UML - Class Diagram

2021-’22 Winter SWE B.Tech

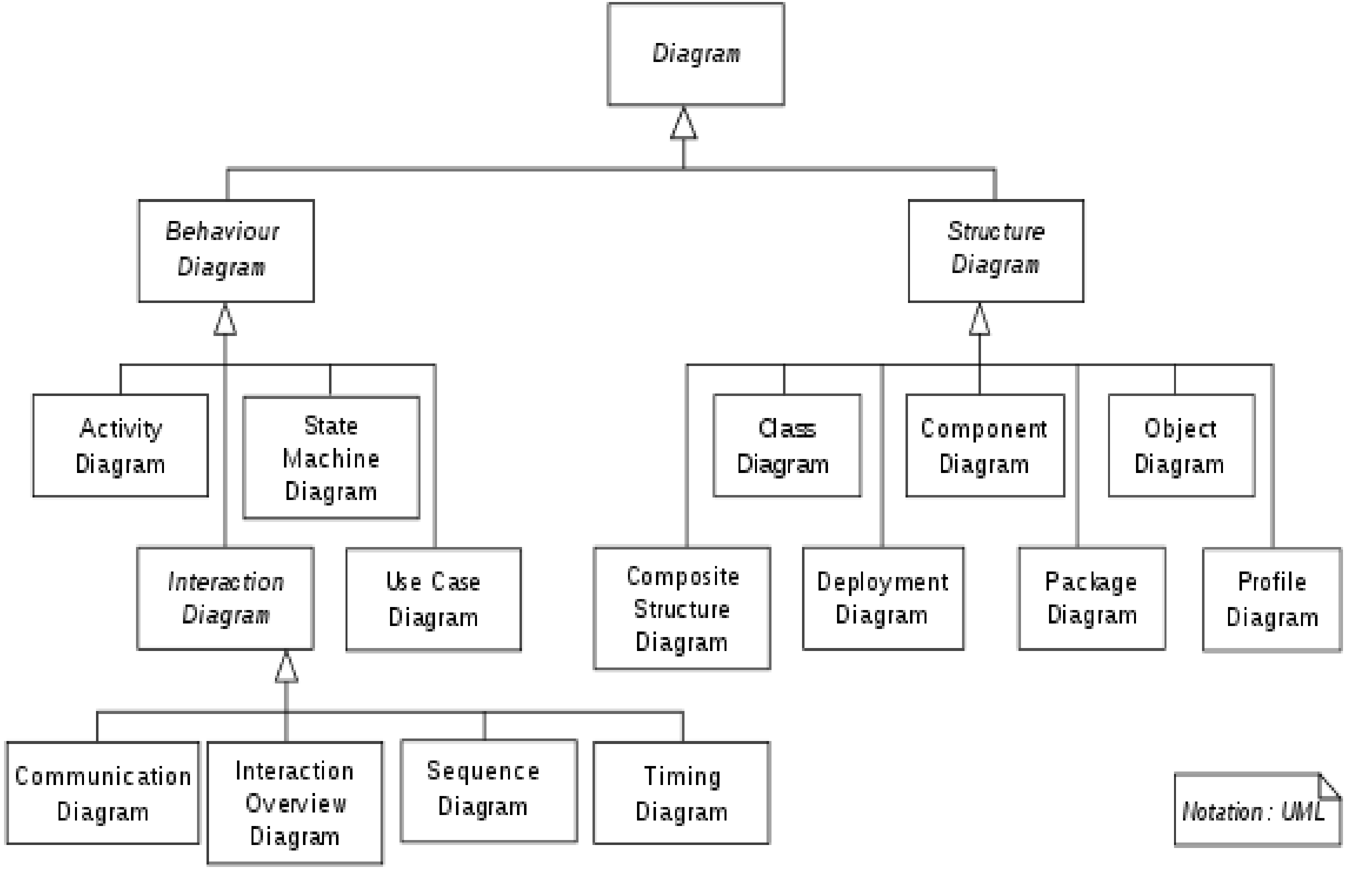


Diagram
Behaviour Diagram
Structure Diagram
Activity Diagram
State Machine Diagram
Interaction Diagram
Use Case Diagram
Class Diagram
Component Diagram
Object Diagram
Composite Structure Diagram
Deployment Diagram
Package Diagram
Profile Diagram
Communication Diagram
Interaction Overview Diagram
Sequence Diagram
Timing Diagram
Notation : UML

