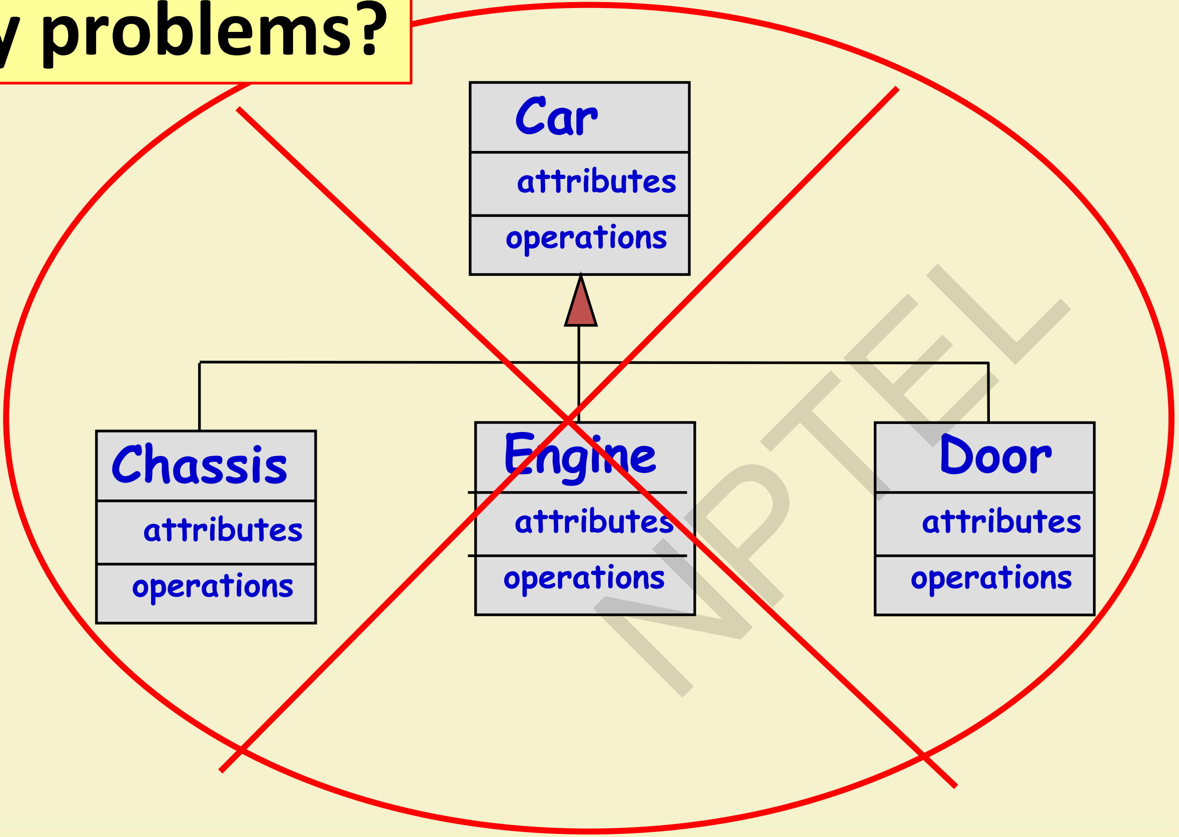
Any problems?



Wrong Generalization ---

violates "is a" or "is a kind of" heuristic

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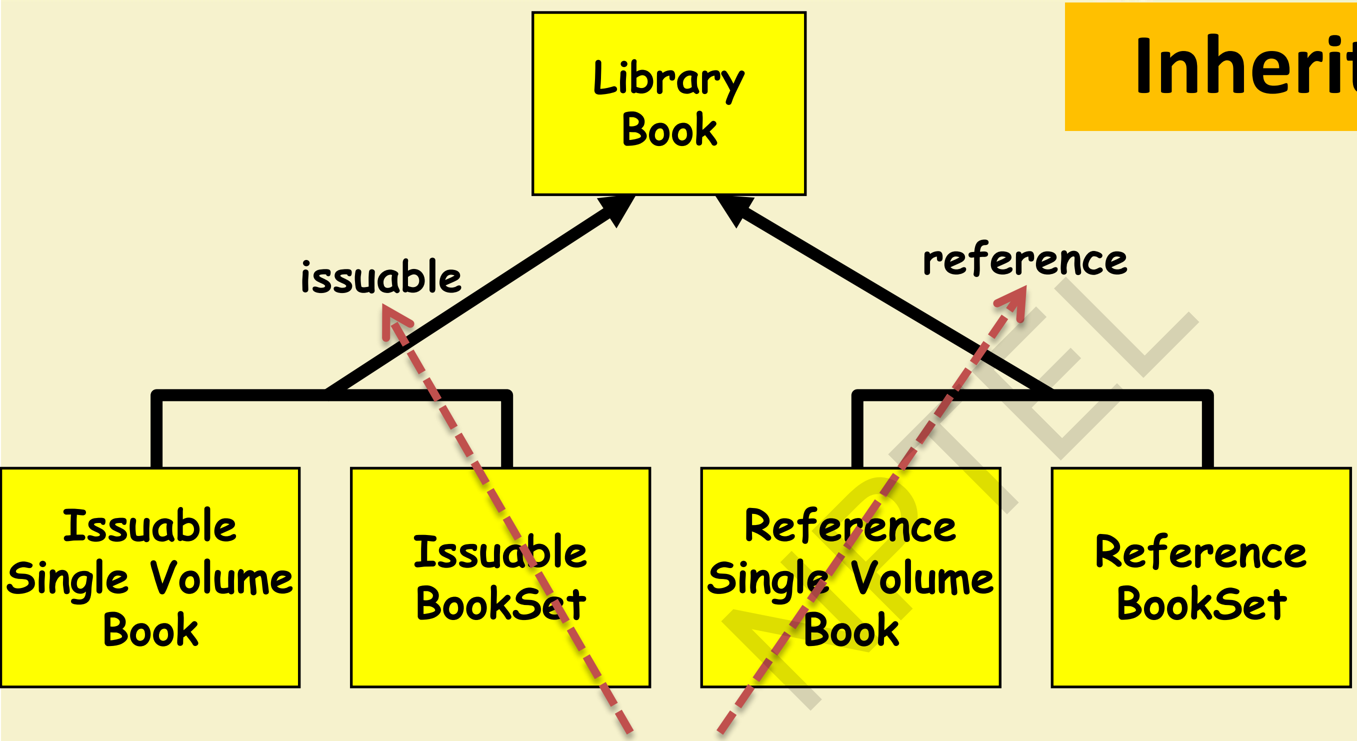
Inheritance Example



