Class modelling (part 2)

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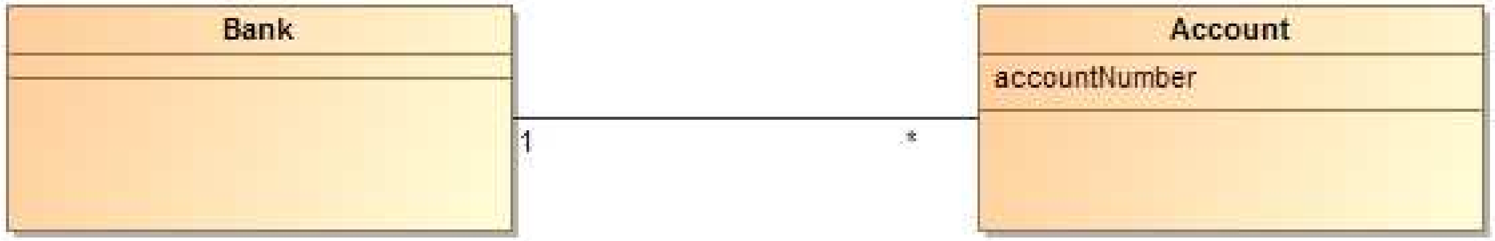
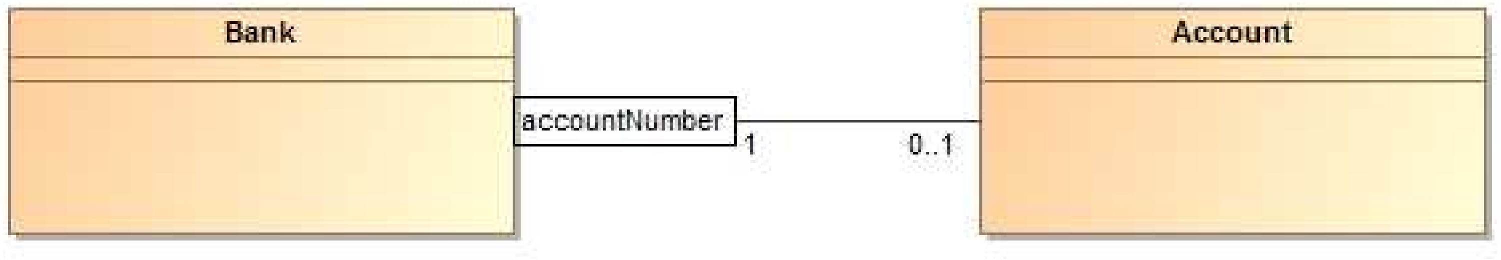
(these slides are derived from the book “Object-oriented modeling and design with UML”)

Qualified Associations



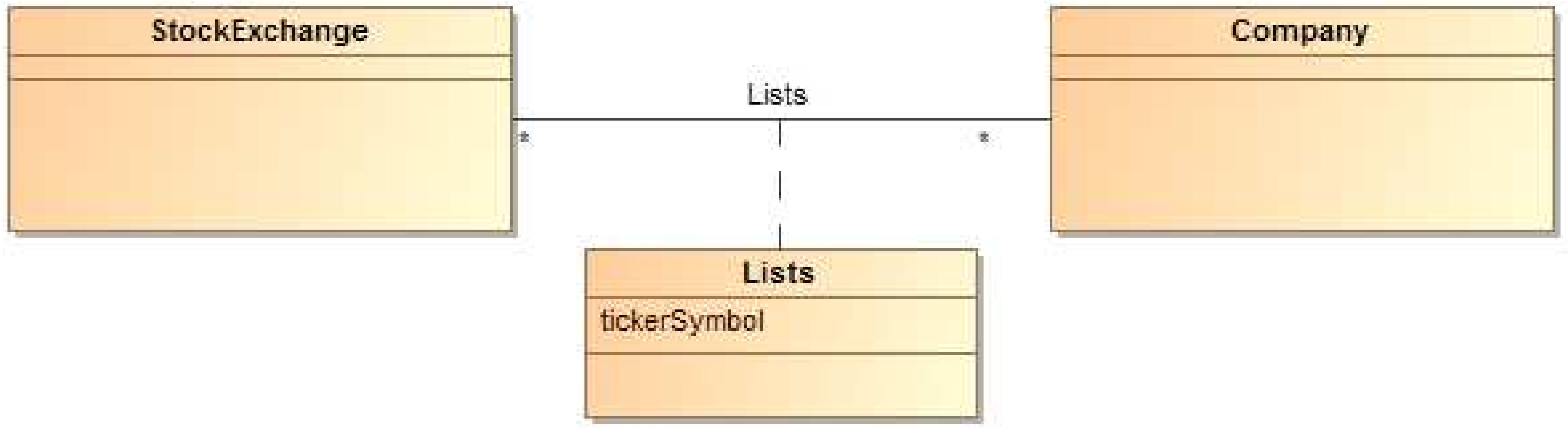
- What is the meaning of this association?
- How can we implement it?
- Is this a realistic representation?

Qualified Associations



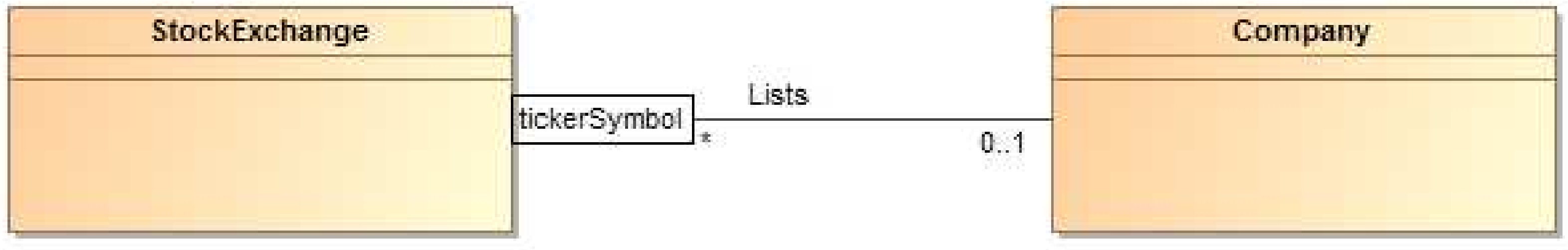
- How can we implement a qualified association?