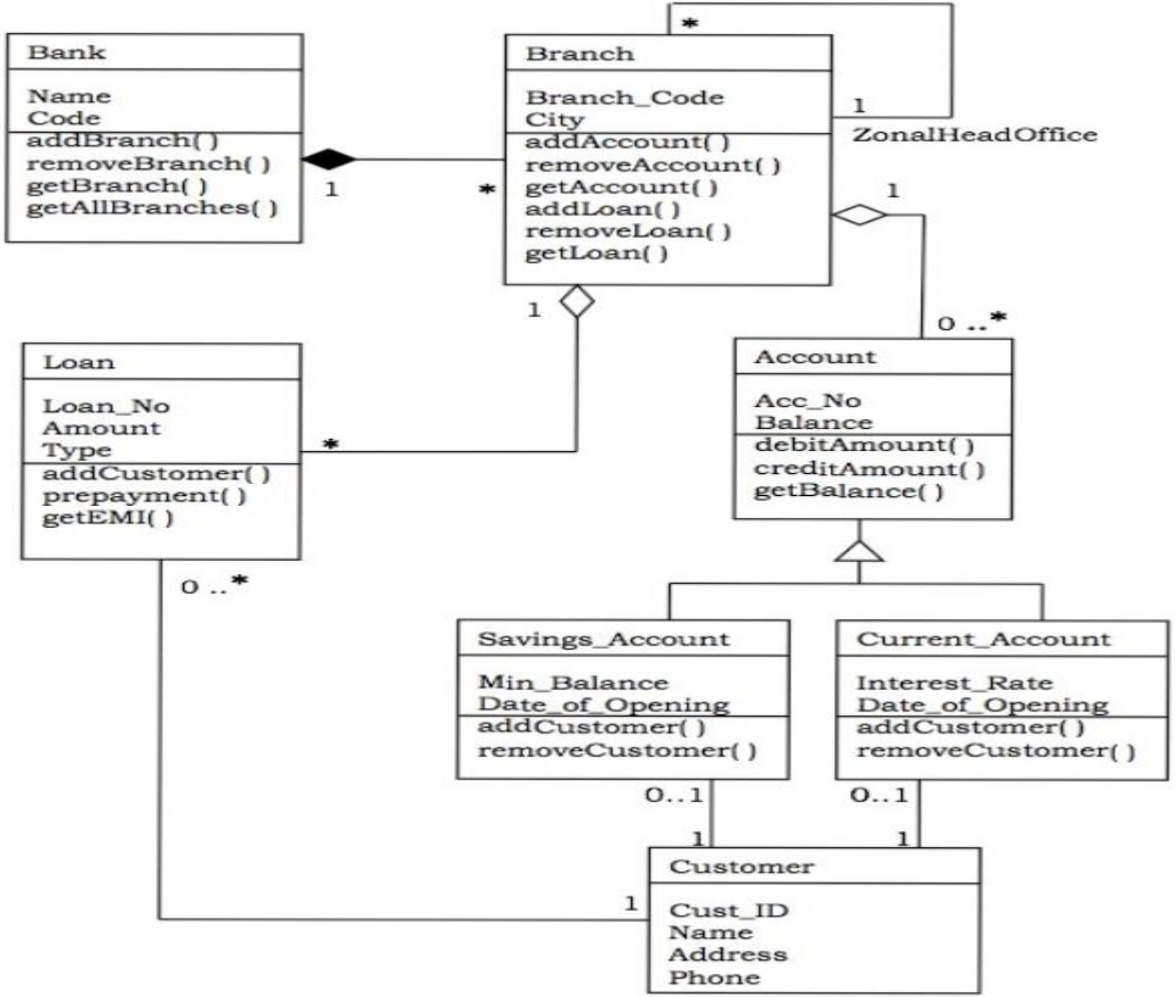
UML Class Diagram

- A type **of static structure diagram**

- In the design of a system**, a number of classes are identified and grouped together that helps to determine the static relations** between them.

Essentials of UML Class Diagrams

- *The main symbols shown on class diagrams are:*
    - ***Classes***
        - represent the types of data themselves
    - ***Attributes***
        - are simple data found in classes and their instances
    - ***Operations***
        - represent the functions performed by the classes and their instances
    - ***Associations***
        - represent linkages between instances of classes
    - ***Generalizations***
        - group classes into inheritance hierarchies



Bank

Name
Code

addBranch()
removeBranch( )
getBranch( )
getAllBranches( )

Branch

Branch_Code
City

addAccount( )
removeAccount( )
getAccount( )
addLoan( )
removeLoan( )
getLoan( )

Loan

Loan_No
Amount
Type

addCustomer( )
prepayment( )
getEMI( )

Account

Acc_No
Balance

debitAmount( )
creditAmount( )
getBalance( )

Savings_Account

Min_Balance
Date_of_Opening

addCustomer( )
removeCustomer( )

Current_Account

Interest_Rate
Date_of_Opening

addCustomer( )
removeCustomer( )

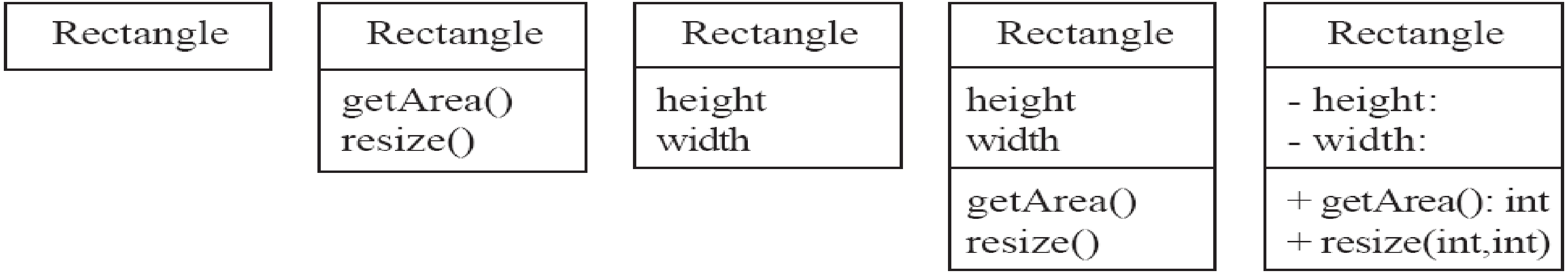
Customer

Cust_ID
Name
Address
Phone

Classes

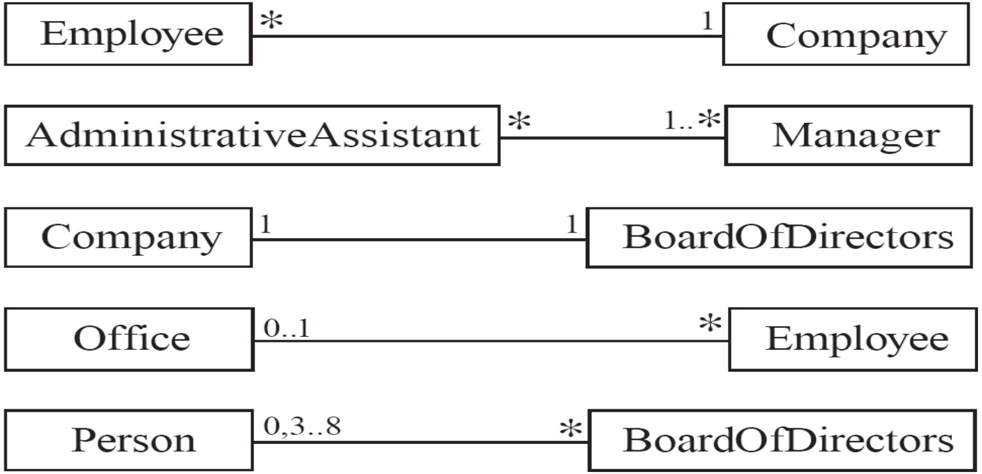
- A class is simply represented as a box with the name of the class
- The complete signature of an operation is:

