Class modelling (part 2)

Fabrizio Maria Maggi

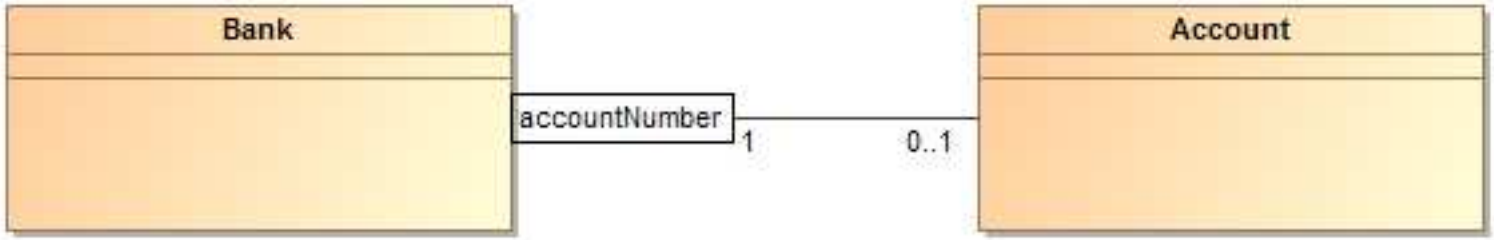
Institute of Computer Science

(these slides are derived from the book "Object-oriented modeling and design with UML")

Qualified Associations

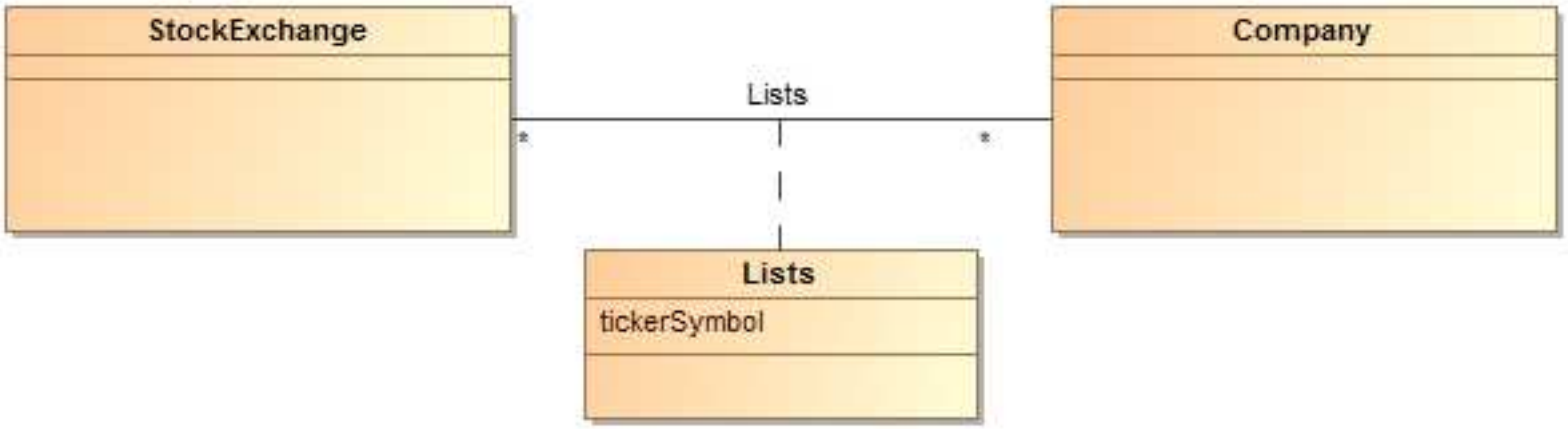
- What is the meaning of this association?
- How can we implement it?
- Is this a realistic representation?

Qualified Associations



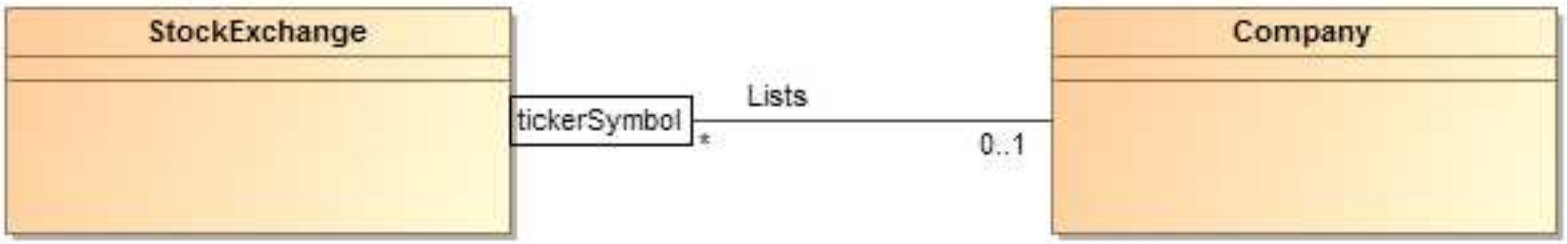
- How can we implement a qualified association?

Qualified Associations



- What is the meaning of this association?
- Given a Stock Exchange, can it list different Companies with different ticker symbols?
- Given a Stock Exchange, can it list different Companies with the same ticker symbol?

Qualified Associations



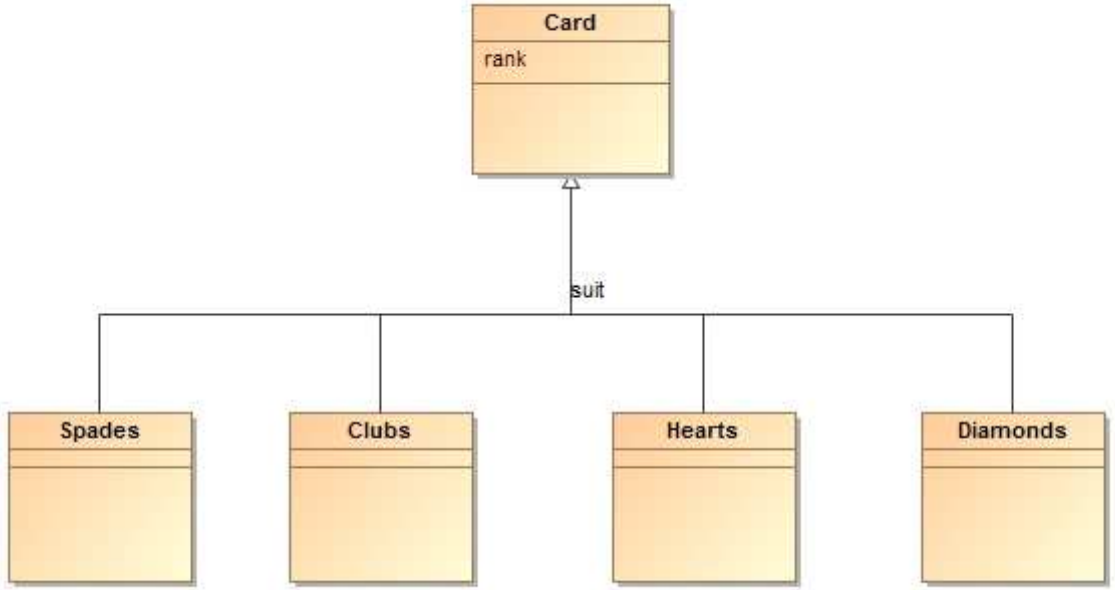
- What is the meaning of this association?
- Given a Stock Exchange, can it list different Companies with different ticker symbols?
- Given a Stock Exchange, can it list different Companies with the same ticker symbol?

Enumerations

- An enumeration is a data type that has a finite set of values.
- Enumeration is a data type: you can declare an enumeration by listing the keyword enumeration in angle quotes (<< >>) above the enumeration name in the top section of a box. The second section lists the enumeration values.
- Do not user generalization to capture the values of an enumerated attribute:
  - An enumeration is a list of values.
  - Introduce generalization only when at least one subclass has significant attributes, operations, or associations that do not apply to the superclass.

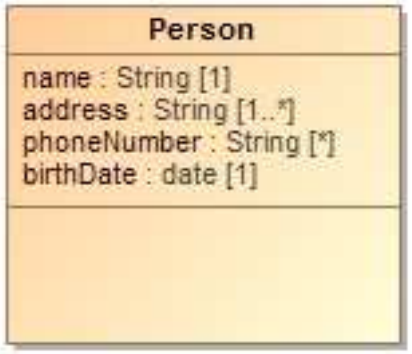
Enumerations

wrong



correct

Multiplicity for attributes

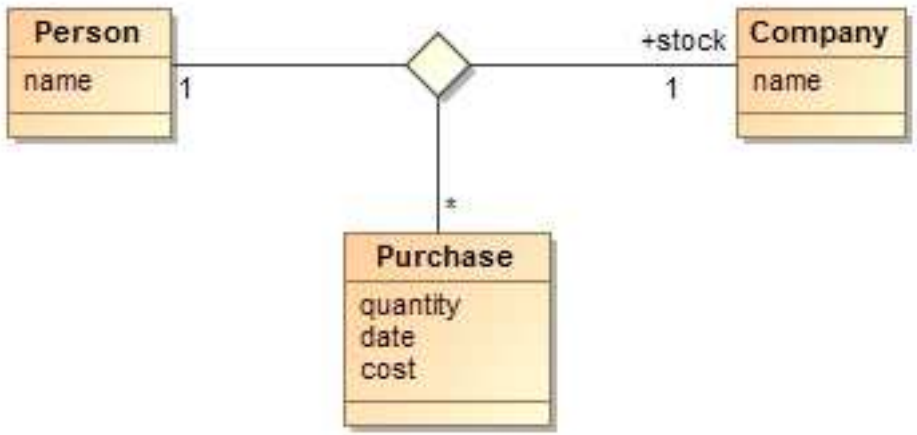


- You can specify if an attribute is single or multivalued, mandatory or optional.