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



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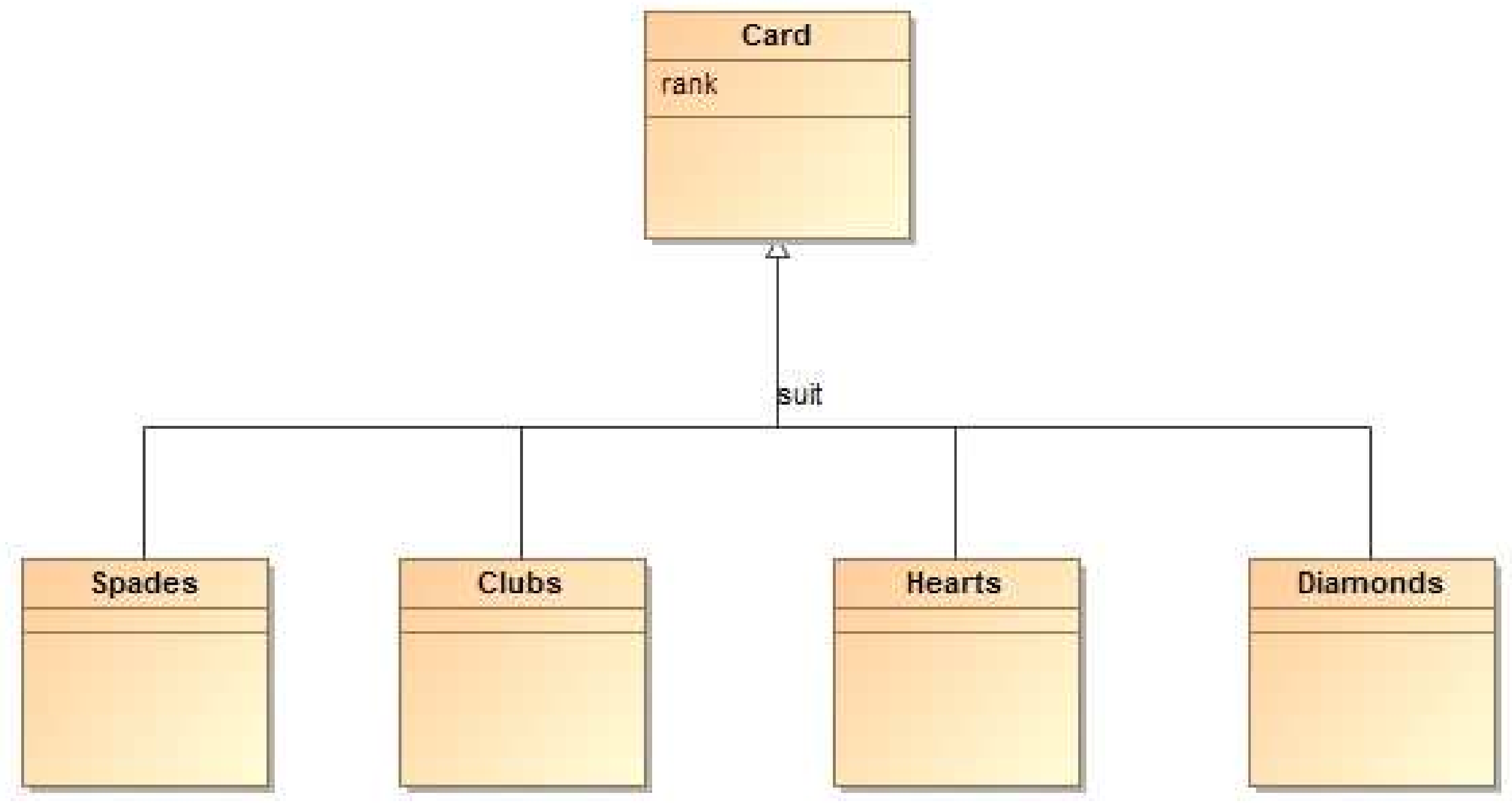
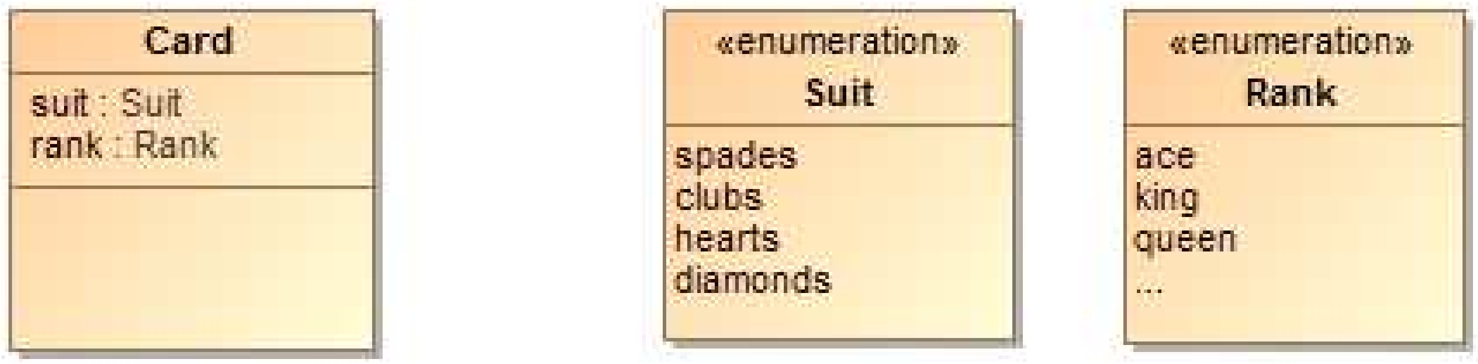
Enumerations

- 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.

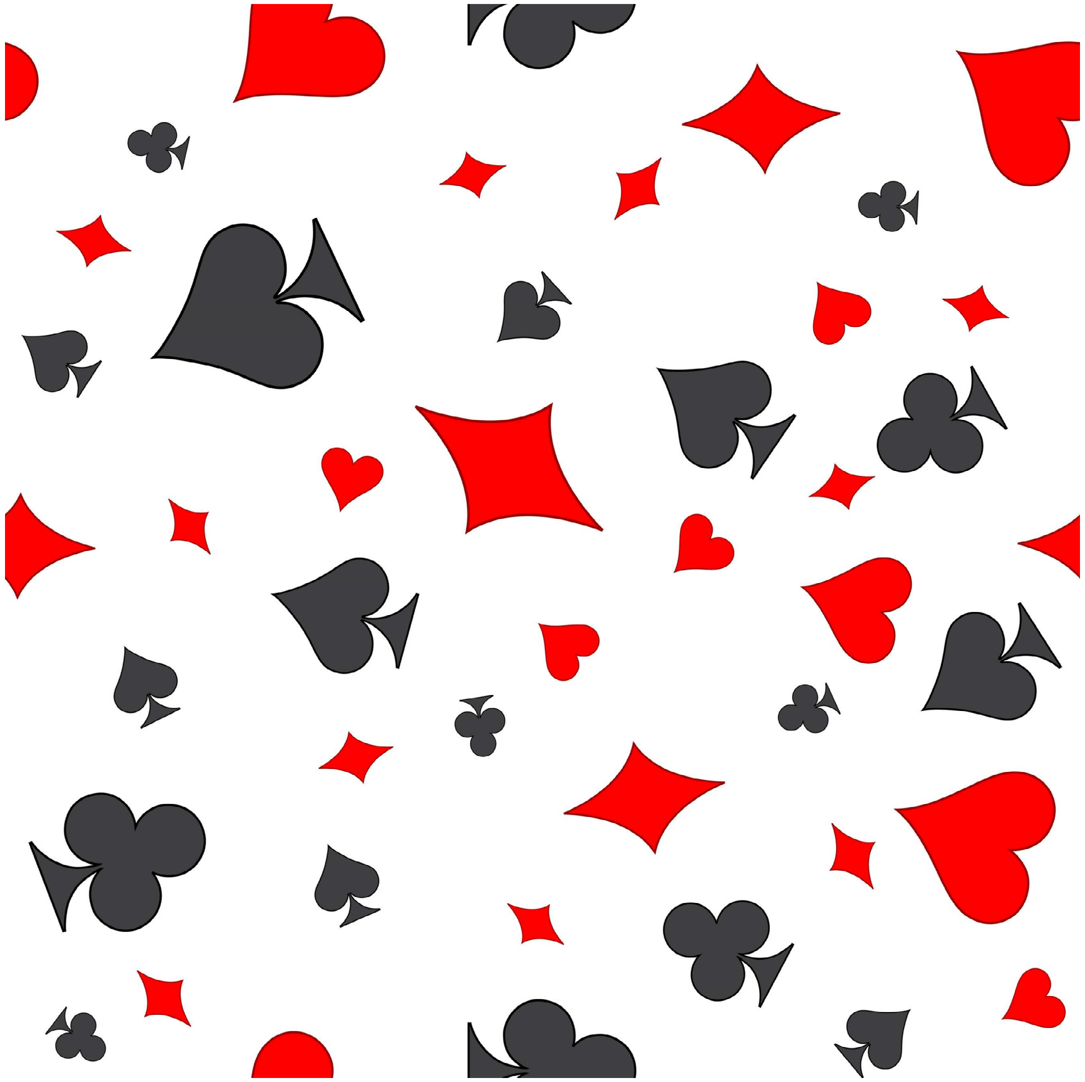
Enumerations



Enumerations



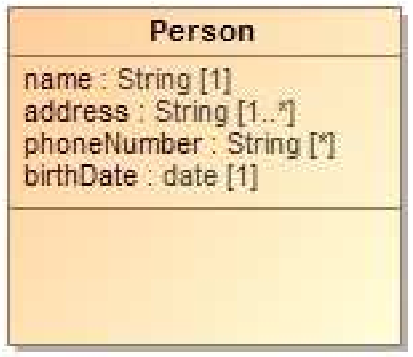
Enumerations



Enumerations

esmaspäev	Monday	Lunedì
teisipäev	Tuesday	Martedì
kolmapäev	Wednesday	Mercoledì
neljapäev	Thursday	Giovedì
reede	Friday	Venerdì
laupäev	Saturday	Sabato
pühapäev	Sunday	Domenica

Multiplicity for attributes

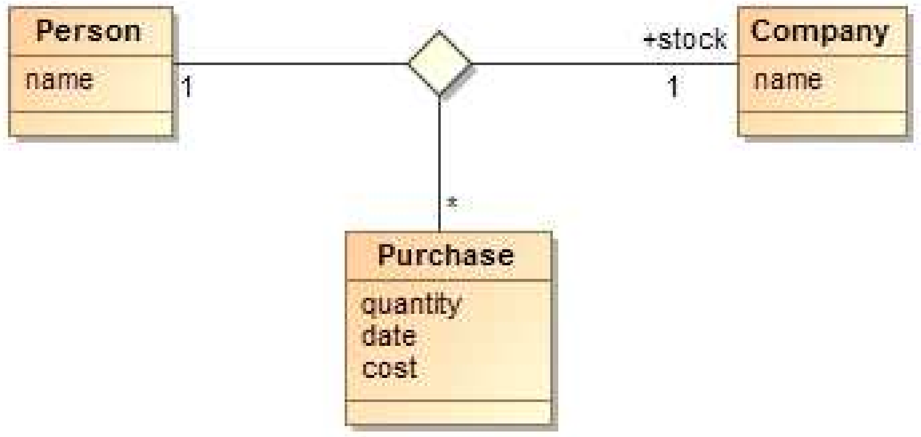


- You can specify if an attribute is single or multivalued, mandatory or optional.