operationName(parameterName: parameterType …): returnType



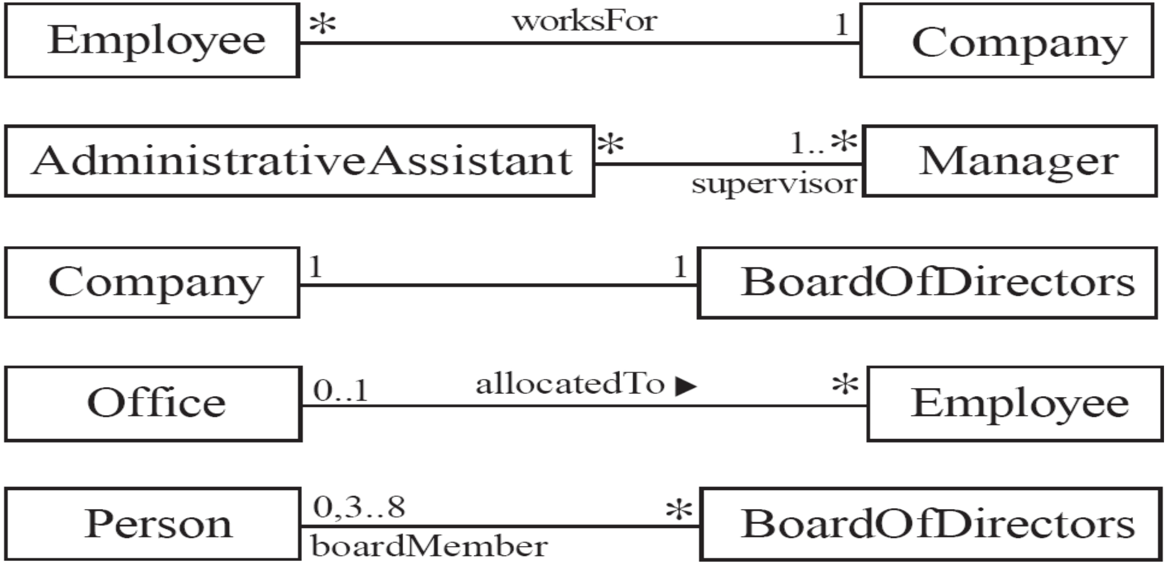
Associations and Multiplicity

An ***association*** is used to show how two classes are related to each other. Symbols indicating ***multiplicity*** are shown at each end of the association



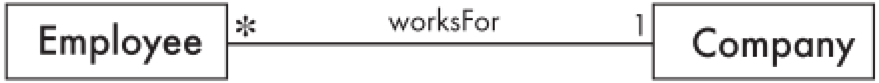
Labelling associations

- Each association can be labelled, to make explicit the nature of the association



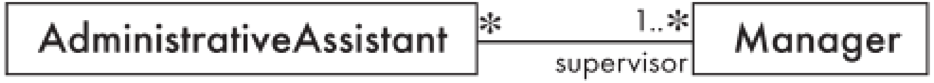
Analyzing and validating associations

- **One to many**
  - A company has many employees,
  - An employee can only work for one company.
  - A company can have zero employees
  - It is not possible to be an employee unless you work for a company



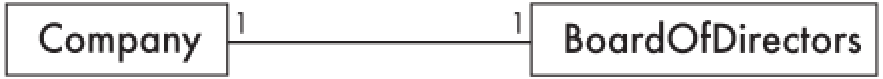
Analyzing and validating associations

- **Many-to-many**
  - An assistant can work for many managers
  - A manager can have many assistants
  - Managers can have a group of assistants
  - Some managers might have zero assistants.
  - Is it possible for an assistant to have, perhaps temporarily, zero managers?



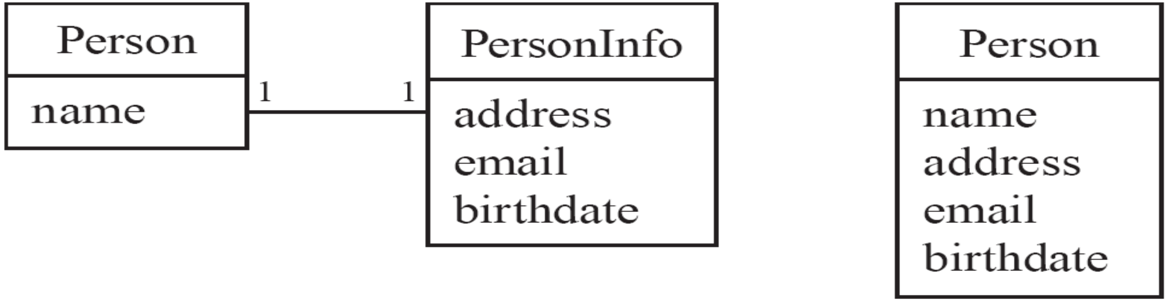
Analyzing and validating associations

- **One-to-one**
  - For each company, there is exactly one board of directors
  - A board is the board of only one company
  - A company must always have a board
  - A board must always be of some company