N-ary associations

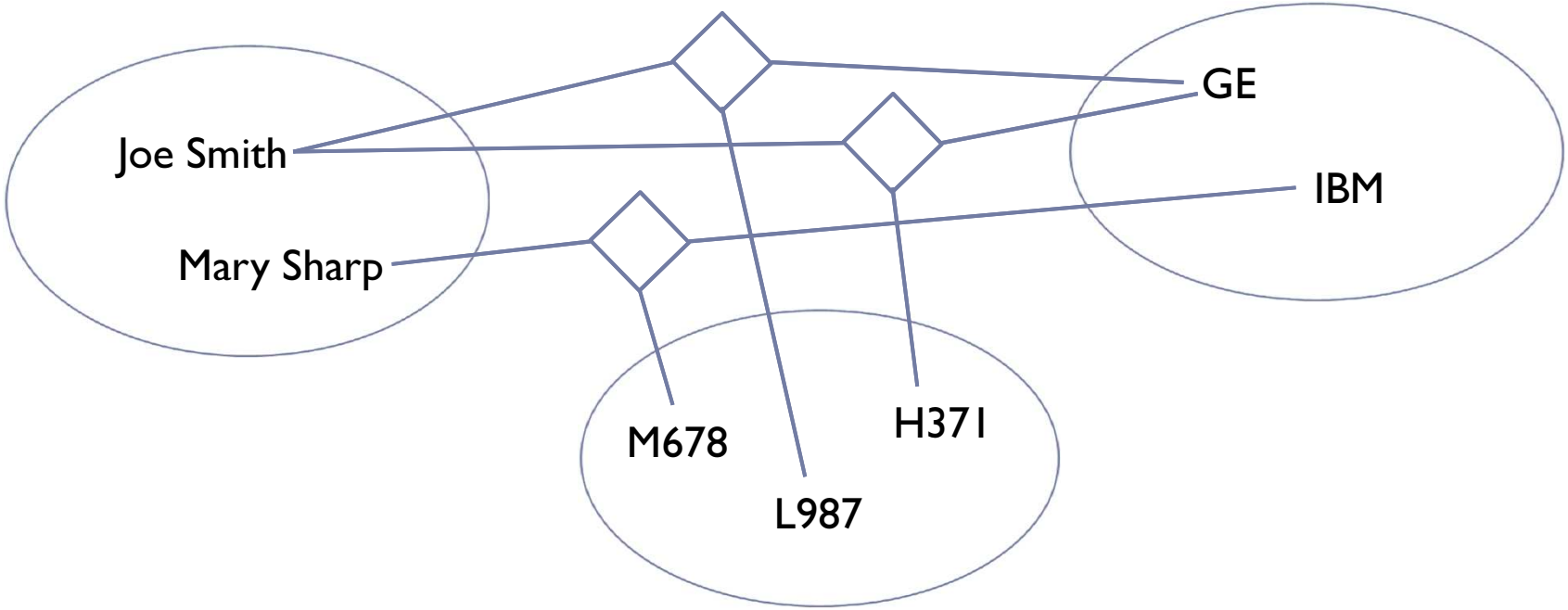
- Many relationships involve just two things and can be modeled with the simple binary association. It is not however uncommon for three or more things to be involved in a relationship.
- An n-ary association can be used in these circumstances and allows any or "n" number of things to be related in a single cohesive group.
- An n-ary association is used when the three or more things are all related to each other in a structural or behavioral way. It does not replace the use of two binary associations where a classifier is related to two other classifiers, but the latter two classifiers aren't related to each other.
  - Think of two people being married by a celebrant or minister; all three are involved and have an association with each other.

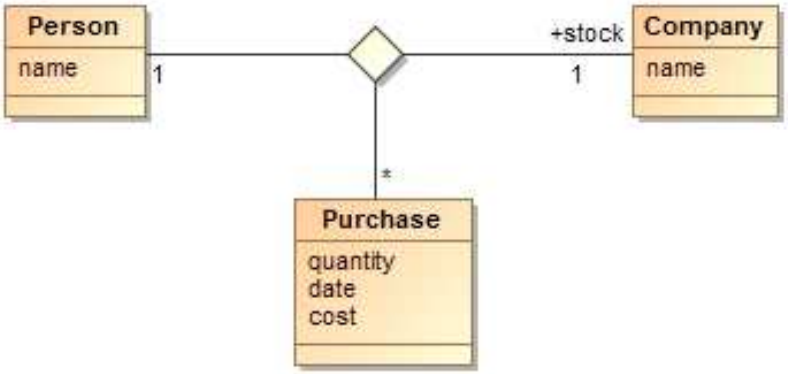
N-ary associations



- Example: a person makes a purchase of stock in a company.
- Read the multiplicities.

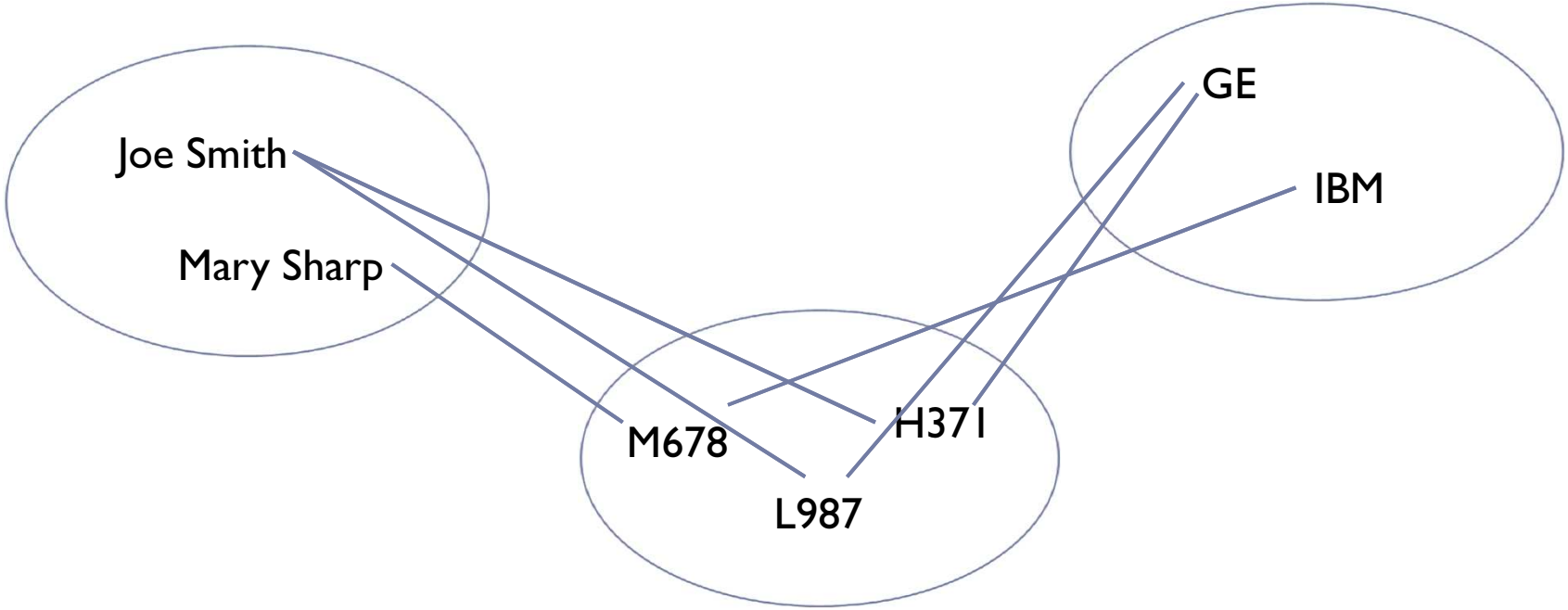
N-ary associations

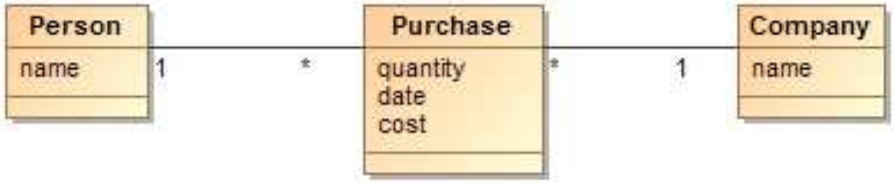




- Is this a genuine ternary association?