N-ary associations

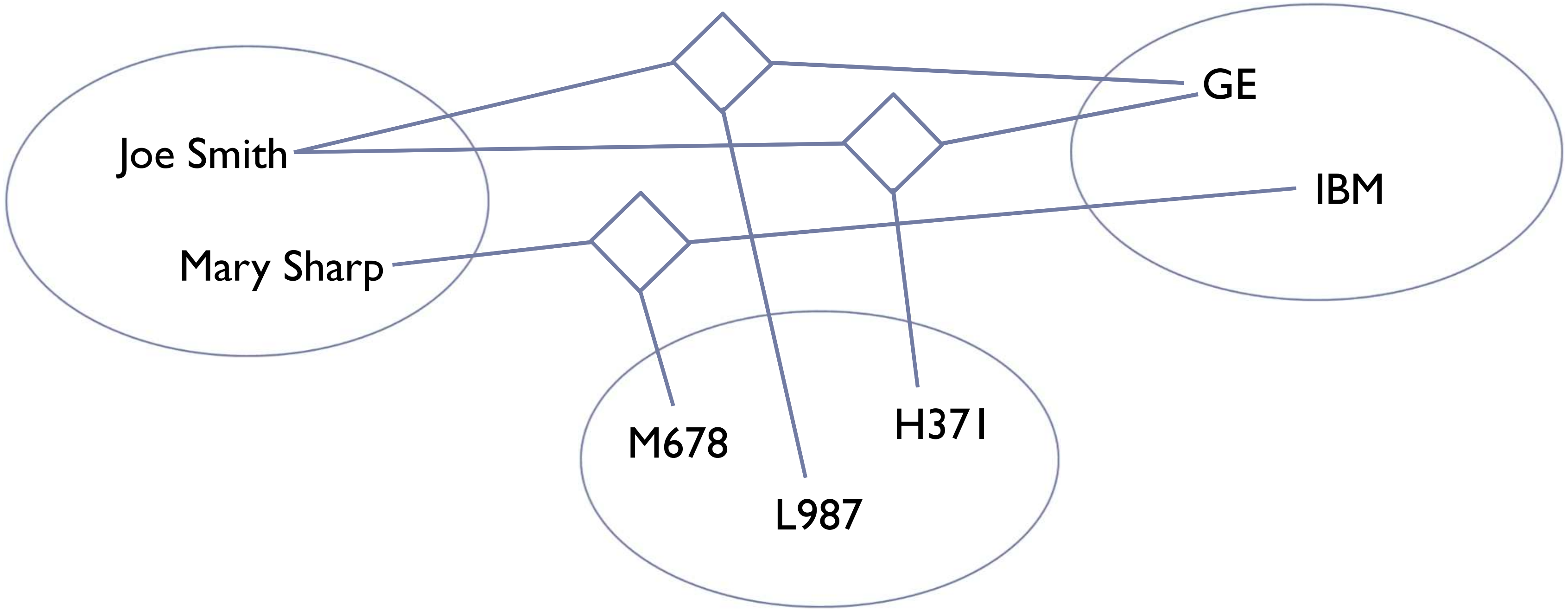
- Many relationships involve just two things and can be modeled with the simple binary association.
  - It is not however uncommon for three or more things to be involved in a relationship.
- An n-ary association can be used in these circumstances and allows any or "n" number of things to be related 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.

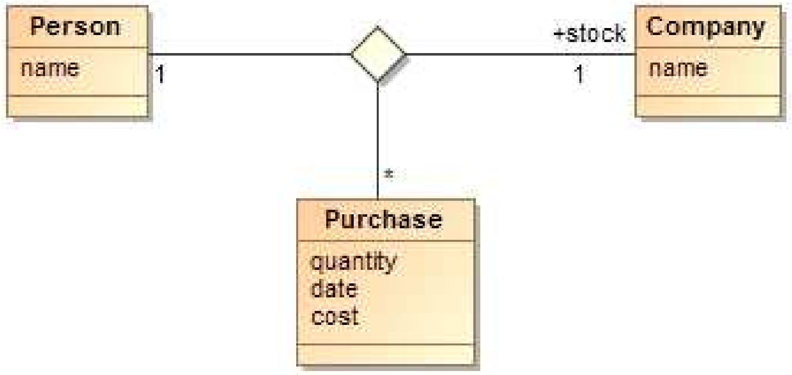
N-ary associations



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

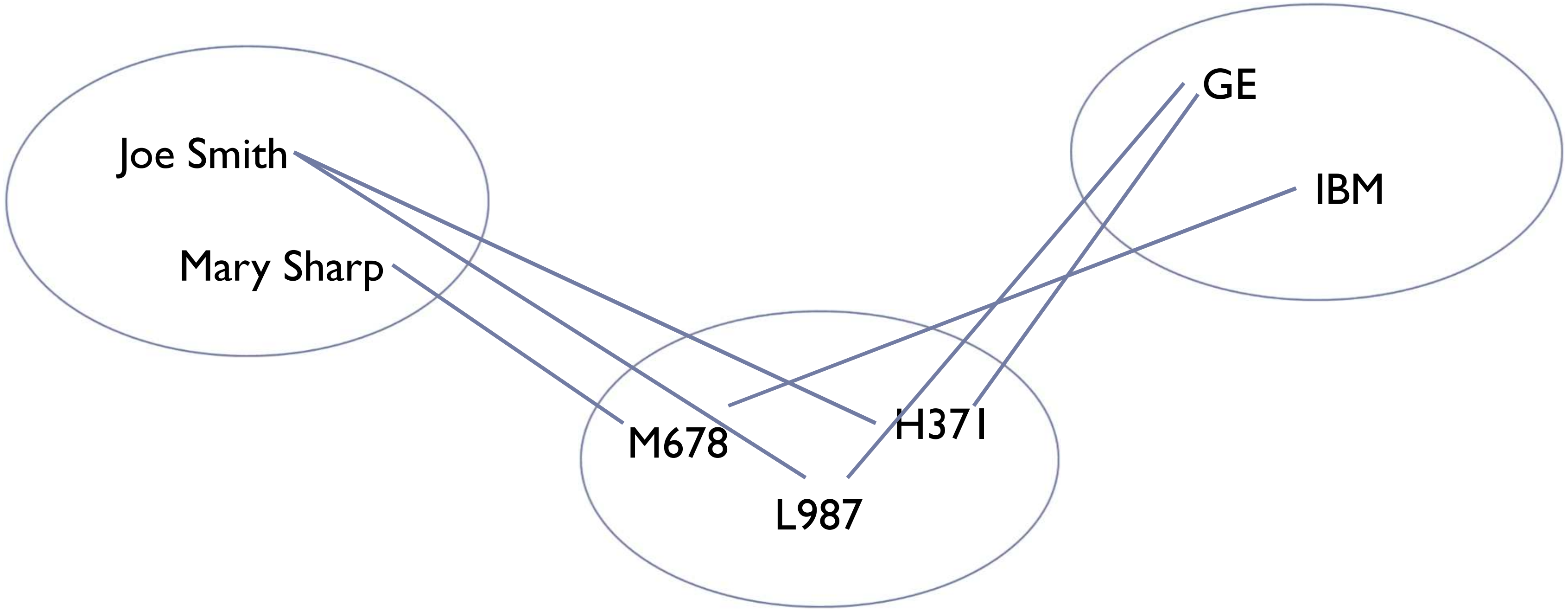
N-ary associations

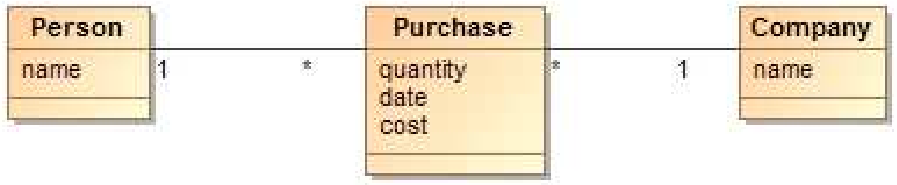




- Is this a genuine ternary association?