Analyzing and validating associations

- Avoid unnecessary one-to-one associations



Person

name

1

1

PersonInfo

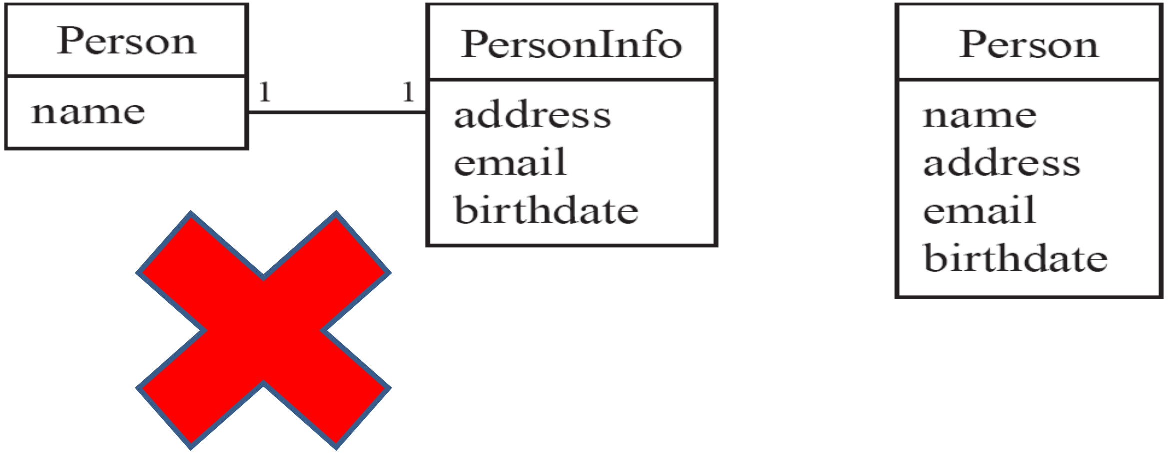
address
email
birthdate

Person

name
address
email
birthdate

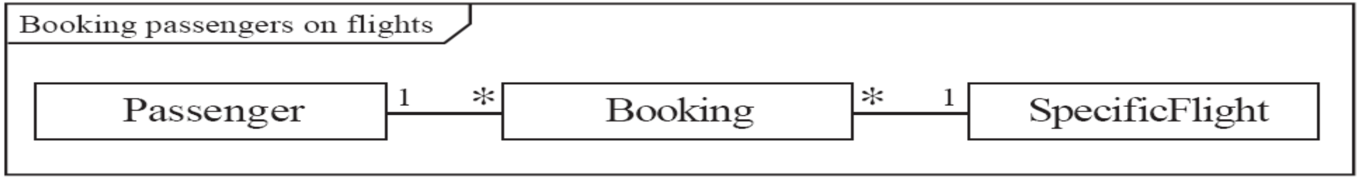
Analyzing and validating associations

- Avoid unnecessary one-to-one associations

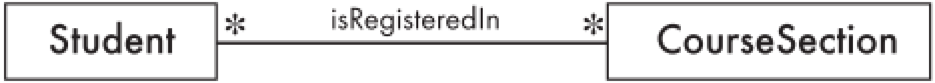


A more complex example

- A booking is always for exactly one passenger
  - no booking with zero passengers
  - a booking could *never* involve more than one passenger.
- A Passenger can have any number of Bookings
  - a passenger could have no bookings at all
  - a passenger could have more than one booking



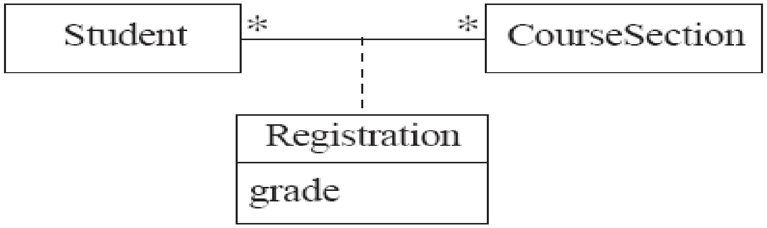
Association classes

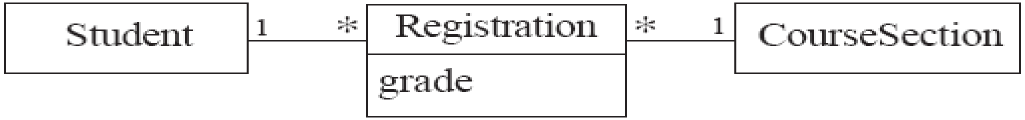


Grade???

Association classes

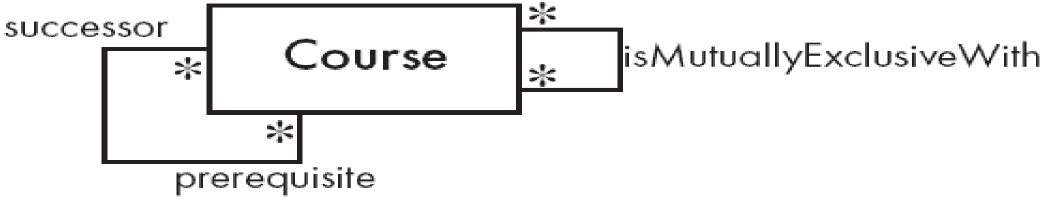
- Sometimes, an attribute that concerns two associated classes cannot be placed in either of the classes
- The following are equivalent





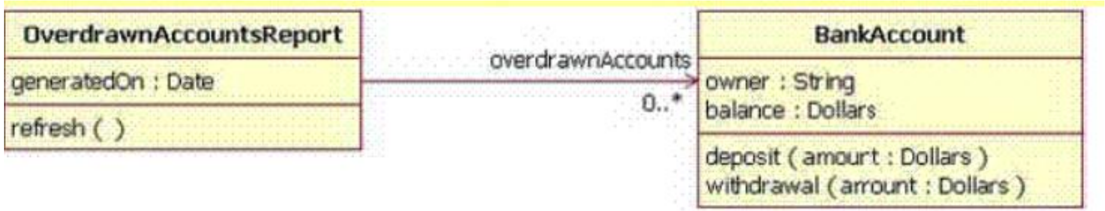
Reflexive associations

- It is possible for an association to connect a class to itself



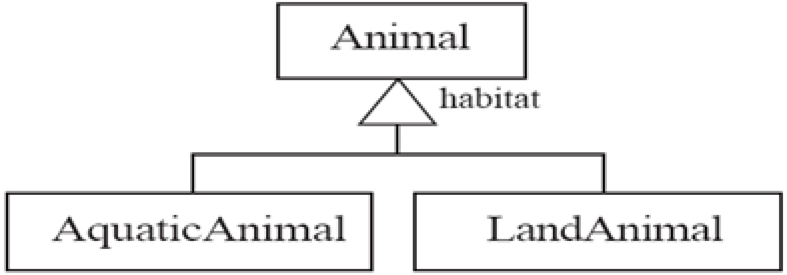
Directionality in associations

- Associations are by default *bi-directional*
- It is possible to limit the direction of an association by adding an arrow at one end