Discriminator: allows one to group subclasses into clusters that correspond to a semantic category.

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Inheritance Pitfalls

- Inheritance certainly promotes reuse.
- **Indiscriminate use can result in poor quality programs.**
- Base class attributes and methods visible in derived class…
  - Leads to tight coupling

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Association Relationship

- How implemented in program?
- Enables objects to communicate with each other:
  - –One object must “know” the ID of the corresponding object in the association.
- Usually binary:
  - –But in general can be n-ary.

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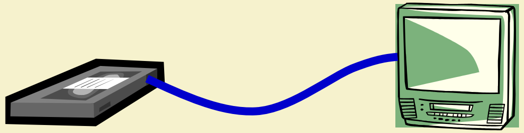
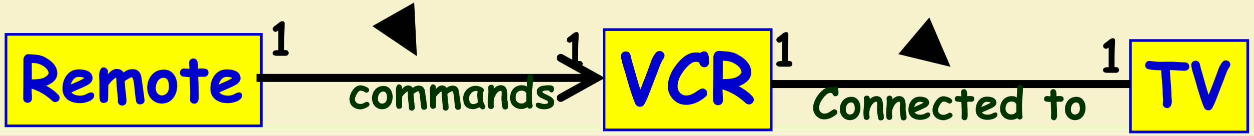
Association – An Example

- In a home theatre system,



  - A TV object is associated with a VCR object
    - It may receive a signal from the VCR
  - VCR may be associated with remote
    - It may receive a command to record



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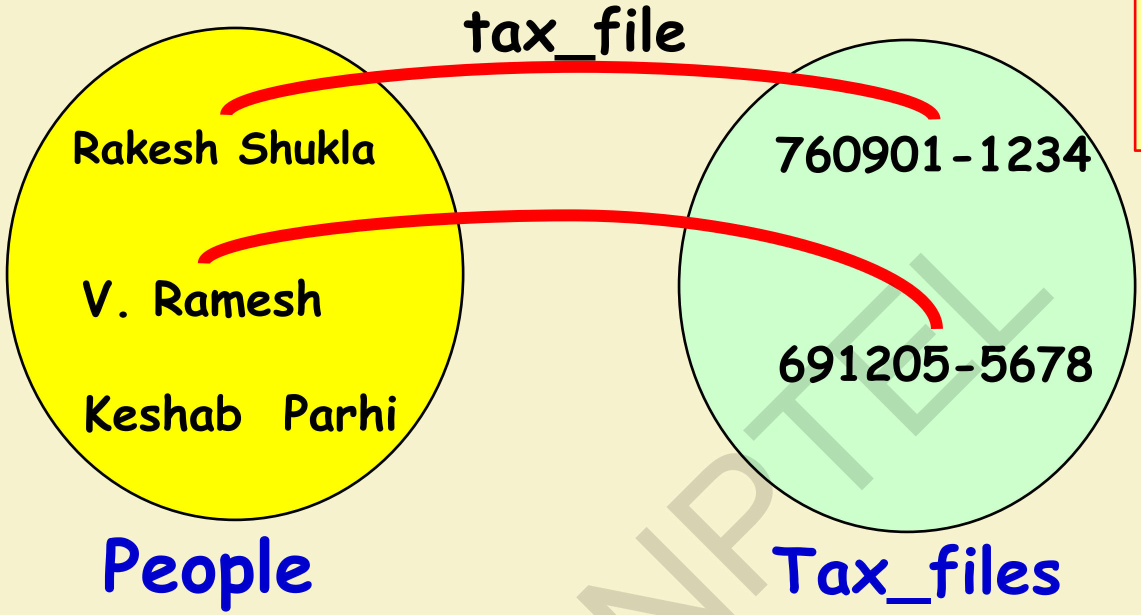
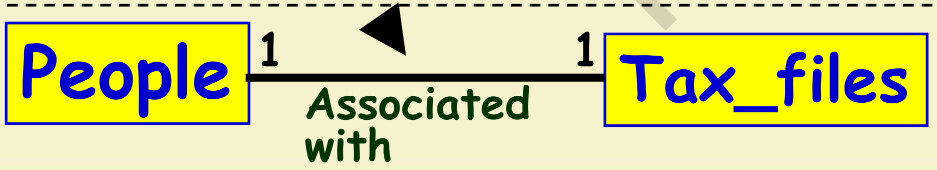
1-1 Association - example