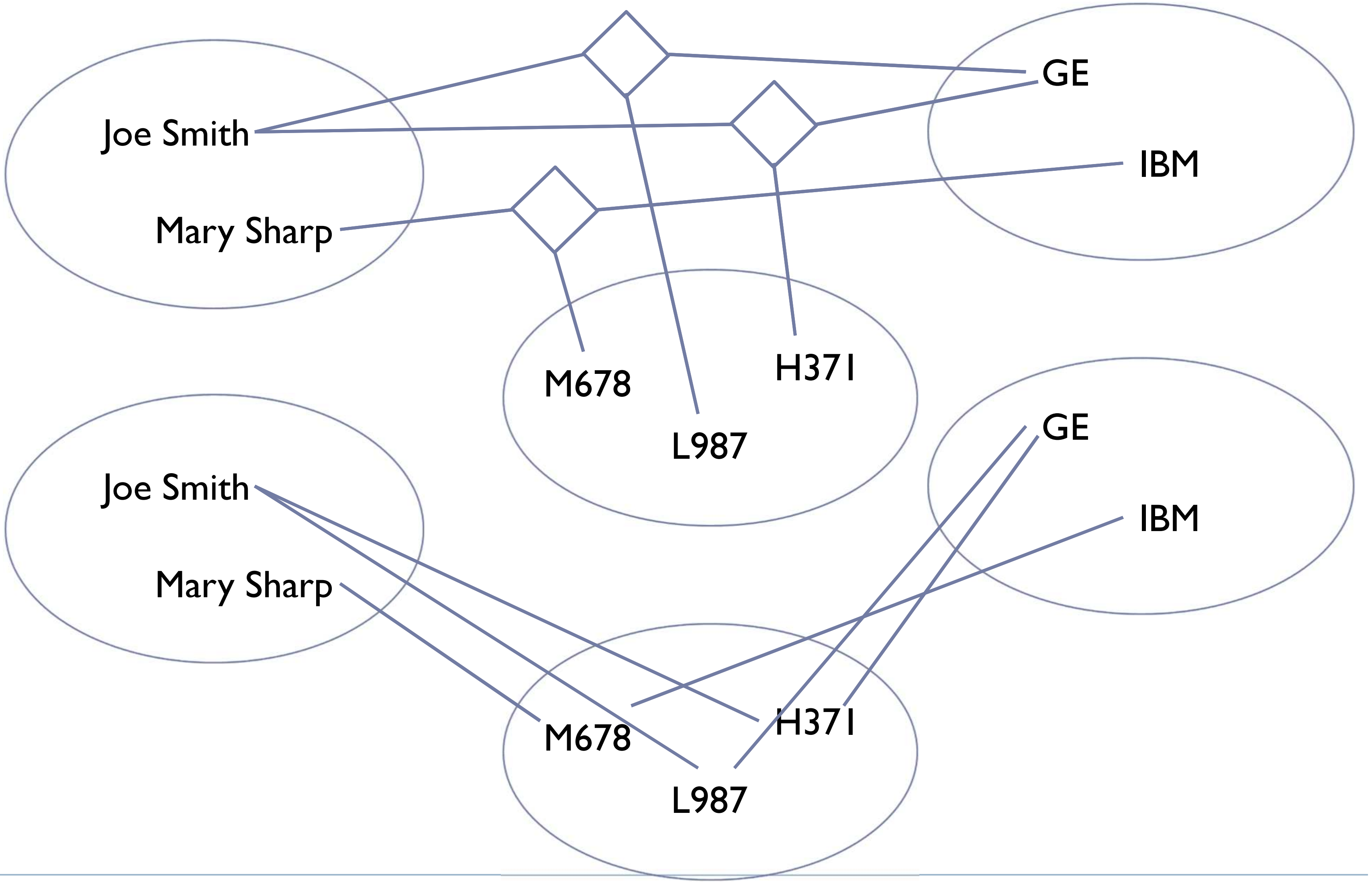
N-ary associations



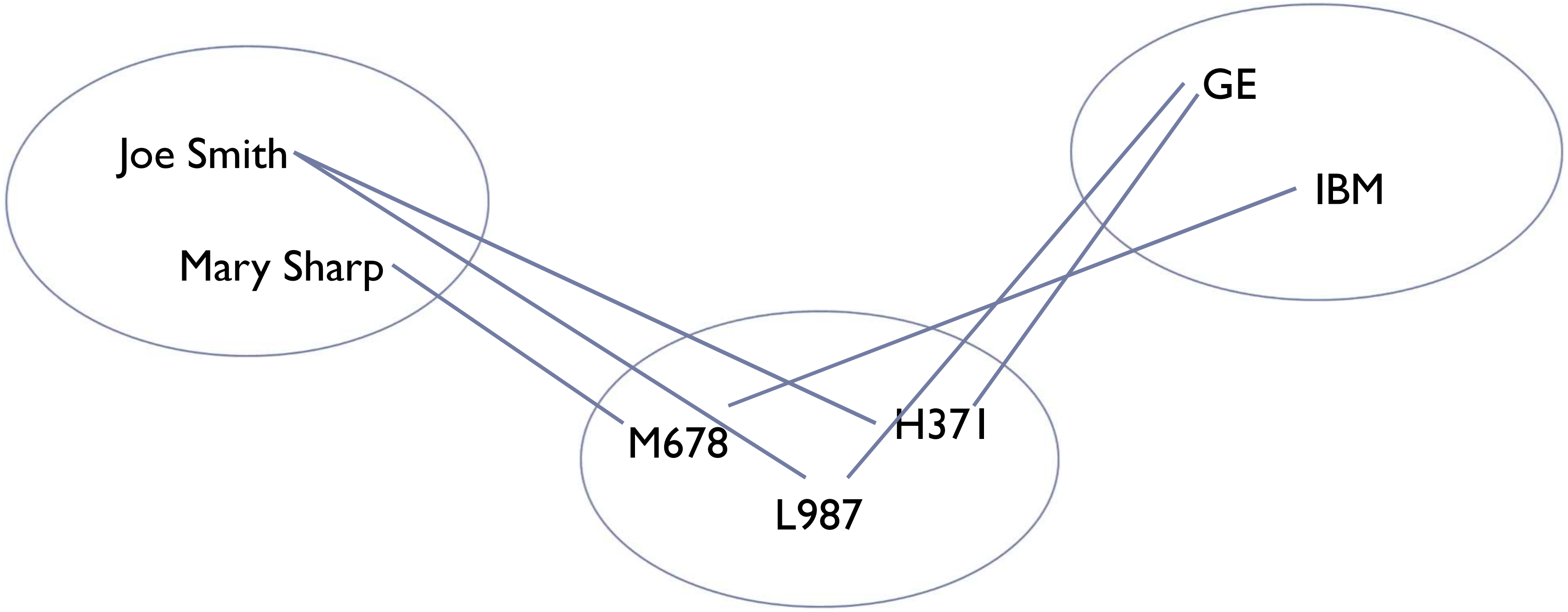


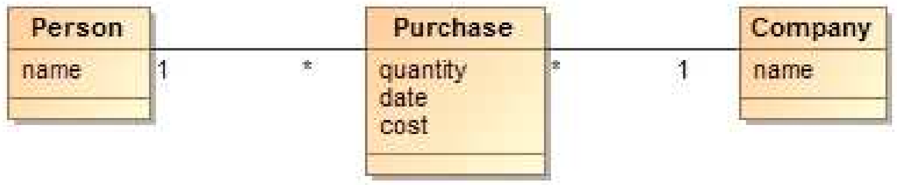
- Are we losing information?