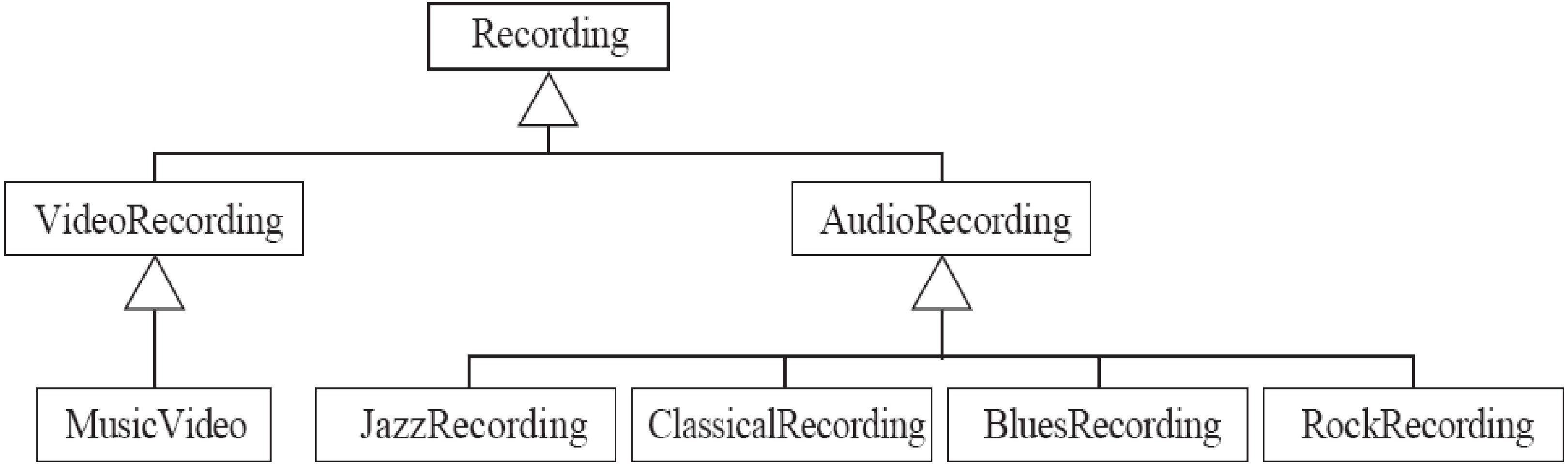


Generalization

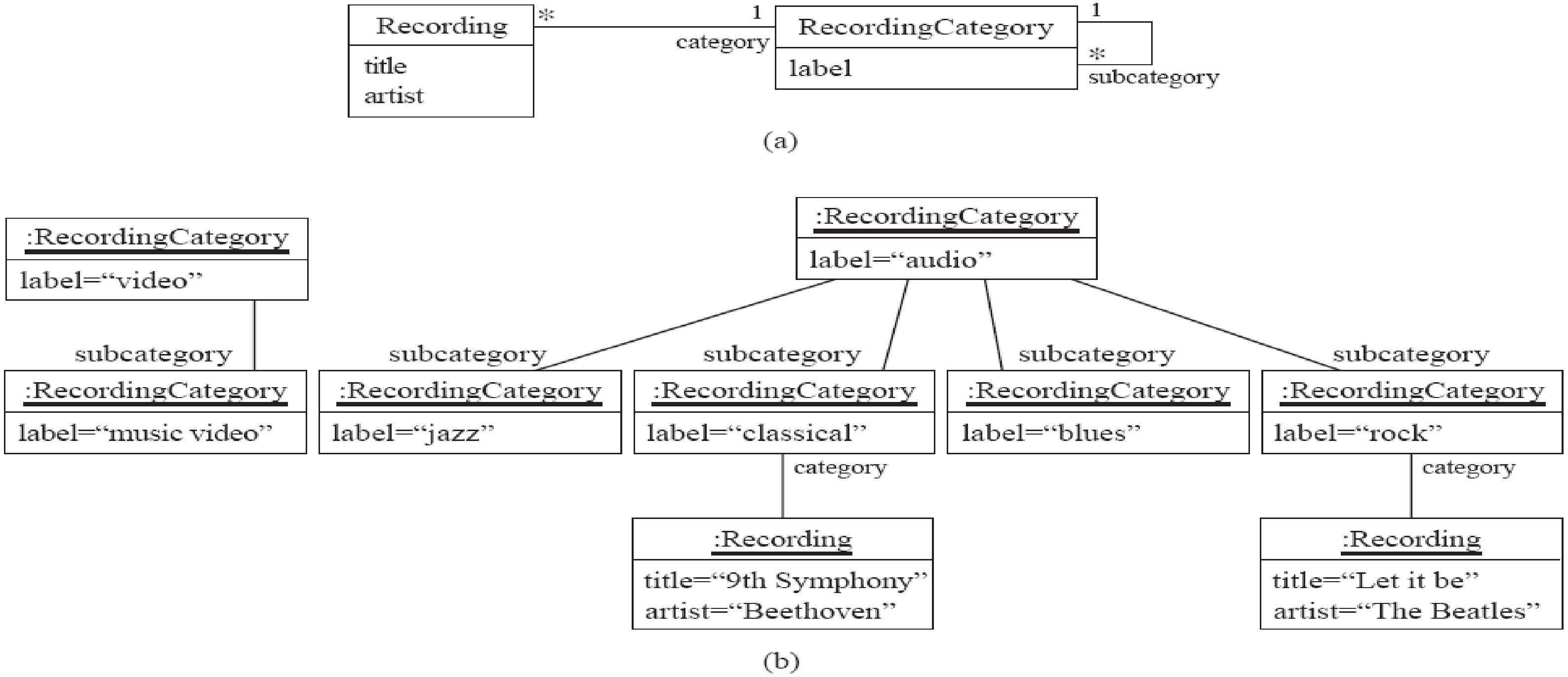
- Specializing a superclass into two or more subclasses
  - A *generalization set* is a labeled group of generalizations with a common superclass
  - The label (sometimes called the *discriminator*) describes the criteria used in the specialization



Avoiding unnecessary generalizations



Avoiding unnecessary generalizations (cont)

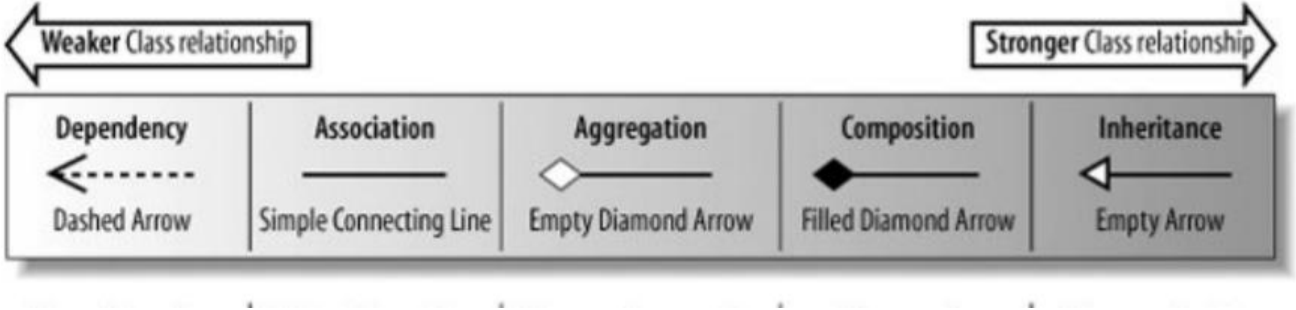


(a)

(b)

Improved class diagram, with its corresponding instance diagram

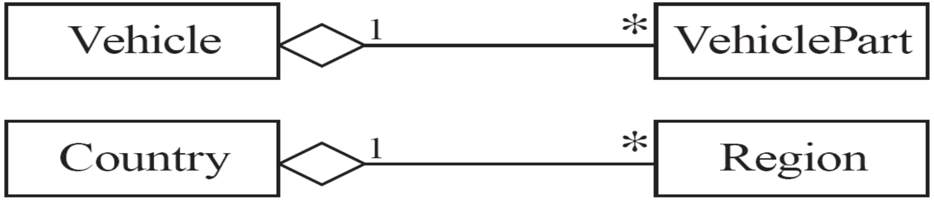
Relationships



Aggregation

Aggregations are special associations that represent ‘part-whole’ relationships.