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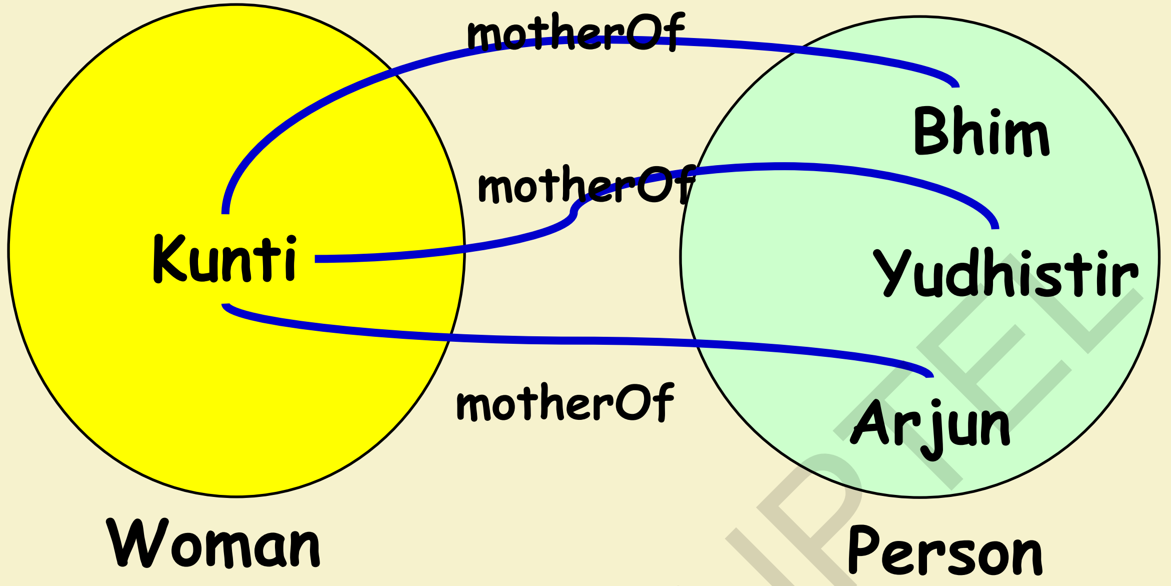
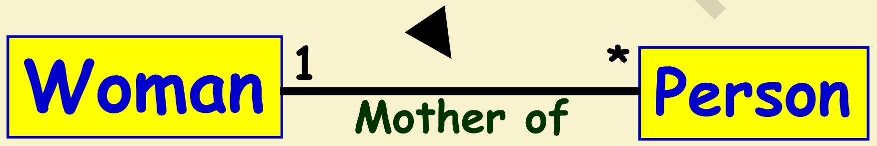
Multiple Association – example





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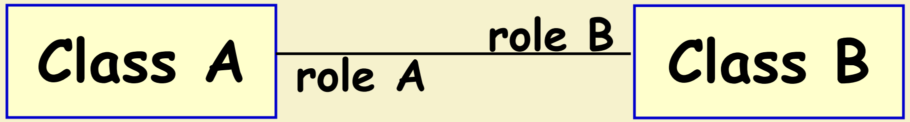
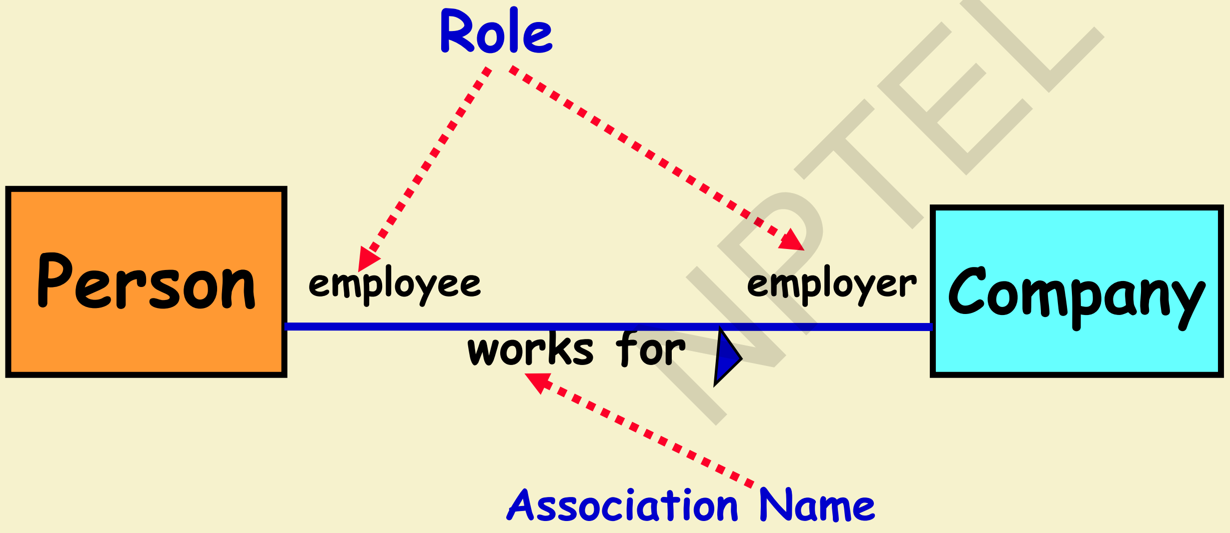
Association UML Syntax