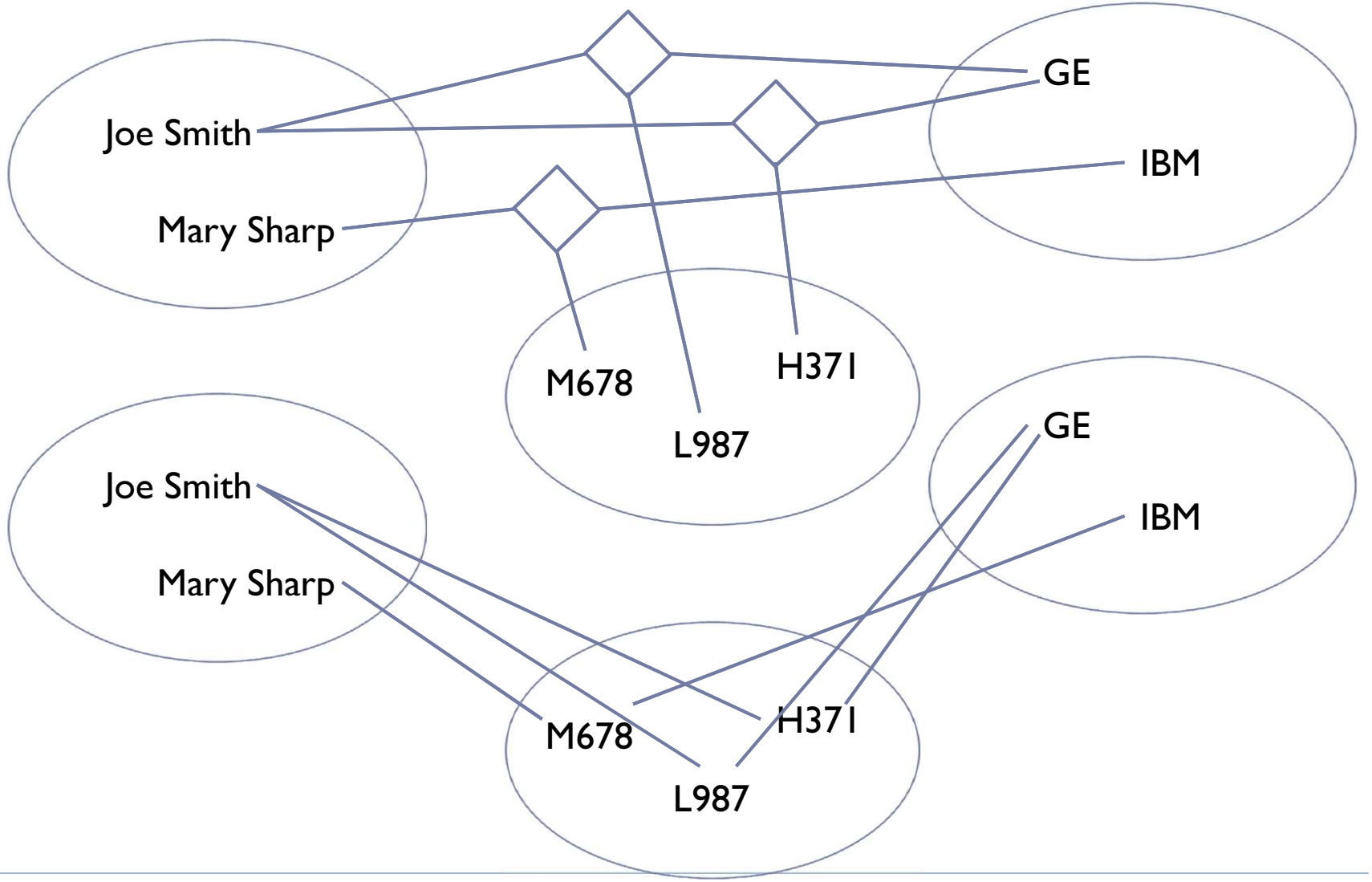
N-ary associations



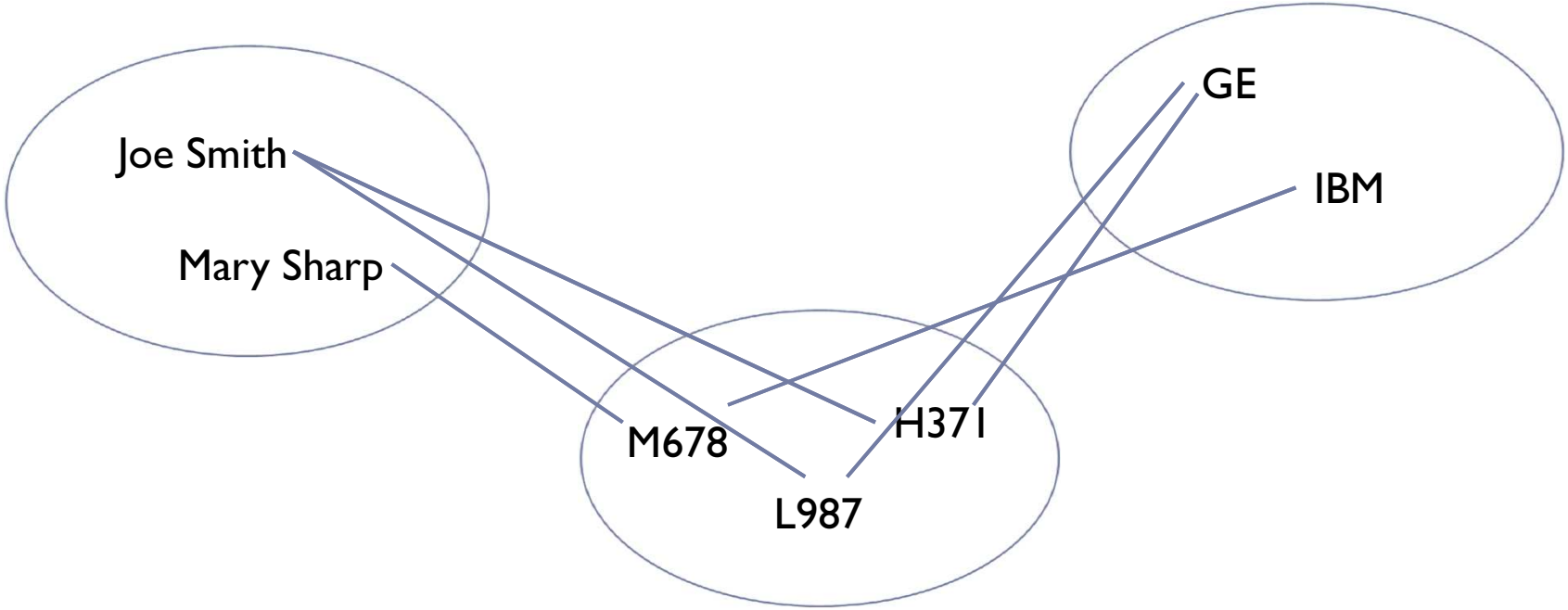


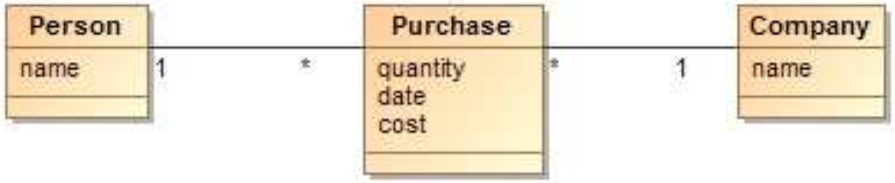
- Are we losing information?