- The ‘whole’ side is often called the *assembly* or the *aggregate*
- This symbol is a shorthand notation association named isPartOf



When to use an aggregation

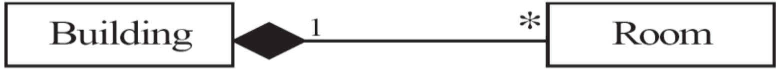
As a general rule, you can mark an association as an aggregation if the following are true:

- *The parts **‘are part of’** the aggregate or the aggregate **‘is composed of’** the parts*
- *When something **owns or controls** the aggregate, then they also own or control the parts*

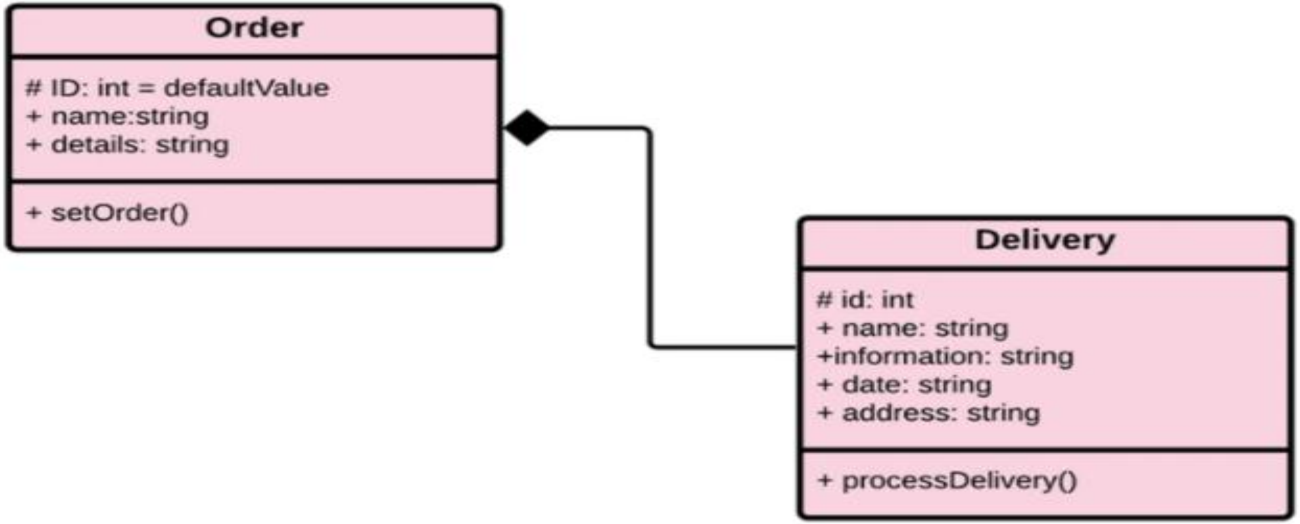
Composition

A *composition* is a strong kind of aggregation

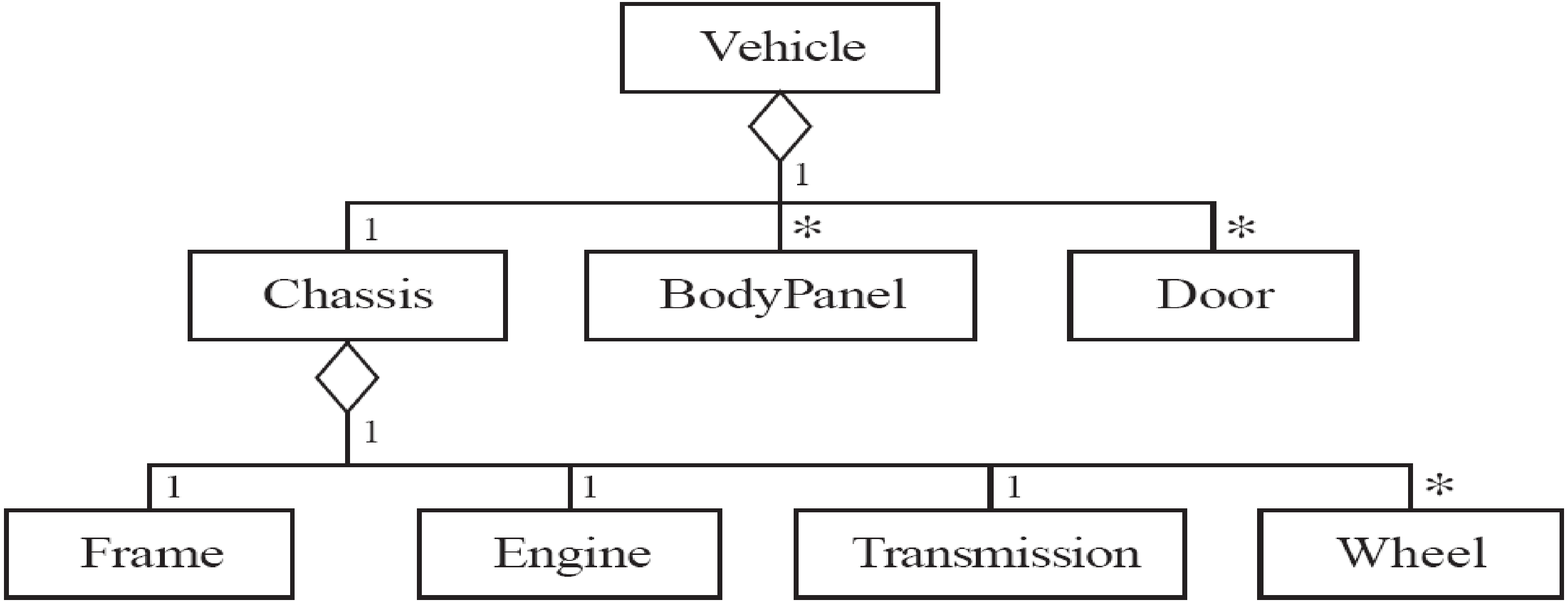
- if the aggregate is destroyed, then the parts are destroyed as well