N-ary associations



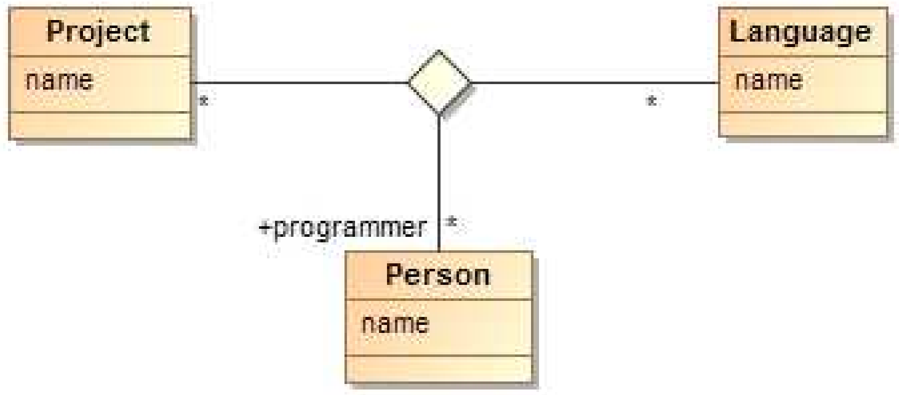
N-ary associations





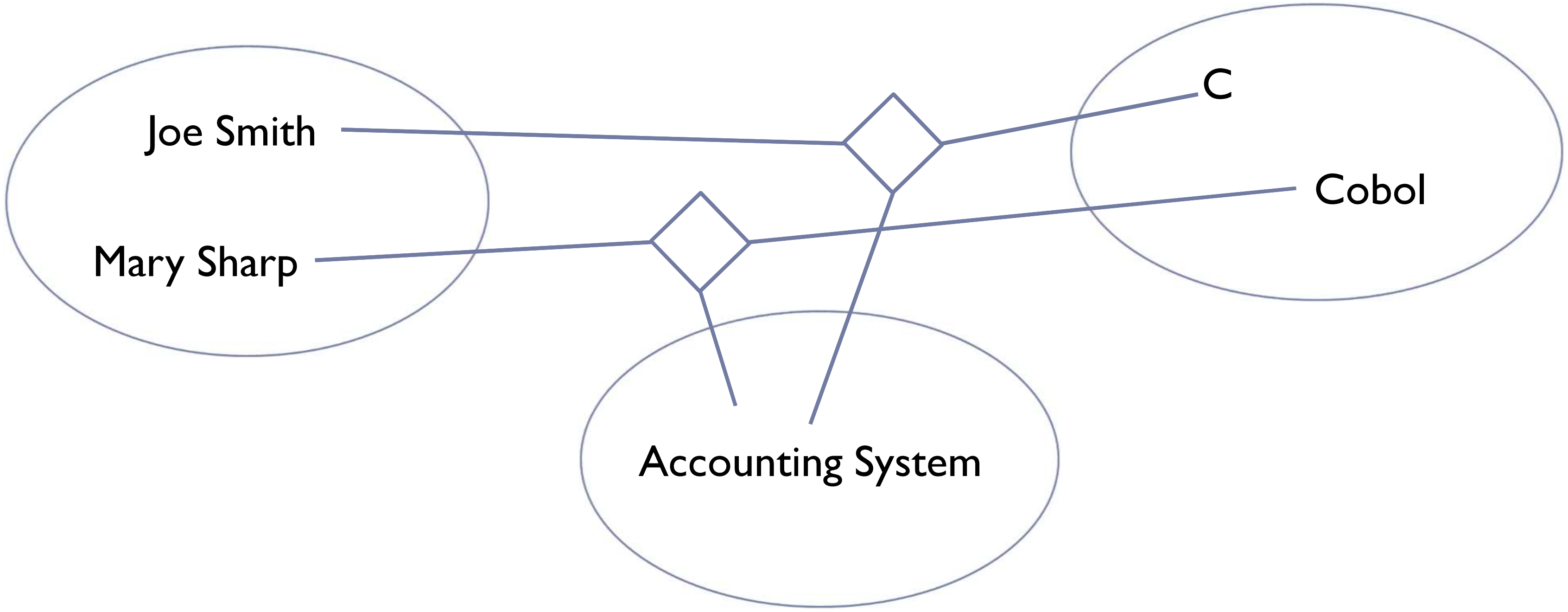
- You can decompose most n-ary associations into binary associations.

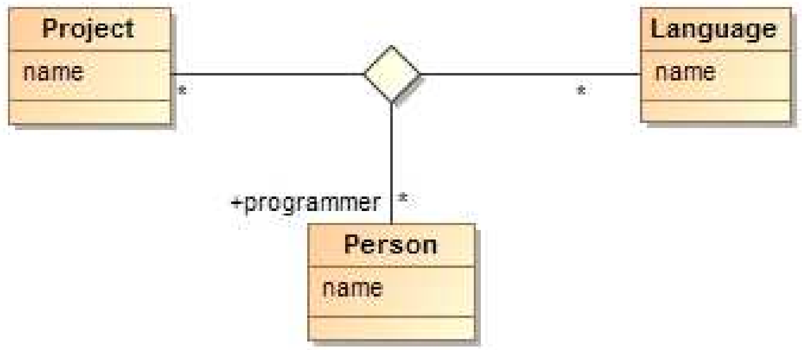
N-ary associations



- Example: programmers use computer languages on projects.

N-ary associations





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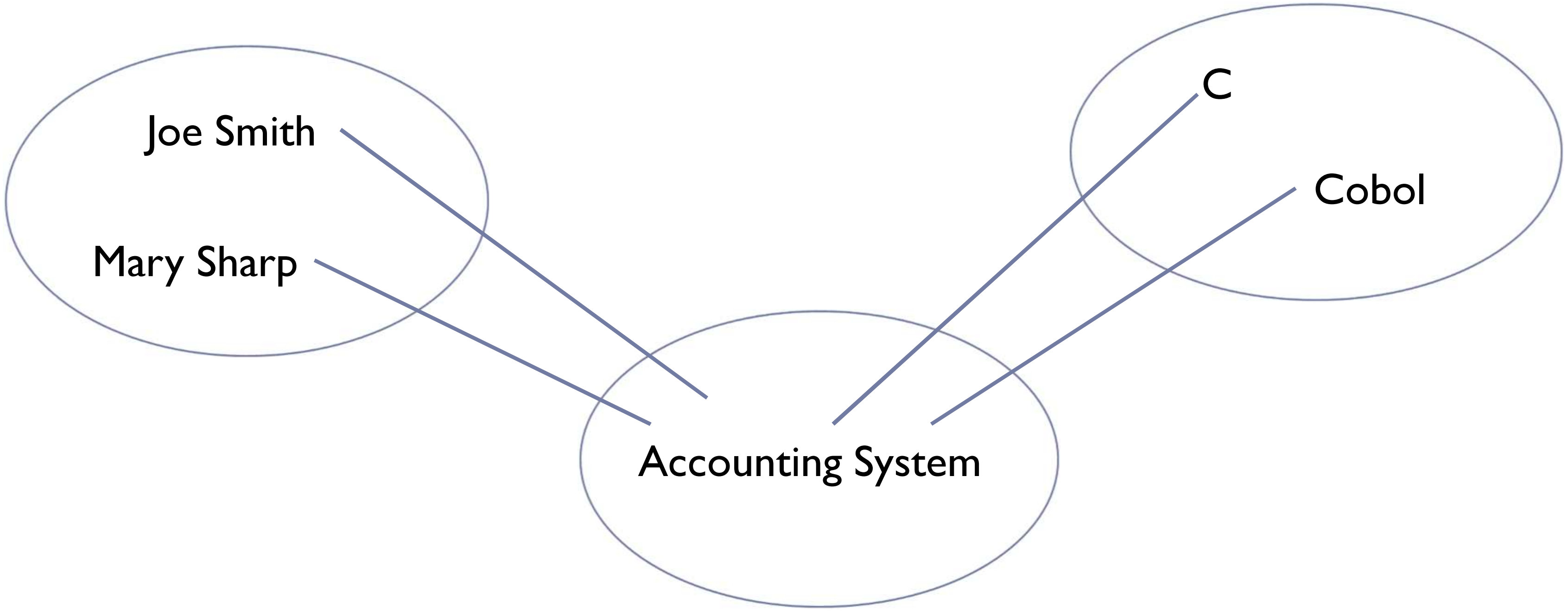
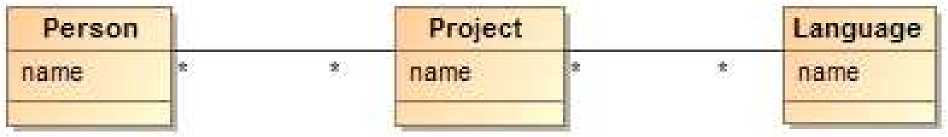
N-ary associations