N-ary associations



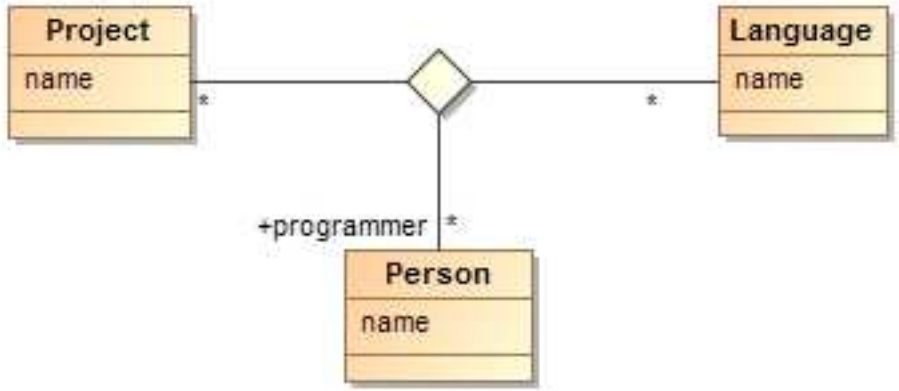
N-ary associations





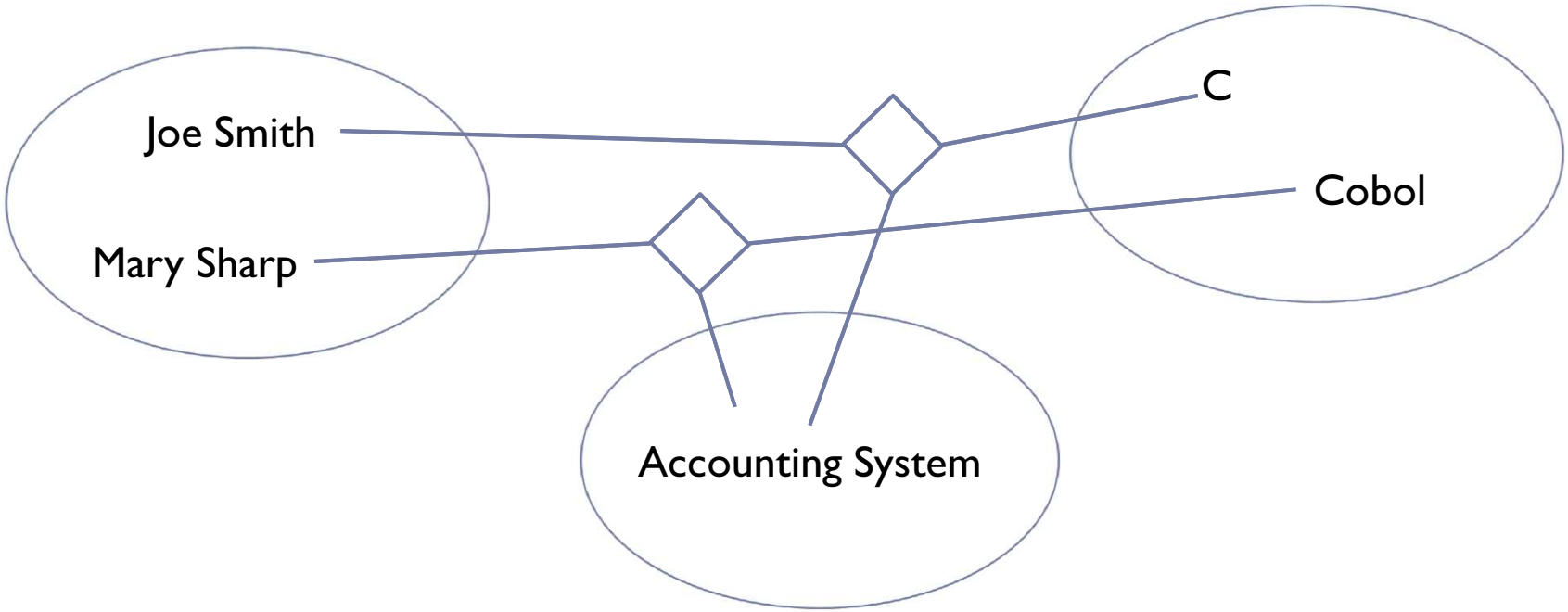
- You can decompose most n-ary associations into binary associations.

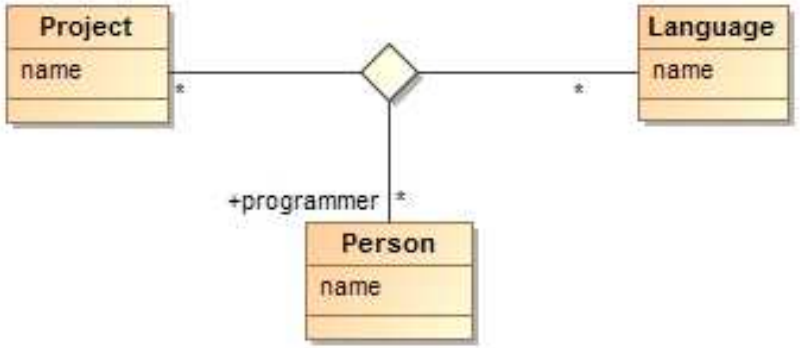
N-ary associations



- Example: programmers use computer languages on projects.

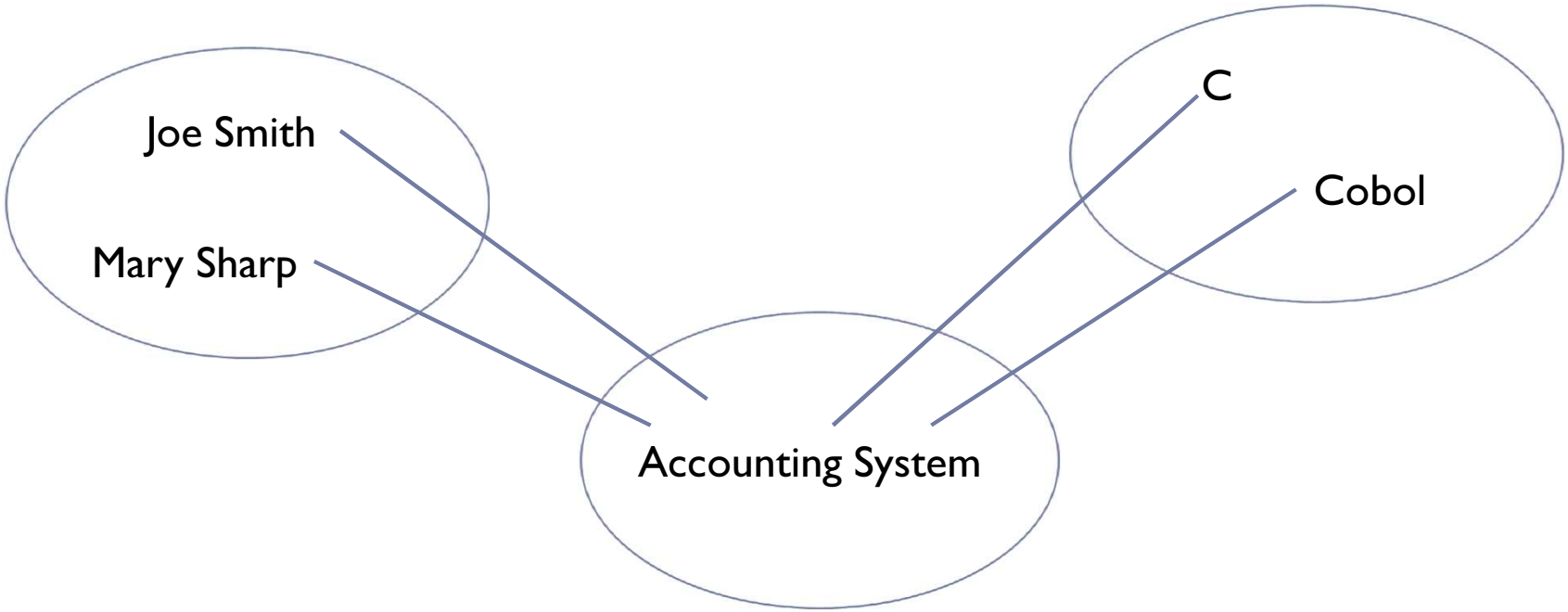
N-ary associations





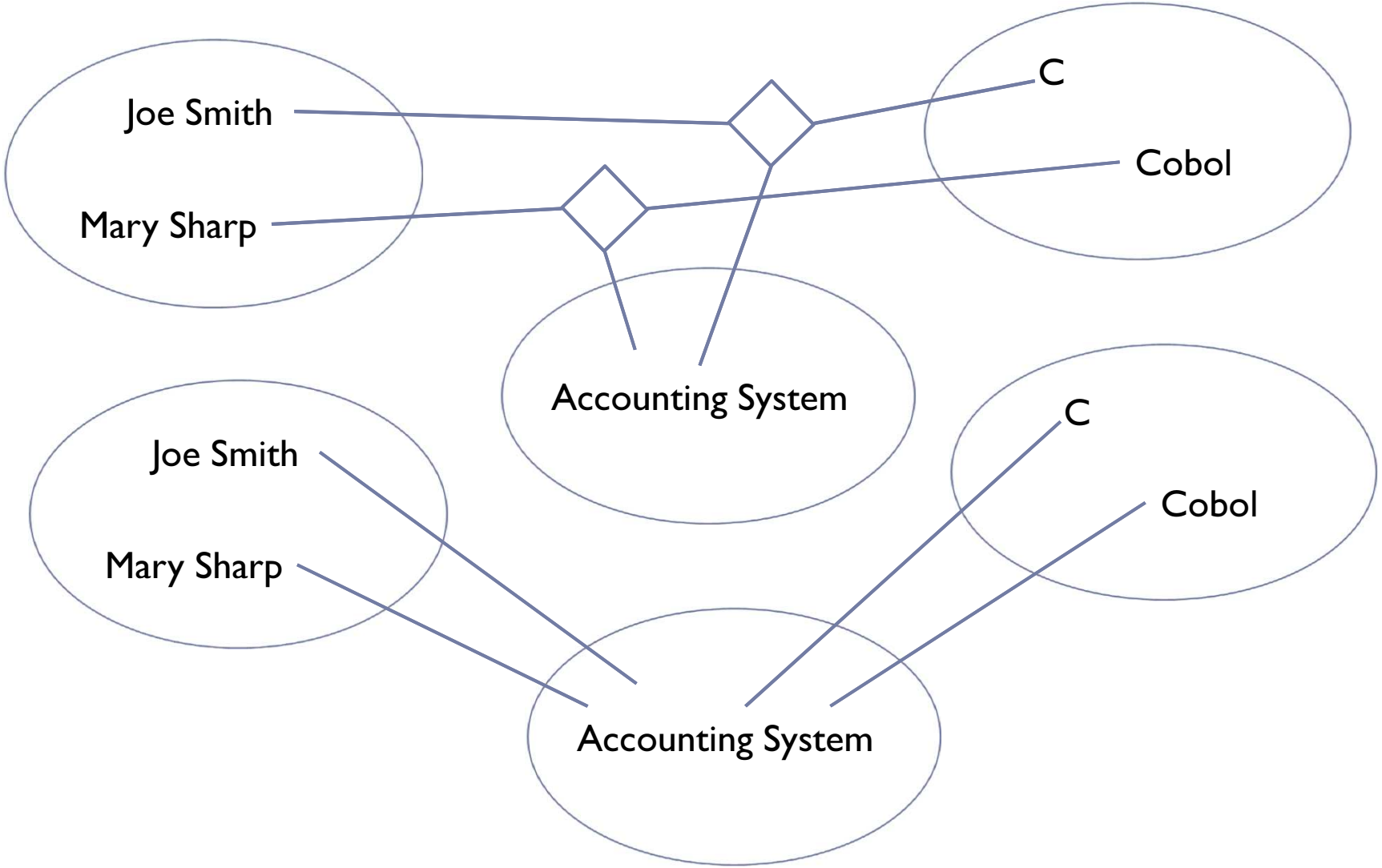
- Is this a genuine ternary association?