Composition Example

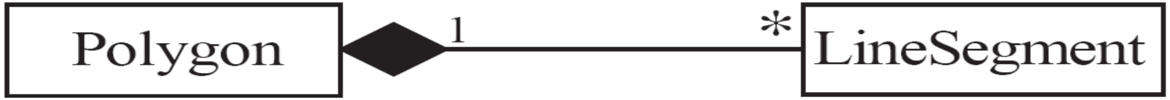


Aggregation hierarchy



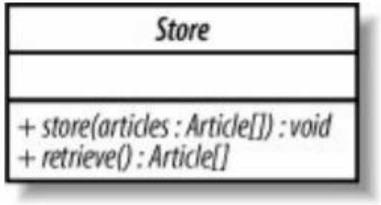
Propagation

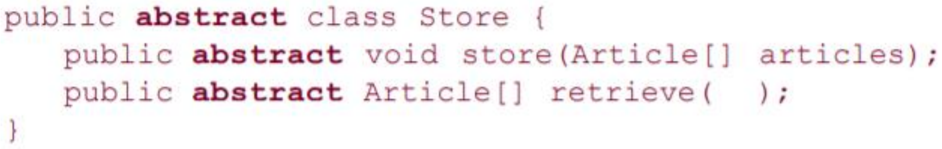
- A mechanism where an **operation in an aggregate** is implemented by having the aggregate perform that operation on its parts
- At the same time, **properties of the parts are often propagated back** to the aggregate



Abstract class

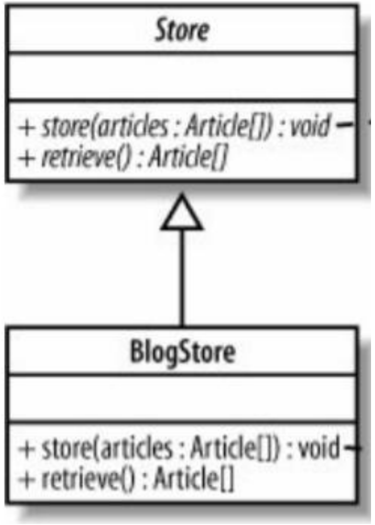
- When the concrete implementation of methods are left for the subclasses.
- Can contain both abstract and non-abstract methods





```
public abstract class Store {
   public abstract void store(Article[] articles);
   public abstract Article[] retrieve(  );
}
```

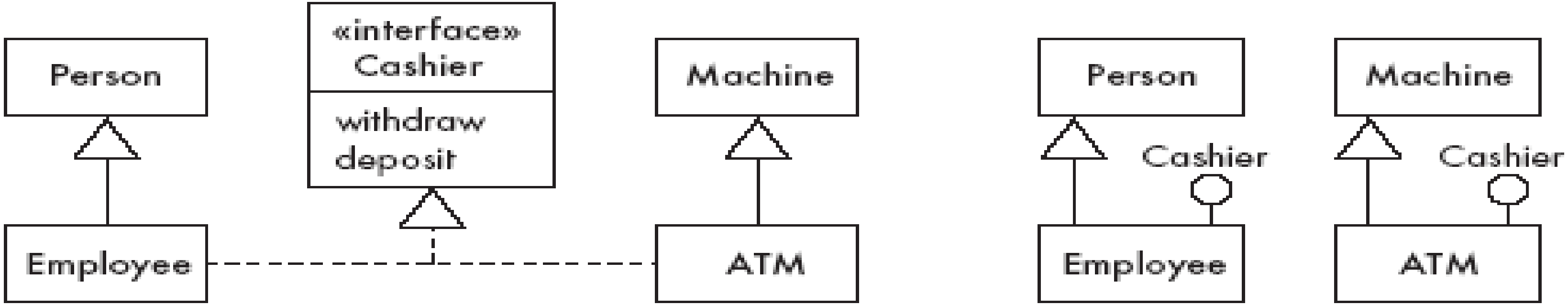
Abstract class



Store
+ *store(articles : Article[]) : void*
+ *retrieve() : Article[]*
BlogStore
+ store(articles : Article[]) : void
+ retrieve() : Article[]

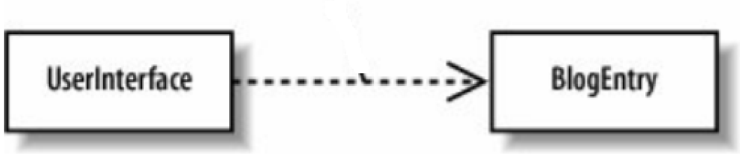
Interfaces

- An *interface* is similar to a class, except it lacks instance variables and implemented methods
- An interface describes a *portion of the visible behaviour* of a set of objects.