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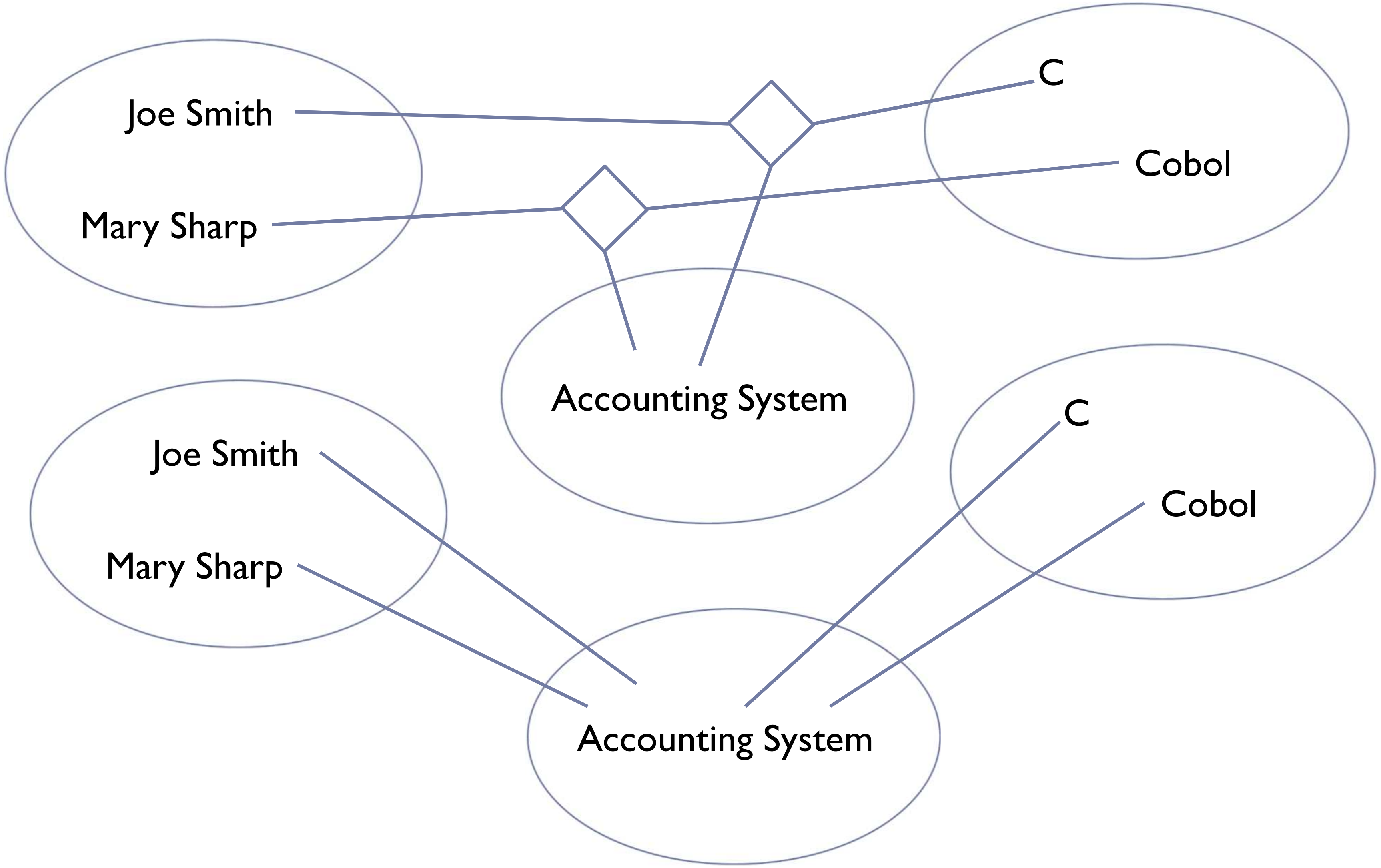
N-ary associations



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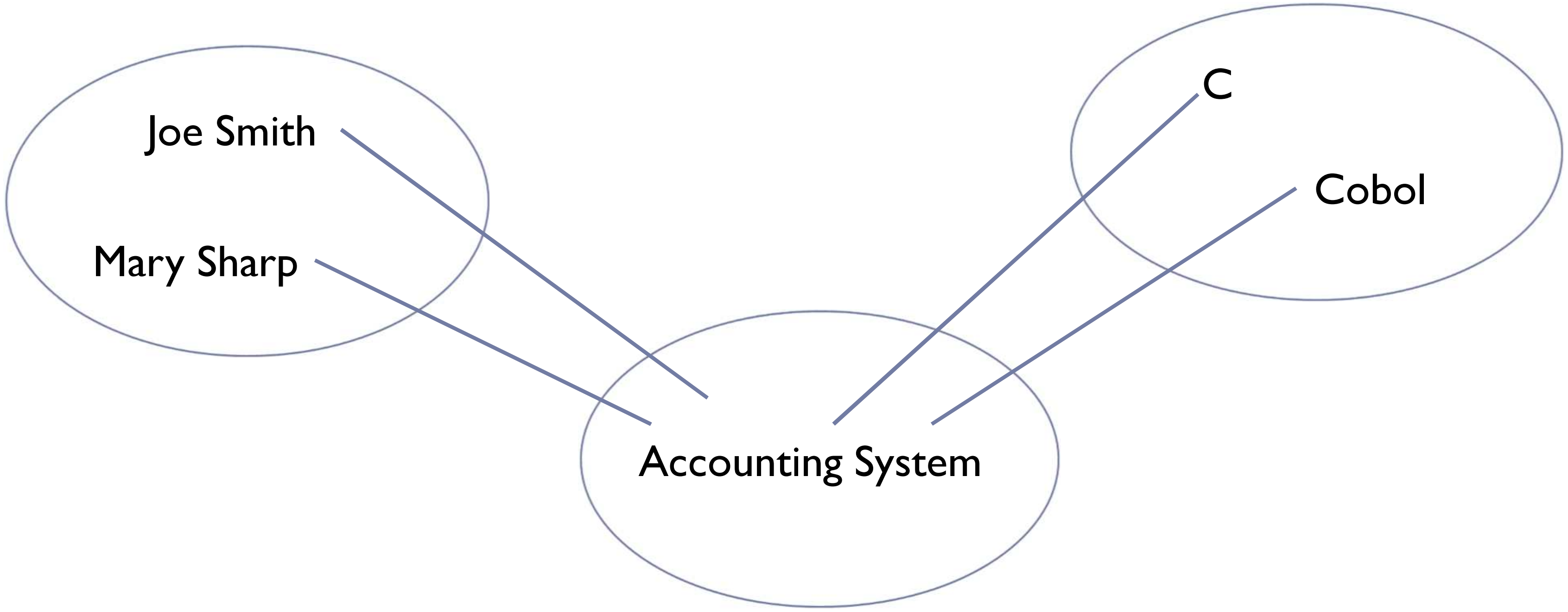

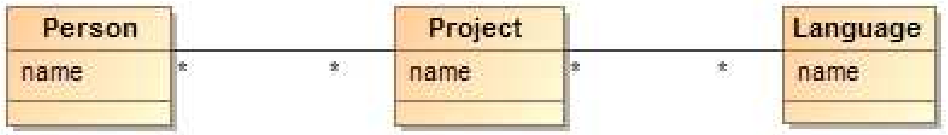

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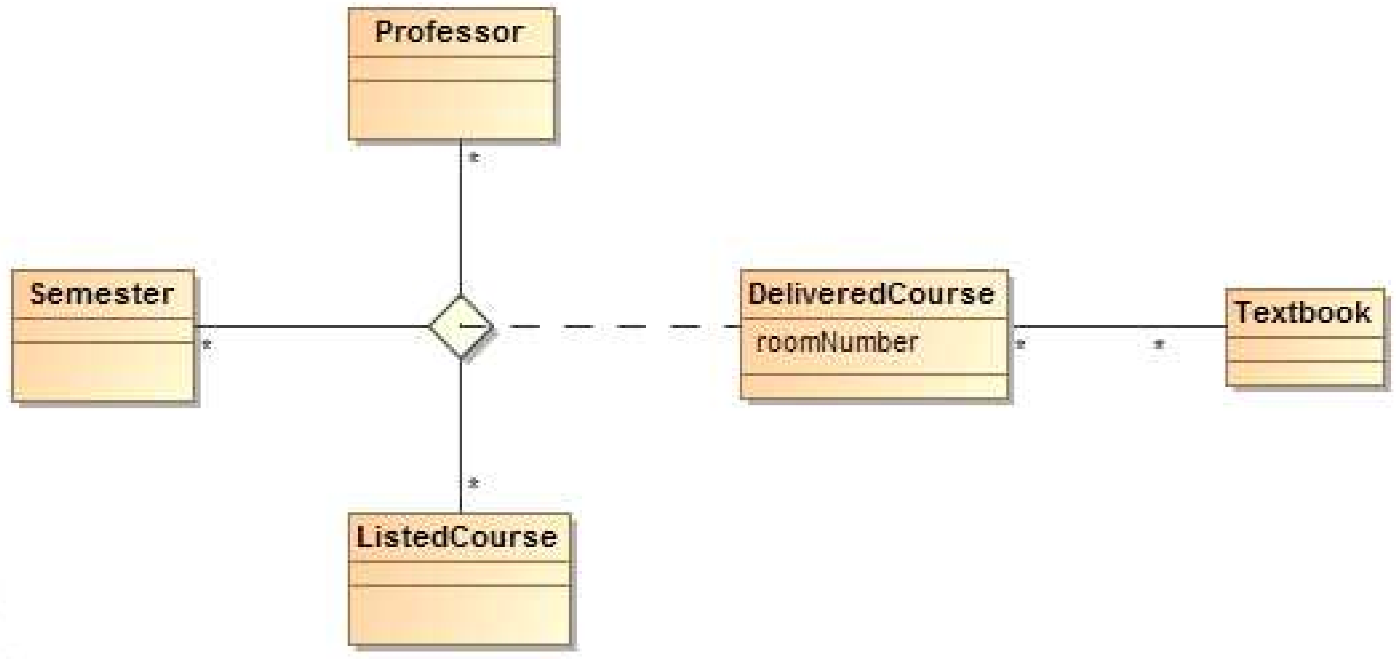
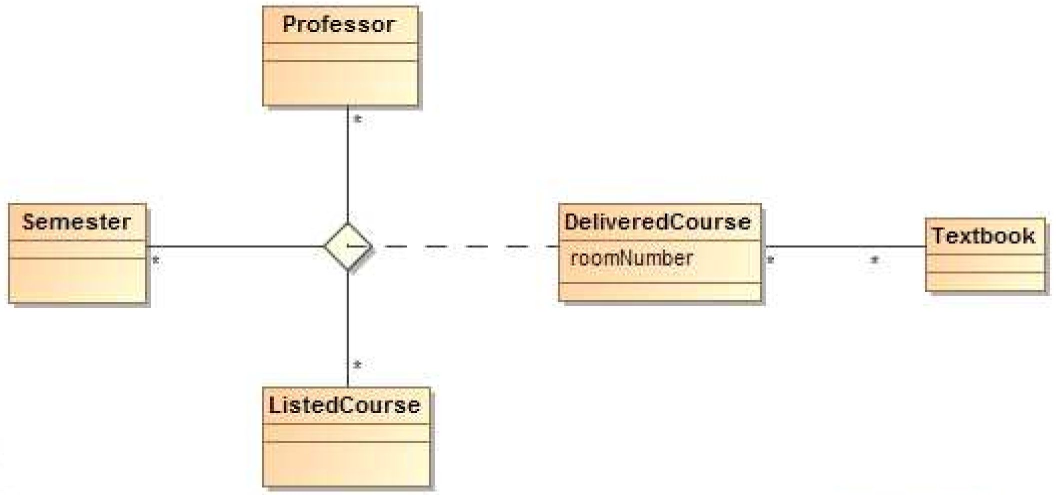
N-ary association classes