N-ary associations

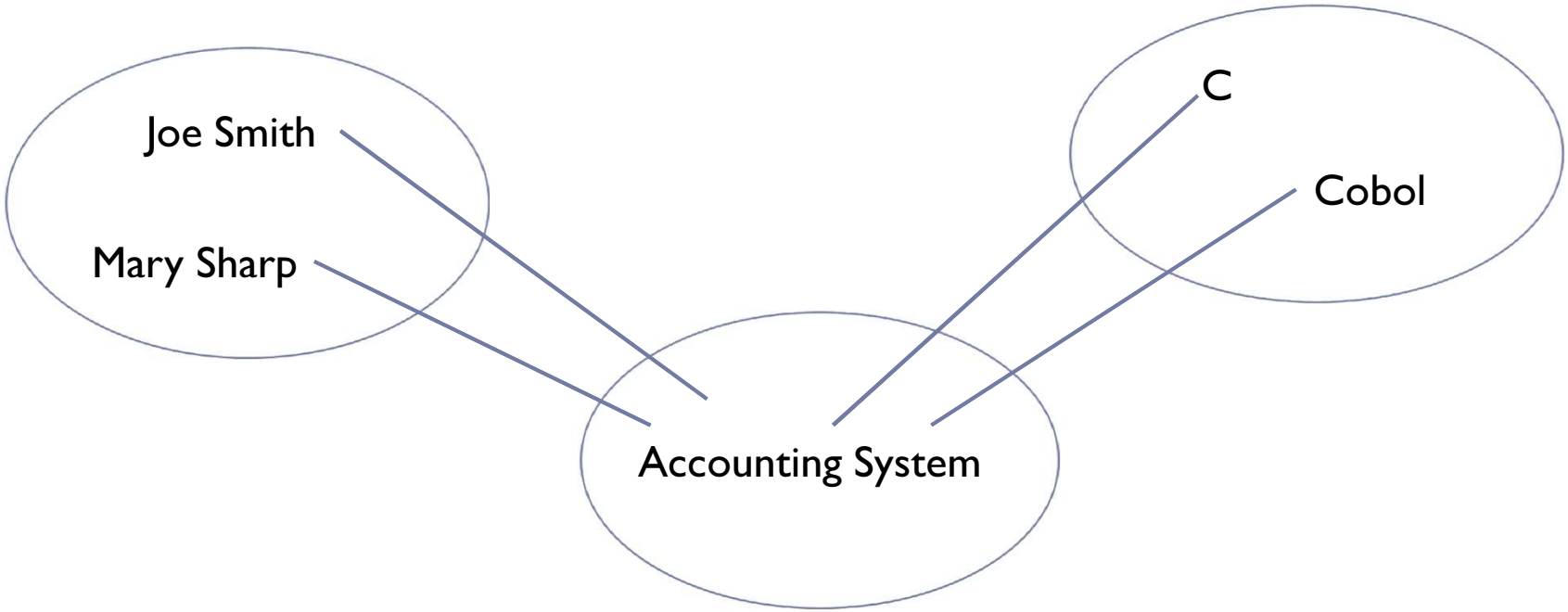


- Are we losing information?

N-ary associations

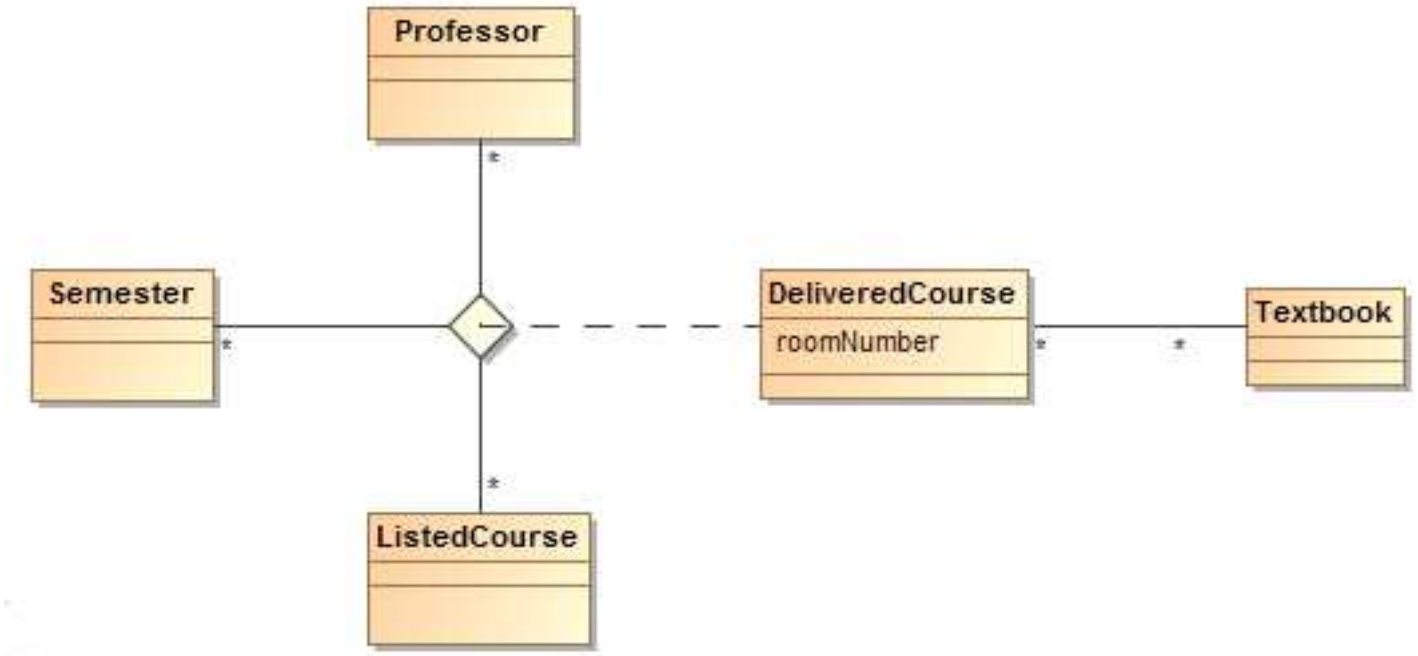


N-ary associations



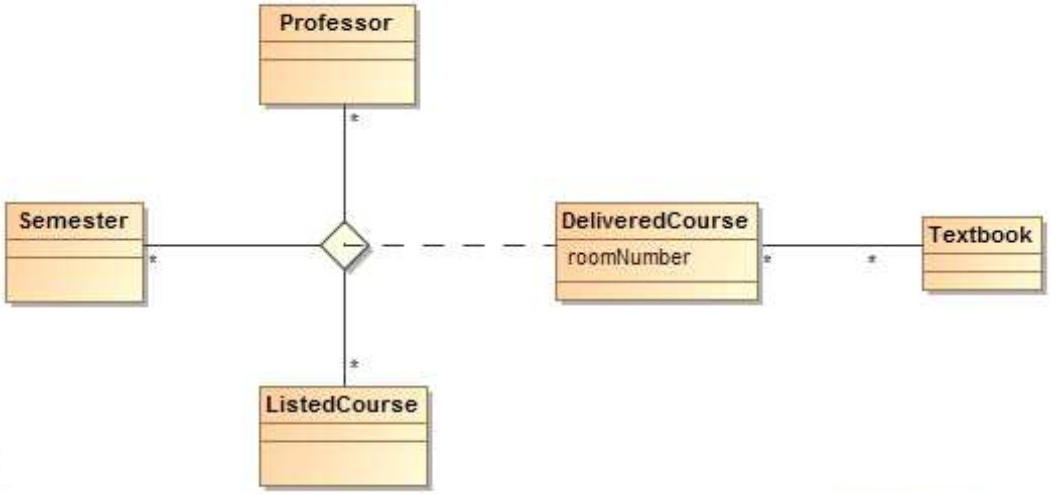
- Are we losing information?

N-ary association classes

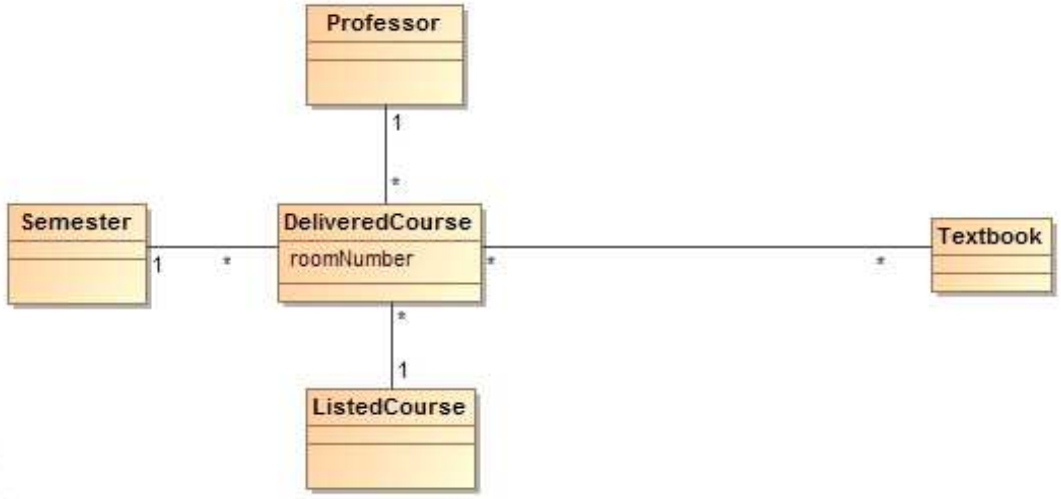


- Professors teach listed courses during semesters. Each delivered course has a room number and any number of textbooks.