Dependency

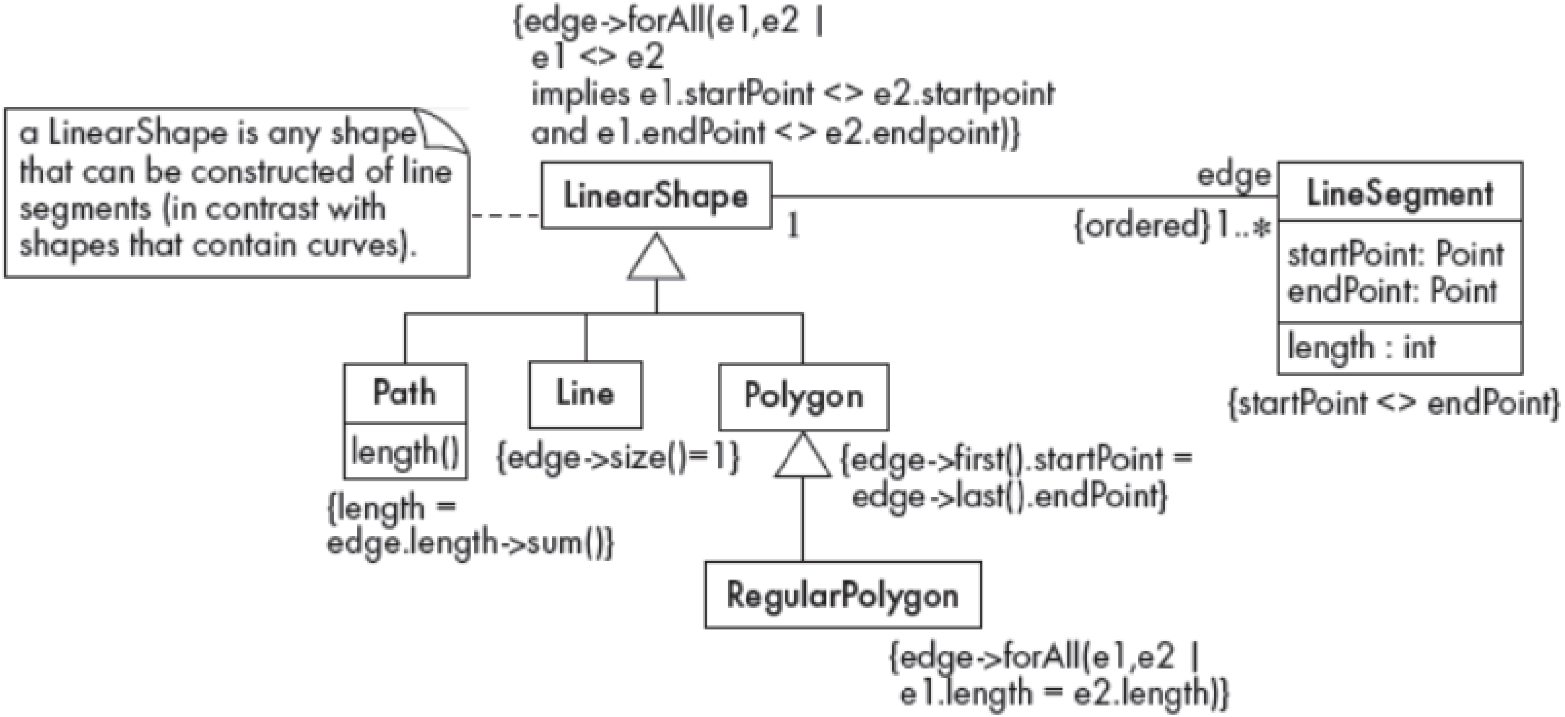
- A class needs to know about the other class in order use it's objects
- When the UserInterface wants to display, it accesses BlogEntry



- Dependency implies only that the classes can work together, so is the weakest relationship

Notes and descriptive text

- **Descriptive text and other diagrams**
  - Embed your diagrams in a larger document
  - Text can explain aspects of the system using any notation you like
  - Highlight and expand on important features, and give rationale
- **Notes**:
  - A note is a small block of text embedded *in* a UML diagram
  - It acts like a comment in a programming language
- Constraints:
  - A constraint is like a note, except that it is written in a formal language that can be interpreted by a computer
  - Recommended language is Object Constraint Language



{edge->forAll(e1,e2 |
e1 <> e2
implies e1.startPoint <> e2.startpoint
and e1.endPoint <> e2.endpoint)}

a LinearShape is any shape that can be constructed of line segments (in contrast with shapes that contain curves).

LinearShape

1

edge

{ordered} 1..*

LineSegment

startPoint: Point
endPoint: Point

length : int

{startPoint <> endPoint}

Path

length()

{length =
edge.length->sum()}

Line

{edge->size()=1}

Polygon

{edge->first().startPoint =
edge->last().endPoint}

RegularPolygon

{edge->forAll(e1,e2 |
e1.length = e2.length)}

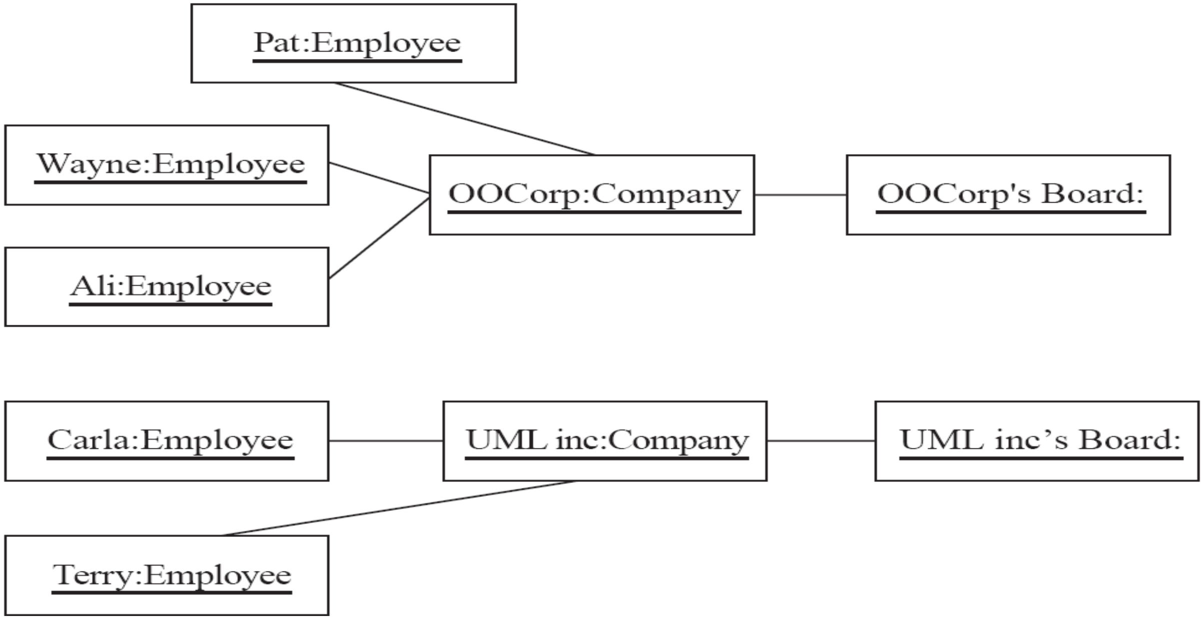
Suggested sequence of activities

- Identify a first set of candidate **classes**
- Add **associations** and **attributes**
- Find **generalizations**
- List the main **responsibilities** of each class
- Decide on specific **operations**
- **Iterate** over the entire process until the model is satisfactory
  - Add or delete classes, associations, attributes, generalizations, responsibilities or operations
  - Identify interfaces

Don’t be too disorganized. Don’t be too rigid either.

Object Diagrams

- A *link* is an instance of an association
  - In the same way that we say an object is an instance of a class



Associations versus generalizations in object diagrams

- Associations describe the relationships that will exist between *instances* at run time.
  - When you show an instance diagram generated from a class diagram, there will be an instance of *both* classes joined by an association

- Generalizations describe relationships between *classes* in class diagrams.
  - They do not appear in instance diagrams at all.
  - An instance of any class should also be considered to be an instance of each of that class’s superclasses