- A Person works for a Company.



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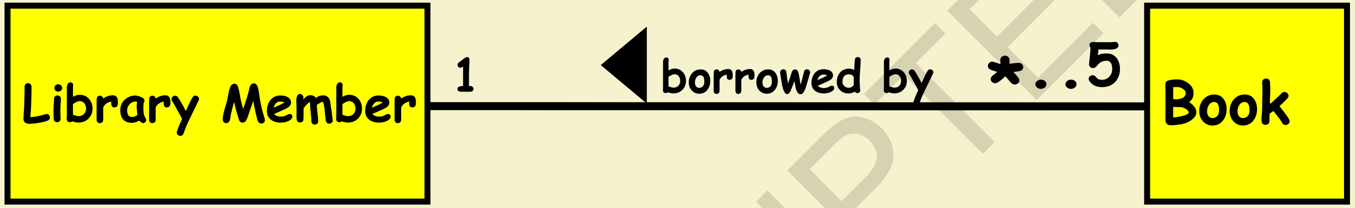
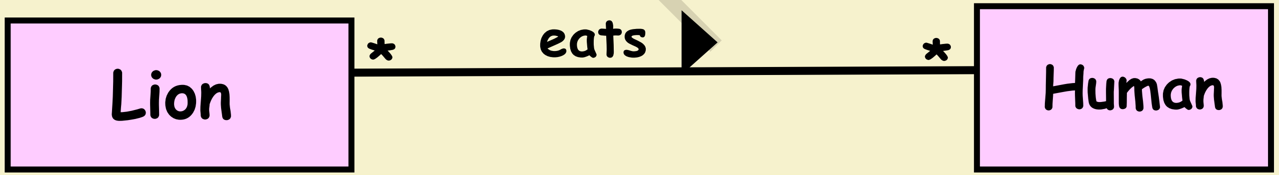
Association - More Examples

Multiplicity: The number of objects from one class that relate with a single object in an associated class.





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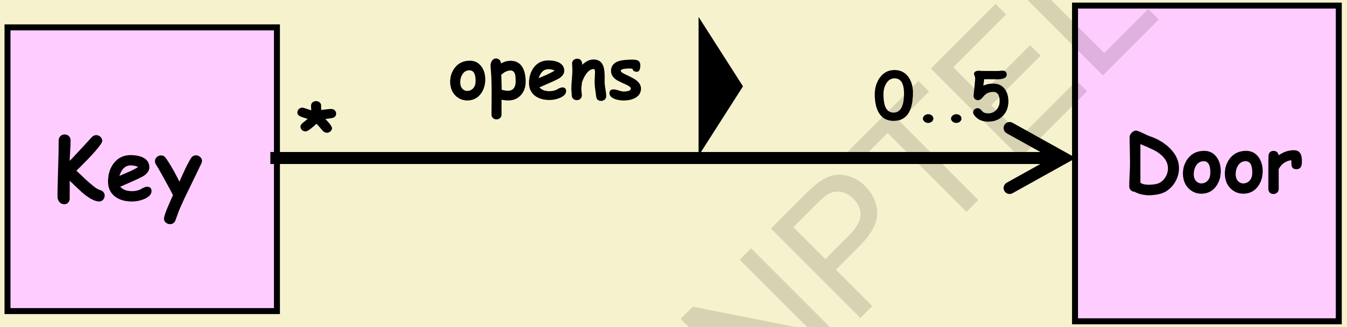
Navigability