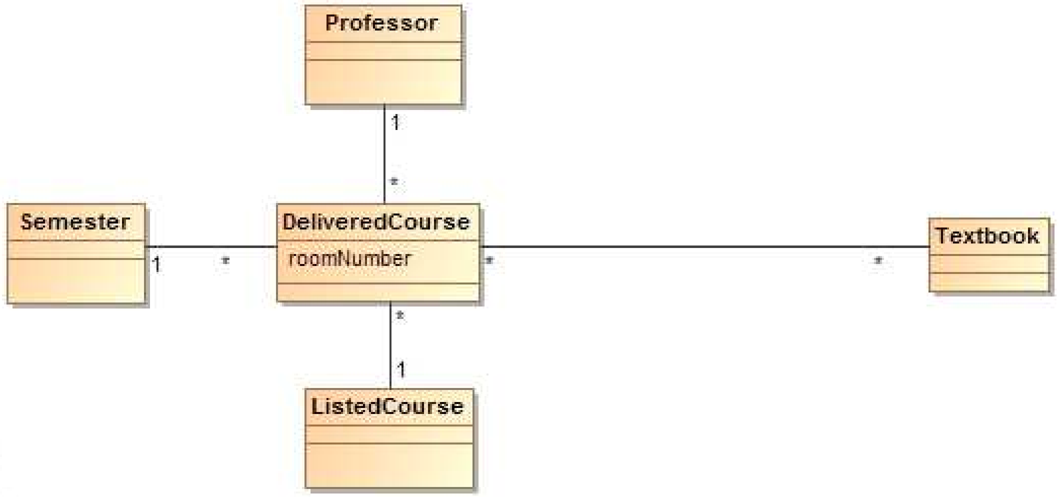


- Professors teach listed courses during semesters. Each delivered course has a room number and any number of textbooks.

N-ary association classes

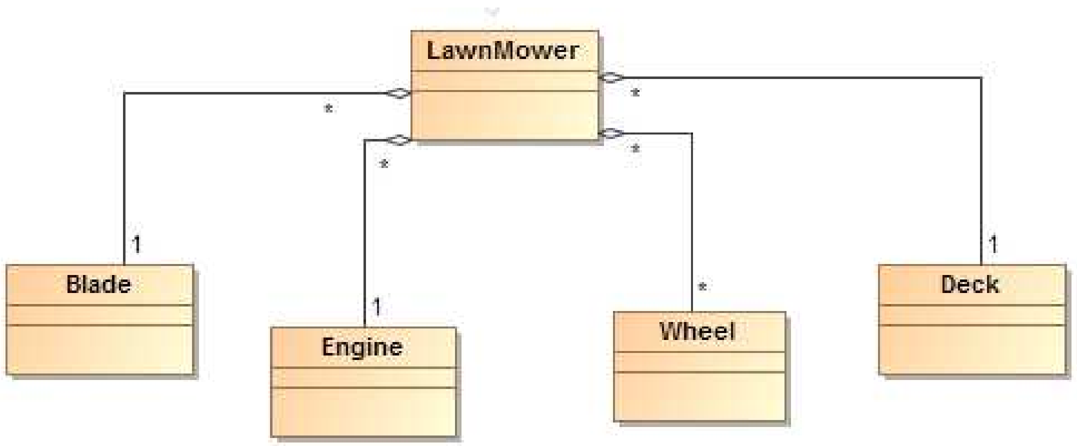


DIFFERENCE?

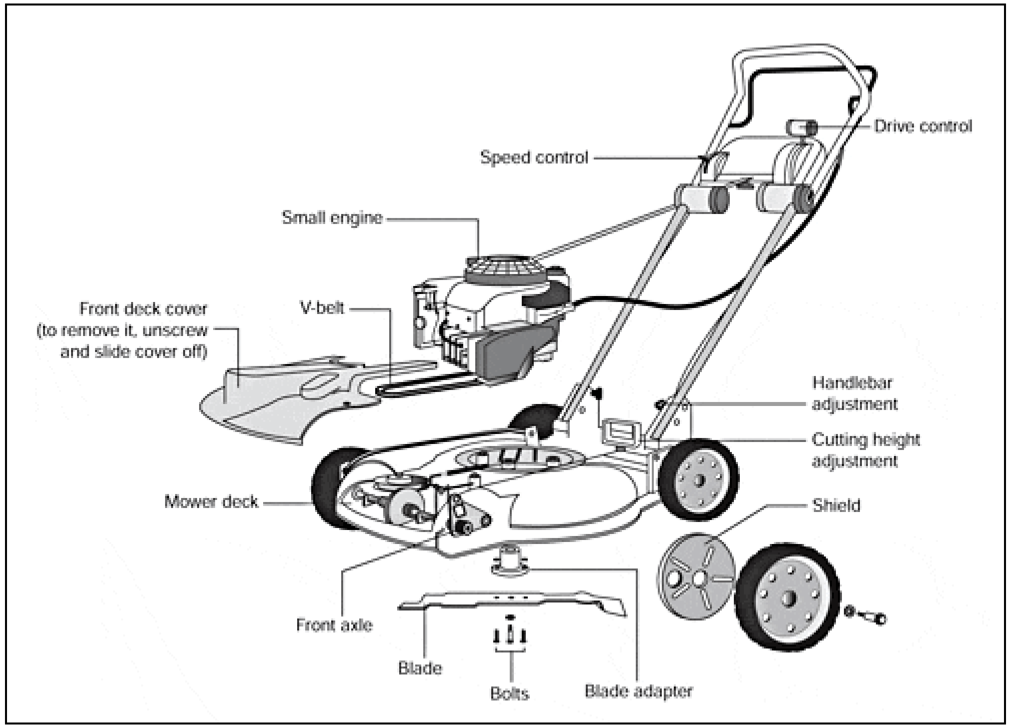


Aggregation

- 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.