N-ary association classes

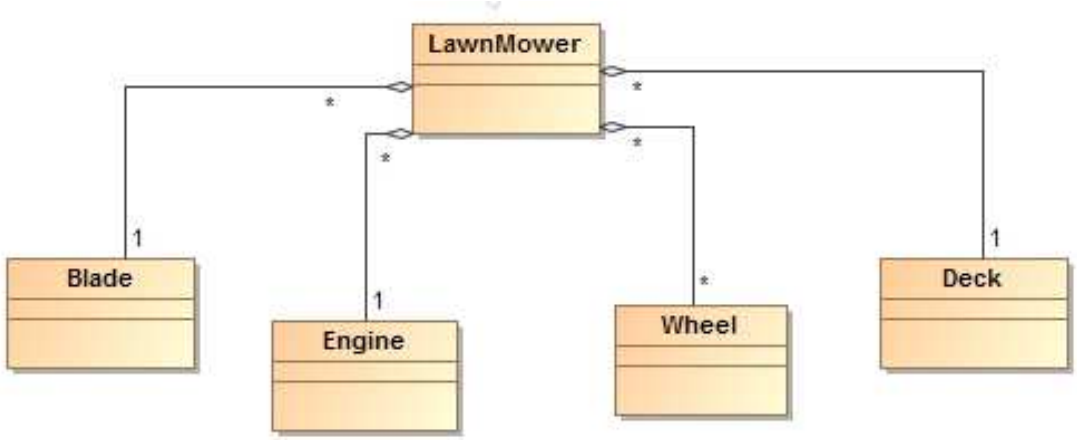


DIFFERENCE?



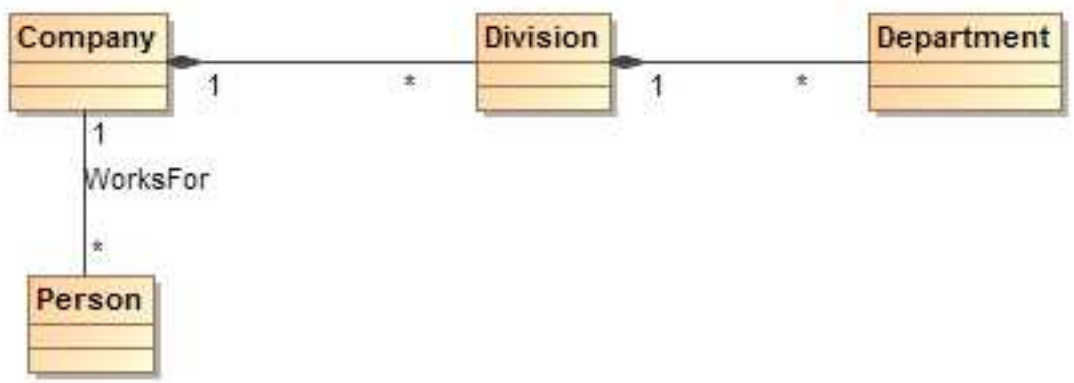
Aggregation

- Aggregation is a special form of association.
  - Underlines the fact that an object is made of constituent parts.
- The UML notation for aggregation is like the one for association with a small diamond indicating the assembly end.



Composition

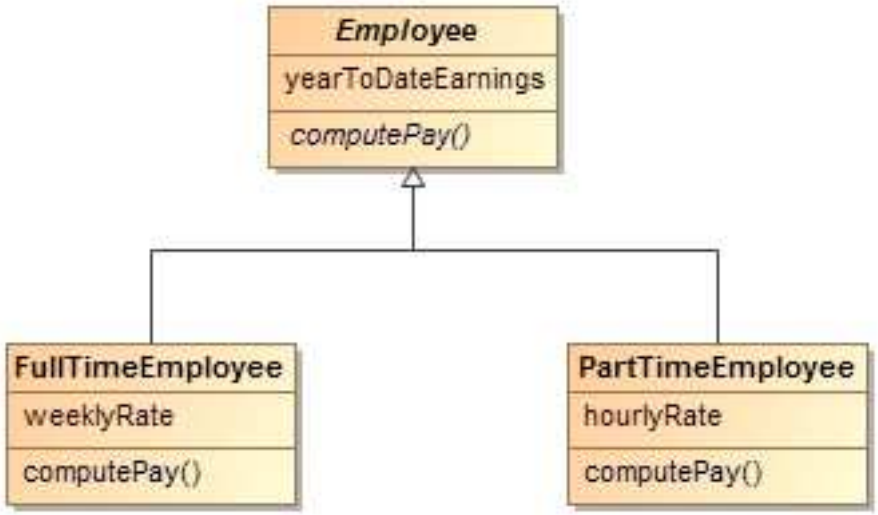
- Composition is a more restrictive form of aggregation.
  - Two additional constraints:
    - A constituent part can belong to at most one assembly.
    - The part has a coincident lifetime as the assembly.
- The UML notation for composition is a small solid diamond next to the assembly class.



Abstract classes

- An abstract class is a class that has no direct instances but whose descendants classes have direct instances.
- A concrete class is a class that is instantiable.
- A concrete class may have abstract subclasses, but they in turn must have concrete descendants: only concrete classes can be leaf classes in an inheritance tree.
- In the UML notation an abstract class name is listed in an italic font (or using {abstract} near the class name) .

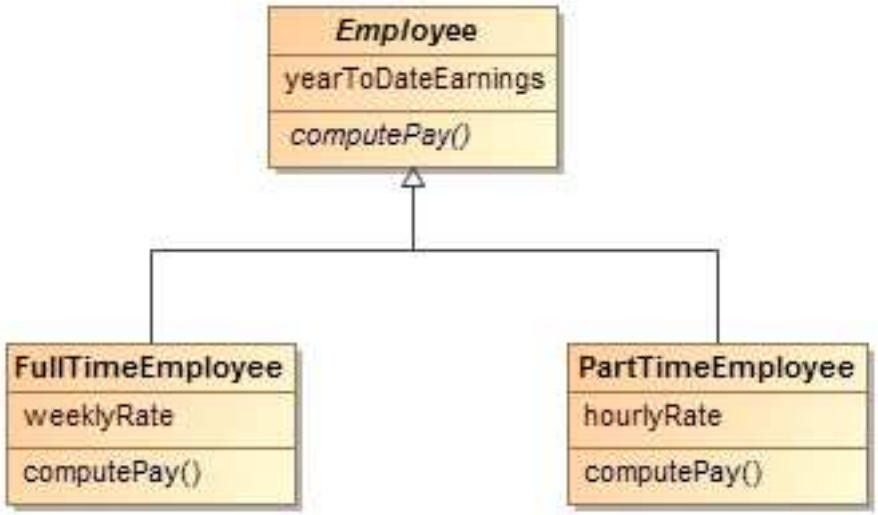
Abstract classes



Abstract classes

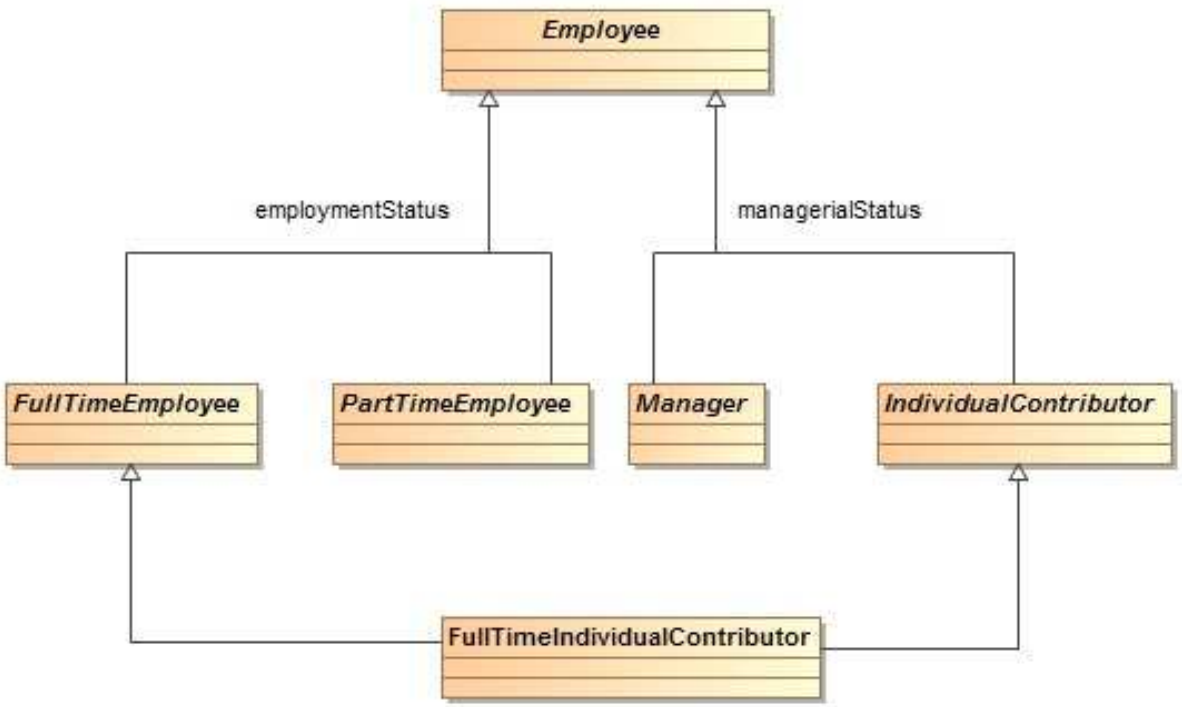
- Abstract classes can be used to define methods that can be inherited by subclasses.
- Abstract classes can define the signature of an operation without supplying a corresponding method.
  - Abstract operations:
    - An abstract operation defines the signature of an operation for which each concrete subclass must provide its own implementation.
    - An abstract operation is designated by italics or the keyword {abstract}.