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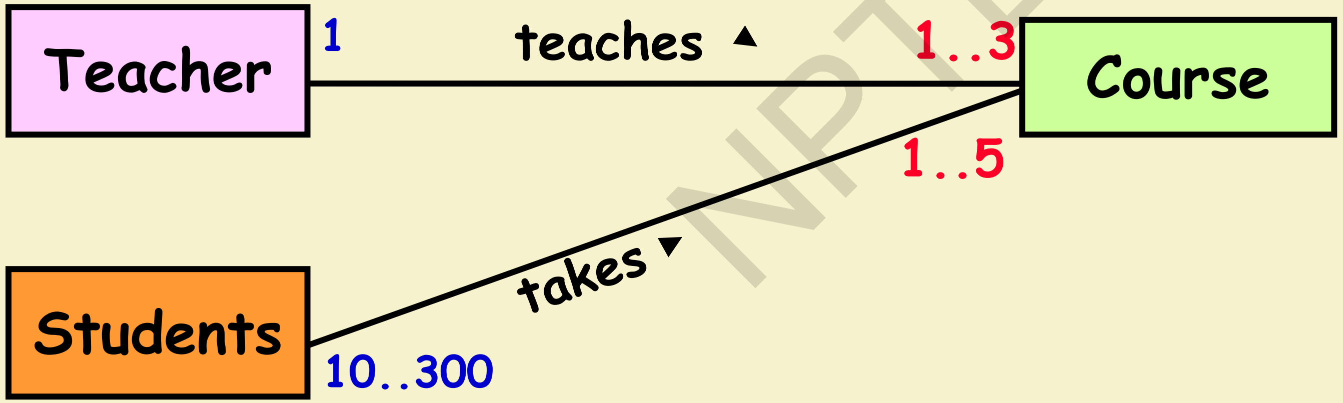
Association – Quiz 1

- A teacher teaches 1 to 3 courses (subjects)
- Each course is taught by only one teacher.
- A student can take between 1 to 5 courses.
- A course can have 10 to 300 students. Draw the class diagram.



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Quiz 2: Draw Class Diagram

- A Student can take up to five Courses.
- A student needs to enroll in at least one course.
- Up to 300 students can enroll in a course.
- An offered subject in a semester should have at least 10 registered students.

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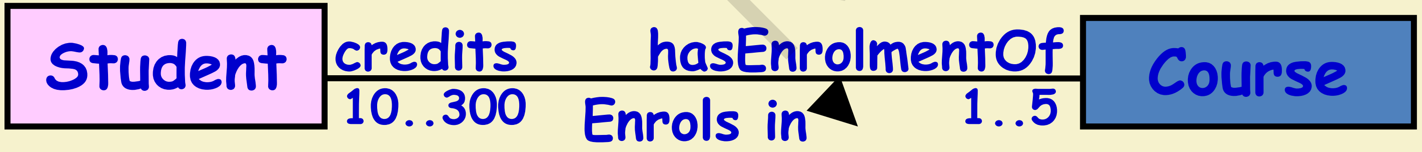