Abstract classes



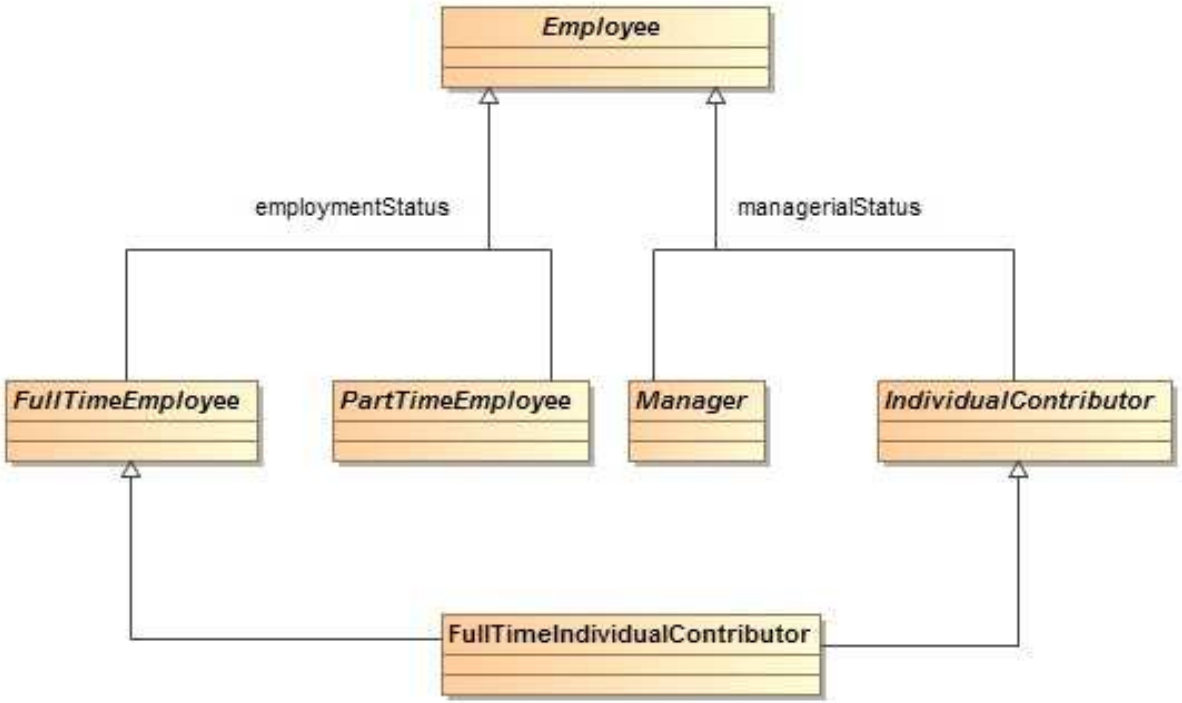
Multiple Inheritance

- Multiple inheritance permits a class to have more than one superclass and to inherit features from all parents.
- The most common form of multiple inheritance is from sets of disjoint classes.



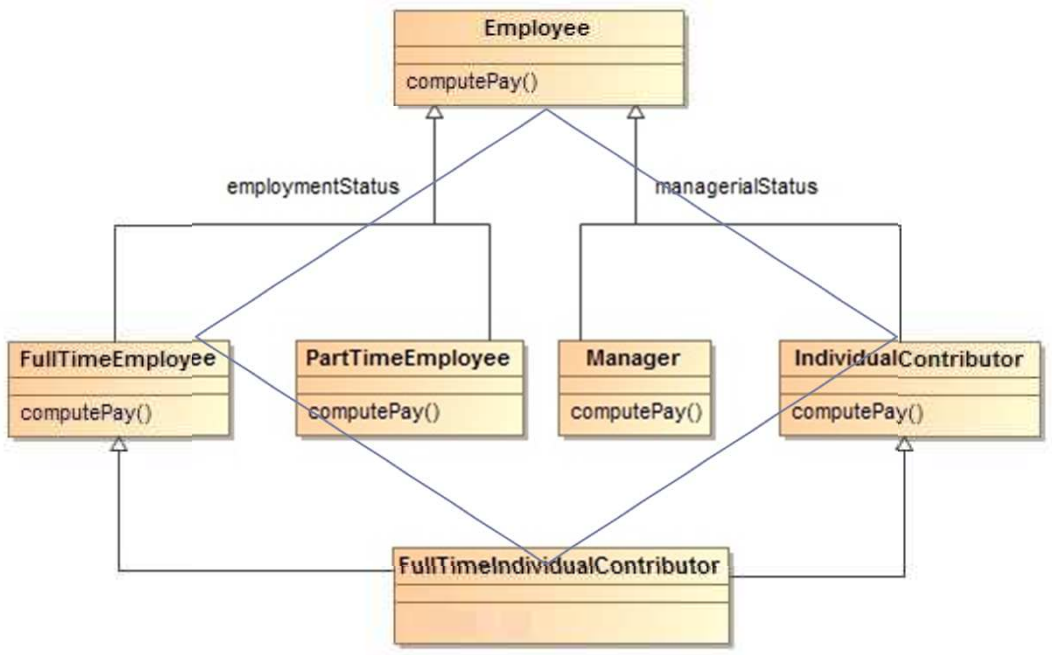
Multiple Inheritance

- A subclass inherits a feature from the same ancestor class found along more than one path only once.
- *FullTimeIndividualContributor* inherits *Employee* features along two paths but it has only a single copy of them.



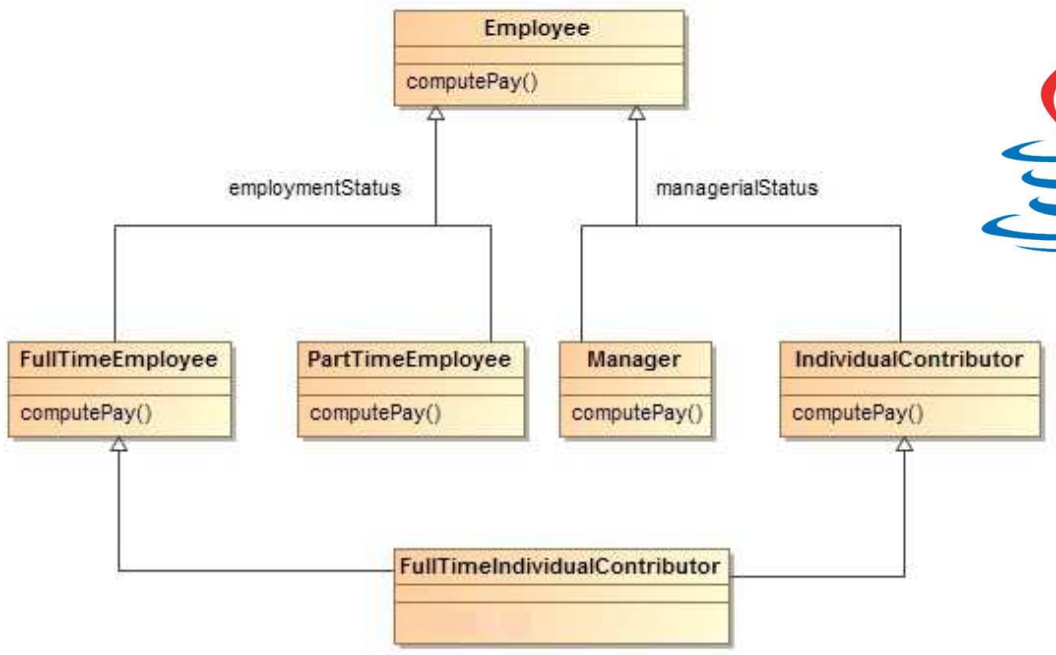
Multiple Inheritance

- Conflicts among parallel definitions create ambiguities that implementations must resolve.
  - Diamond problem: which version of *computePay()* should be used in *FullTimeIndividualContributor*?



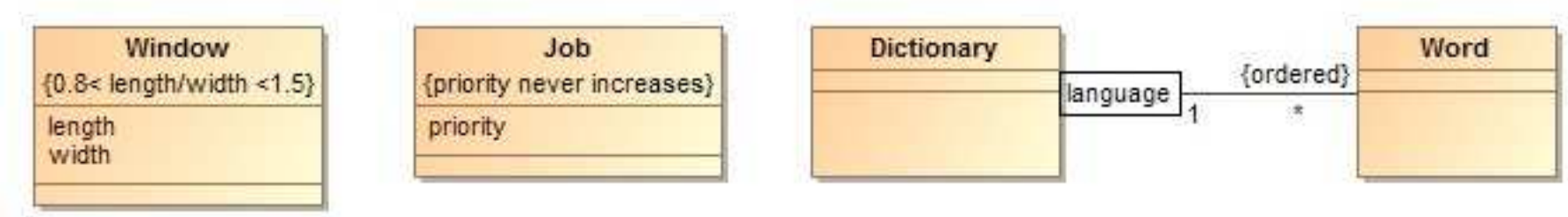
Multiple Inheritance

- Conflicts among parallel definitions create ambiguities that implementations must resolve.
  - Diamond problem: which version of *computePay()* should be used in *FullTimeIndividualContributor*?



Constraints

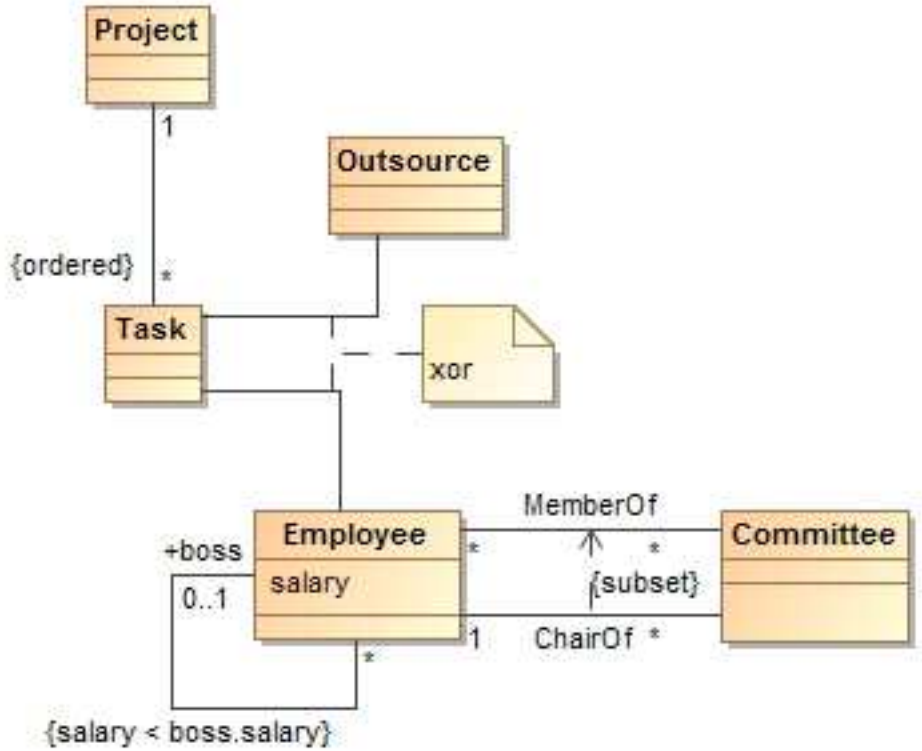
- A constraint is a condition involving model elements, such as objects, classes, attributes, links, associations and generalization sets.
  - A constraint restricts the values that elements can assume.
  - A constraint specifies limitations that implementers need to satisfy.



Constraints

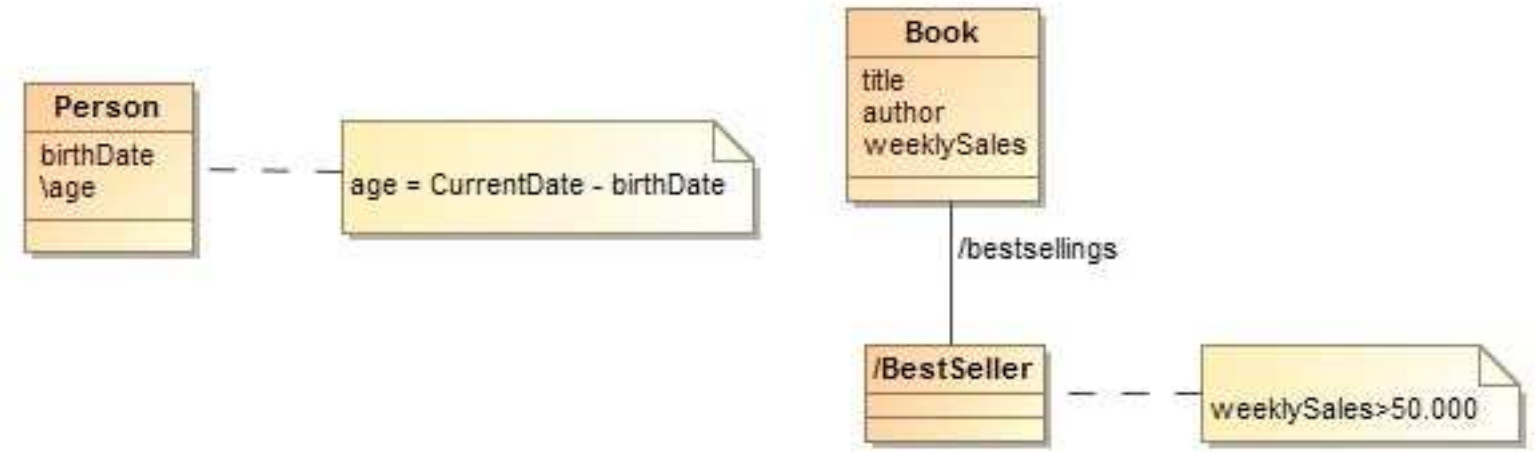
- Multiplicity is a constraint:
  - Multiplicity for an association restricts the number of objects associated to a given object.
  - Multiplicity for an attribute specifies the number of values that are possible for each instantiation of an attribute.
- Qualification is a constraint:
  - A qualifier attribute is significant in resolving the "many" objects at an association end.
- There are several UML notations for constraints:
  - Delimit constraints with braces.
  - Place a constraint in a "dog-eared" comment box.
  - Use dashed lines to connect constrained elements.
  - Use a dashed arrow to connect a constrained element to the element on which it depends.

Examples of constraints



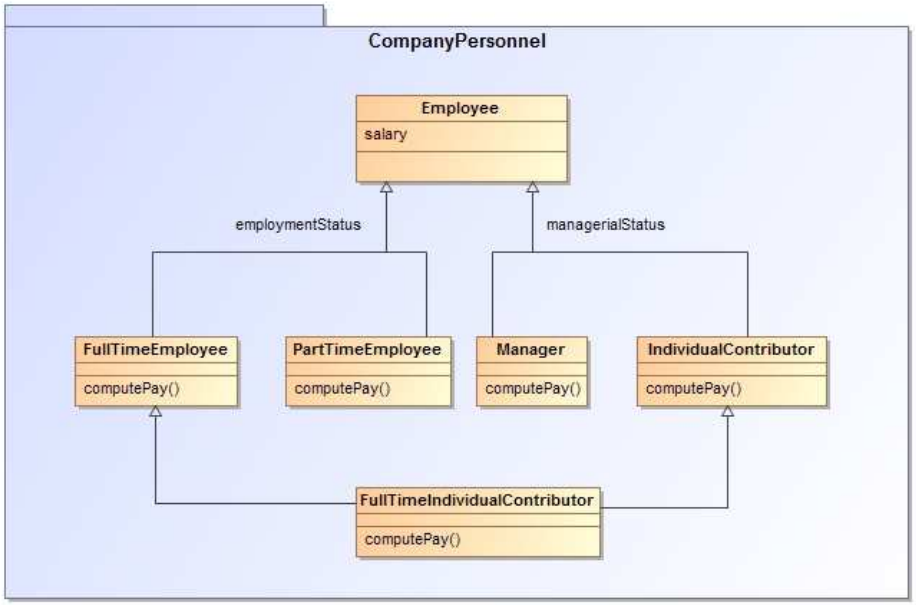
Derived data

- A derived element is a function of one or more elements, which in turn can be derived.
- Ultimately the derivation tree terminates with base elements (elements that cannot be derived).
- Classes, associations and attributes may be derived.
- The notation for a derived element is a slash in front of the element name.
- The constraint that determines the derivation must be shown.



Packages

- You can fit a class model on a single page for many small and medium-sized problems
  - However it is often difficult to grasp the entirety of a large model.
- A package is a group of elements (classes, associations, generalizations and nested packages) with a common theme.
  - A package partitions a model making it easier to understand and manage,
- The UML notation for a package is a box with a tab:
  - The tab suggests the enclosed content, like a tabbed folder.



Homework

HW1: Class Modeling ***(6 points, due on 17.09.2013 at 10 am)***

Create a class diagram modeling an application for designing and analyzing PERT charts.

For information about PERT charts read
http://en.wikipedia.org/wiki/Program_Evaluation_and_Review_Technique

Requirements:

- it is compulsory to include in the class diagram the notion of "Subtask";
- the PERT charts we are interested in are the Activity On Node diagrams.

Notes:

- use MagicDraw to create the model;
- the task is to be completed in pairs;
- submissions: one of the members of the group has to log in and submit the assignment using the link "submit" on the course webpage. Please specify in a comment the members of the group.