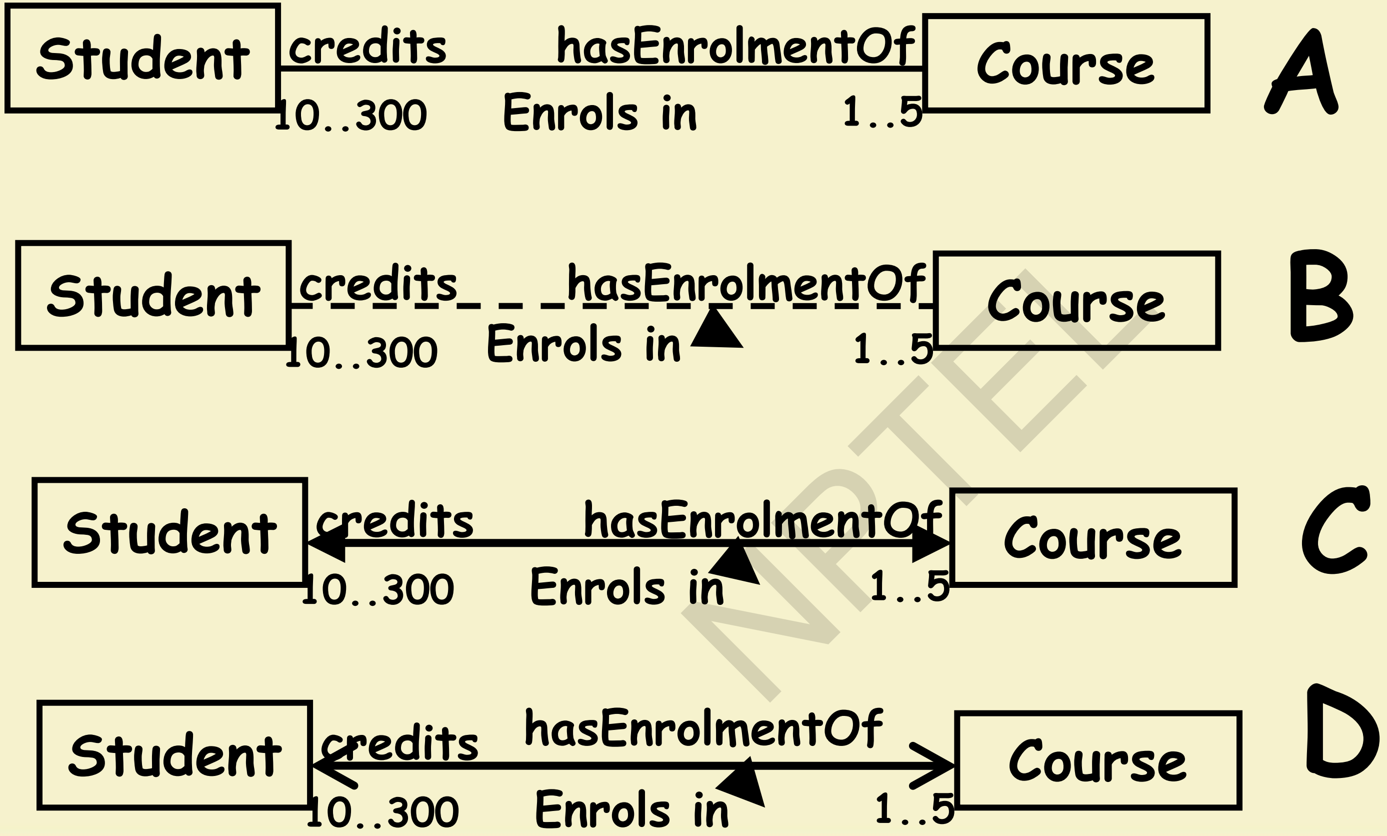

Identify as Correct or Wrong

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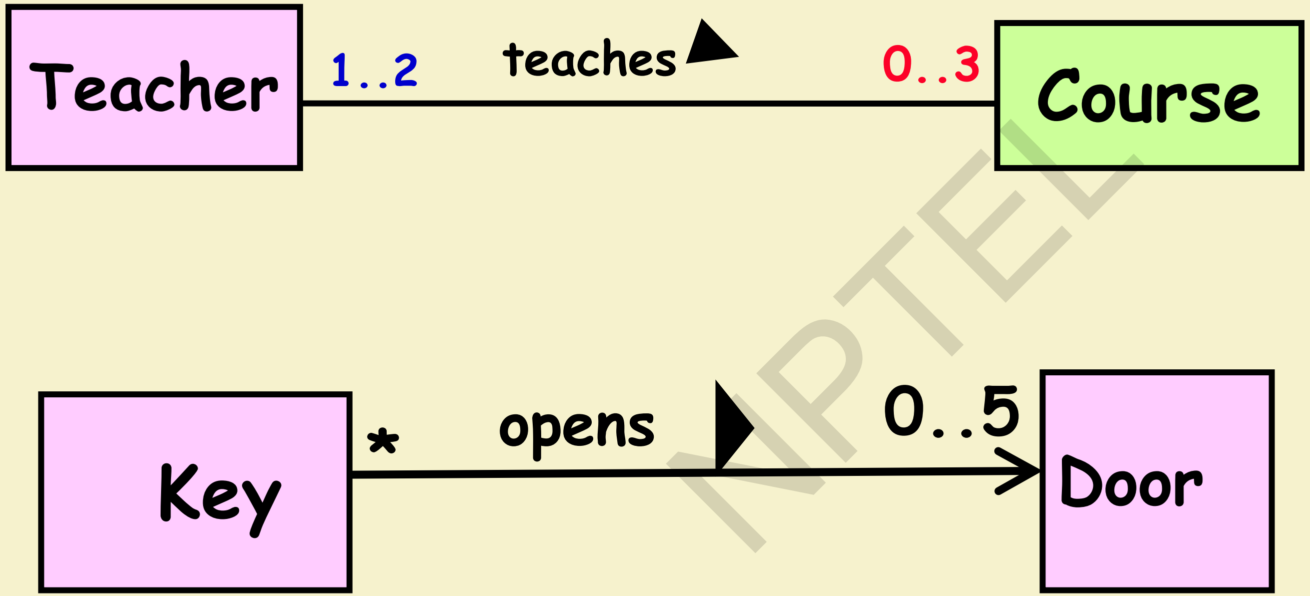
Quiz: Read the Diagram



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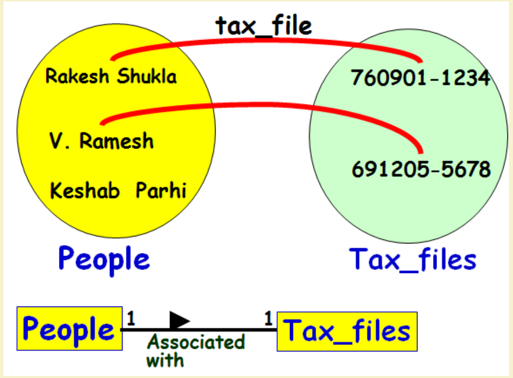
Association and Link

- **A link:**
  - An instance of an association
  - Exists between two or more objects
  - **Dynamically created and destroyed as the run of a system proceeds**
- For example:
  - An employee joins an organization.
  - Leaves that organization and joins a new organization.



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Unary Association

- A class can be associated with itself (**unary** association).
  - **Give an example?**
- An arrowhead used along with name:
  - Indicates direction of association.
- Multiplicity (association cardinality) indicates # of instances taking part in the association.

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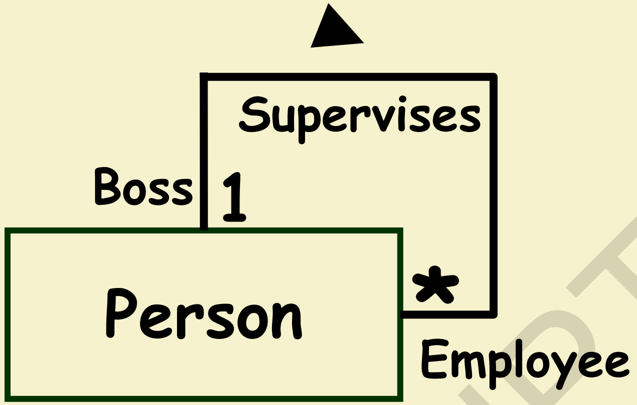
Uniary Association: Example 1



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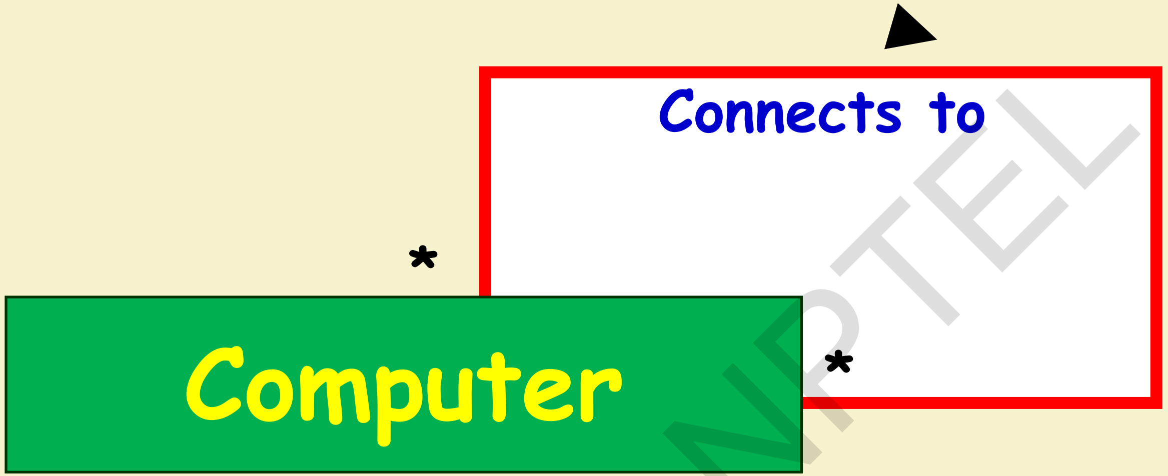
Self Association: Example 2 Computer Network



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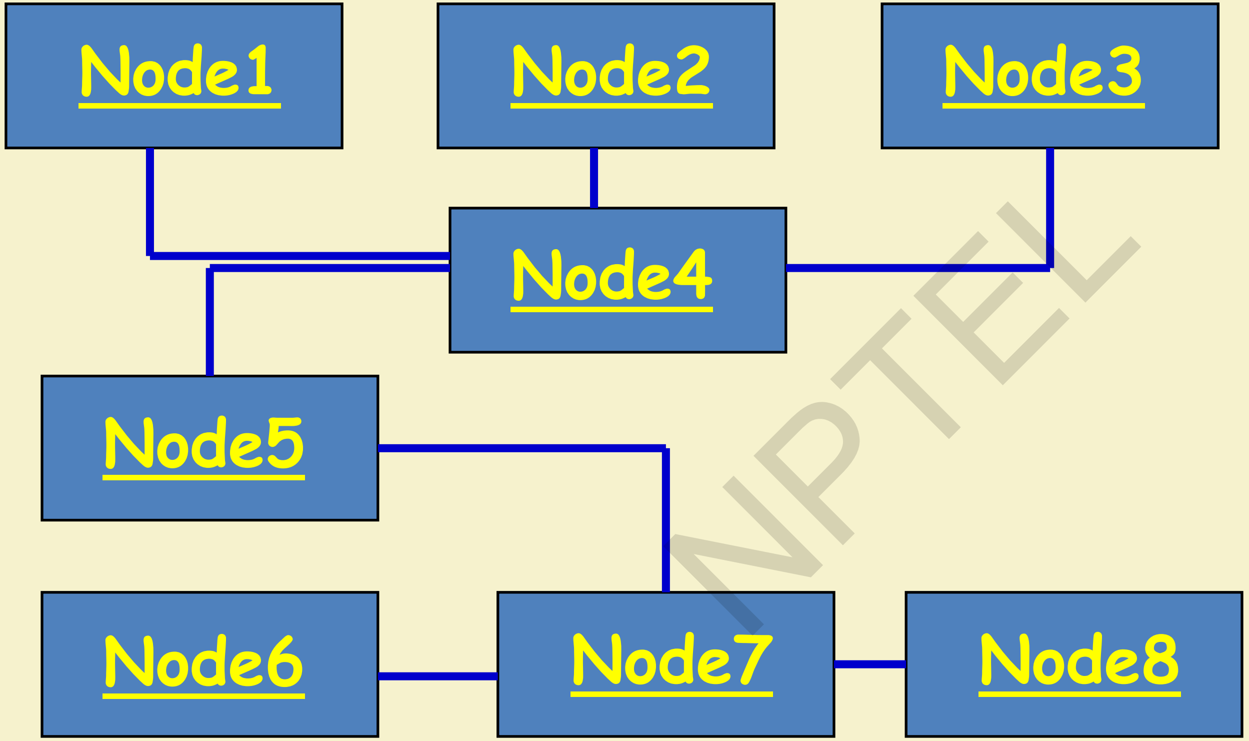
Computer Network: Object Diagram



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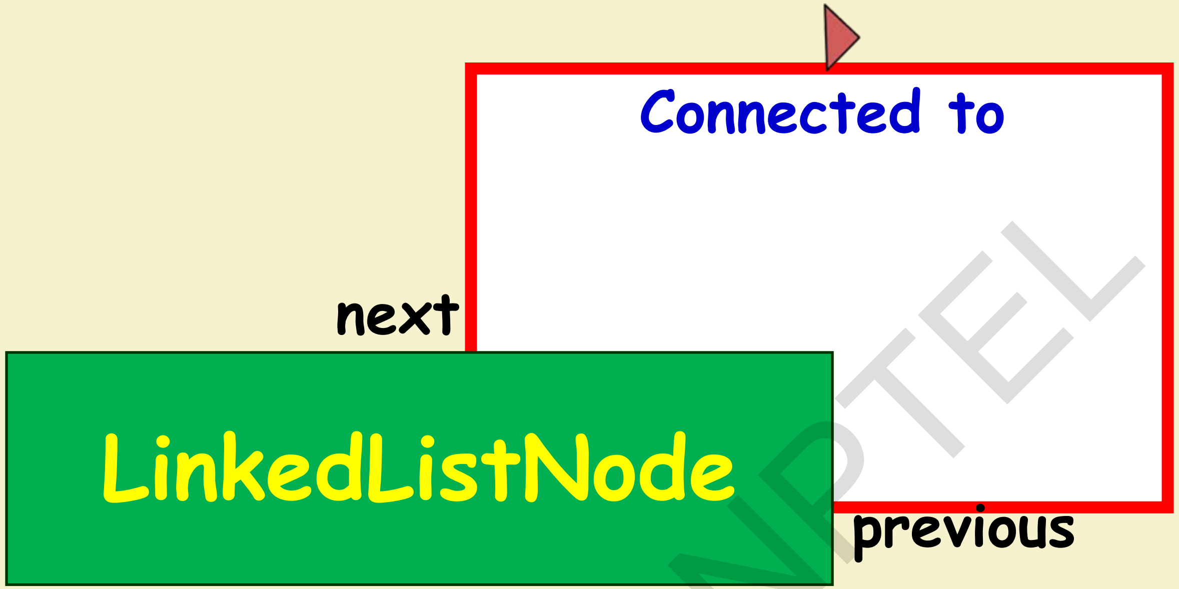
Self Association: Example 3



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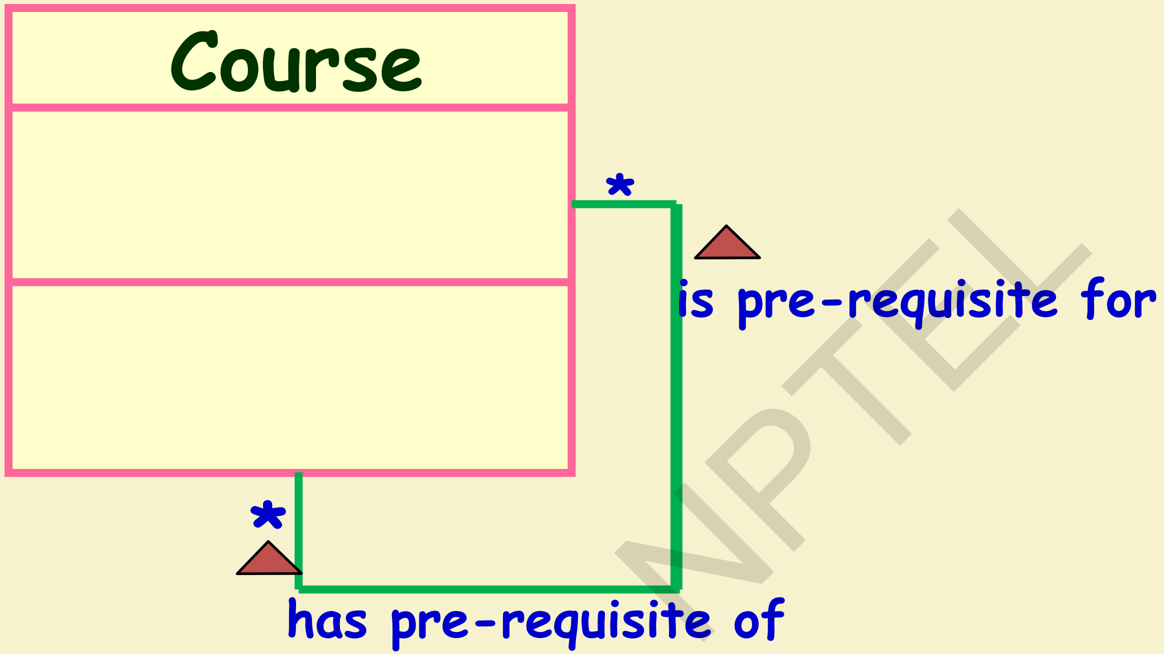
Reflexive Association: Example 4



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