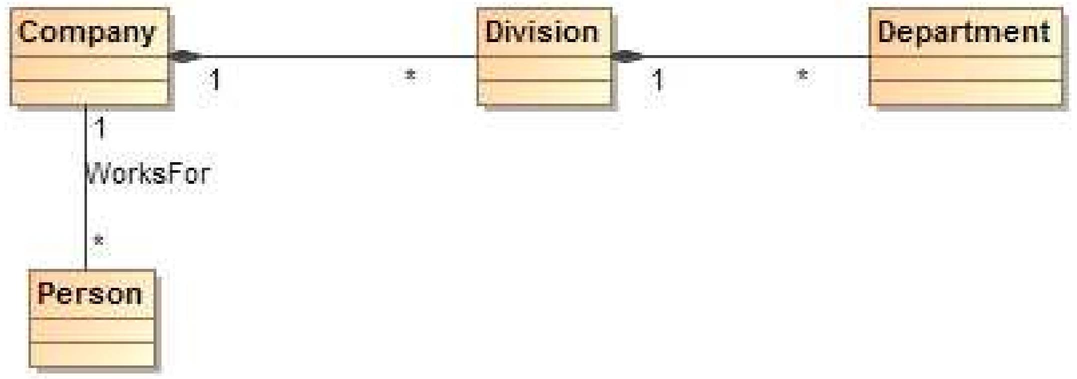


Aggregation



Composition

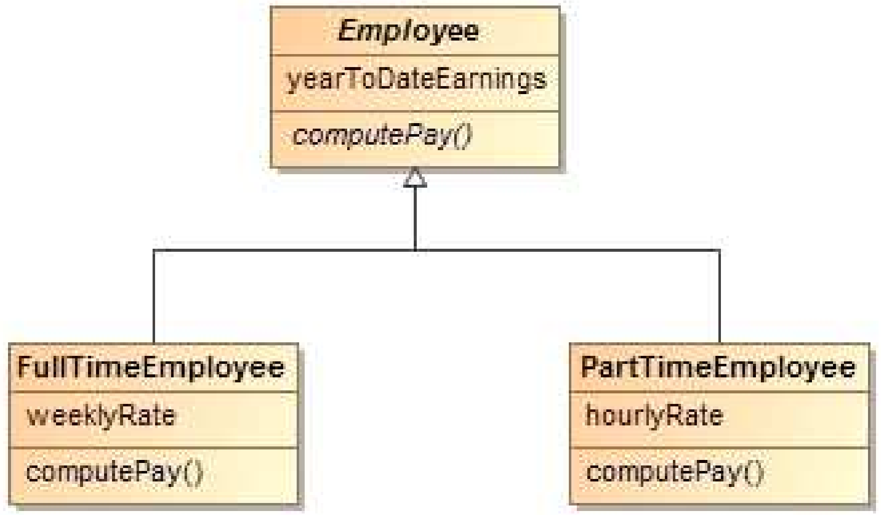
- Composition is a more restrictive form of aggregation.
  - Two additional constraints:
    - A constituent part can belong to at most one assembly.
    - The part has a coincident lifetime as the assembly.
- The UML notation for composition is a small solid diamond next to the assembly class.



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) .

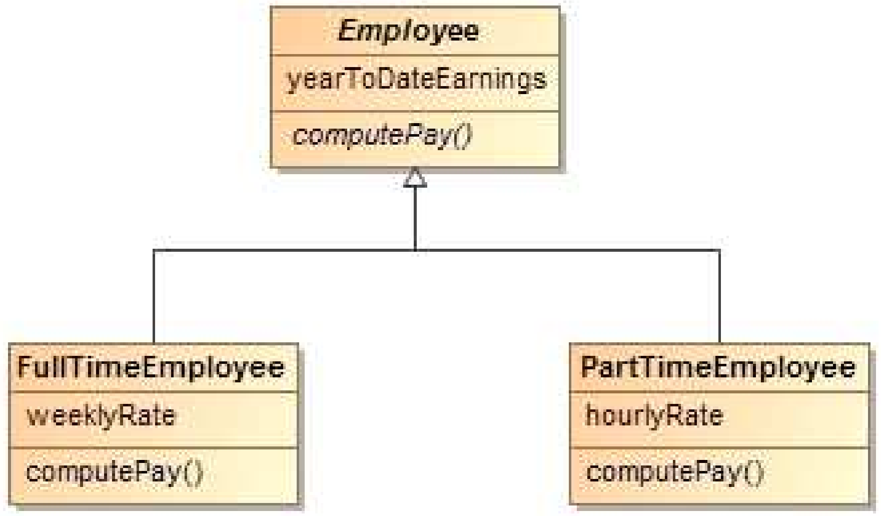
Abstract classes



Abstract classes

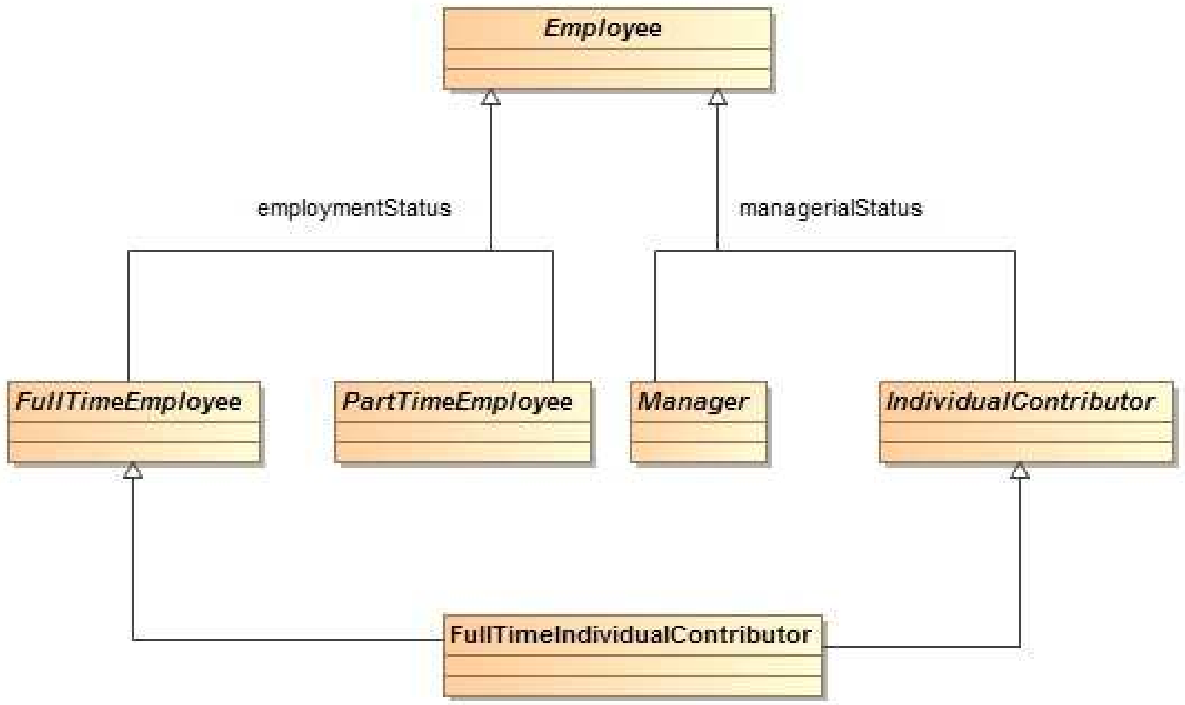
- Abstract classes can be used to define methods that can be inherited by subclasses.
- Abstract classes can define the signature of an operation without supplying a corresponding method.
  - Abstract operations:
    - An abstract operation defines the signature of an operation for which each concrete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

Abstract classes



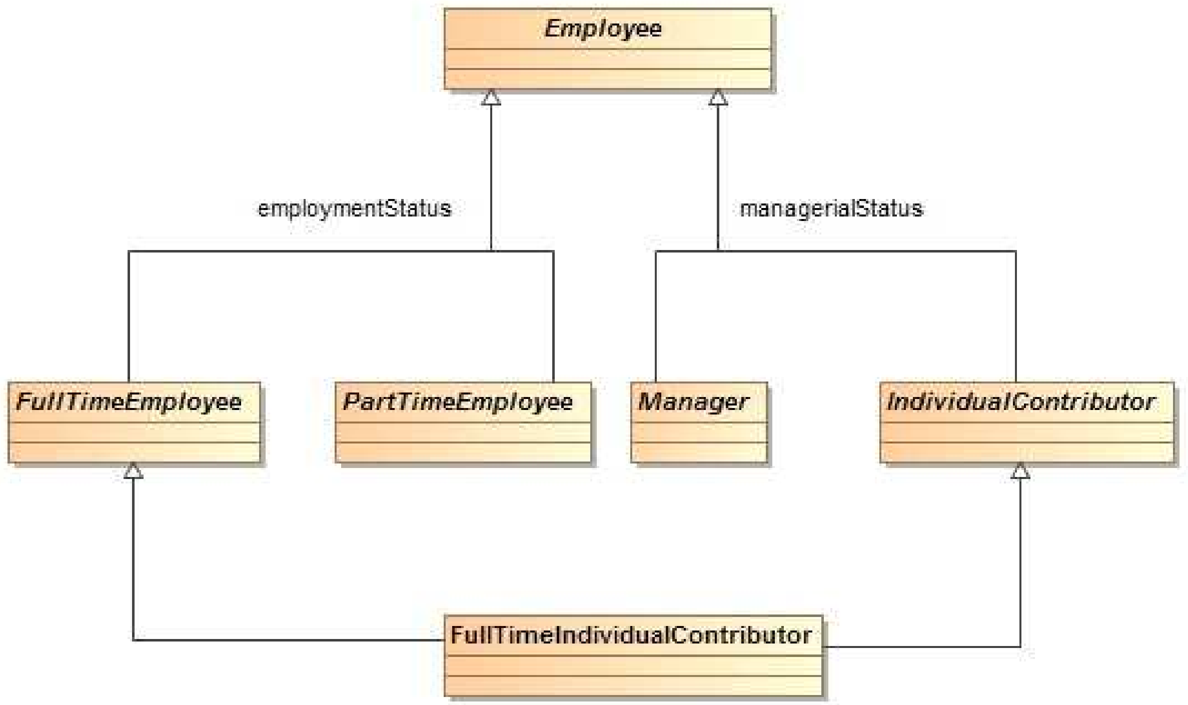
Multiple Inheritance

- 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.



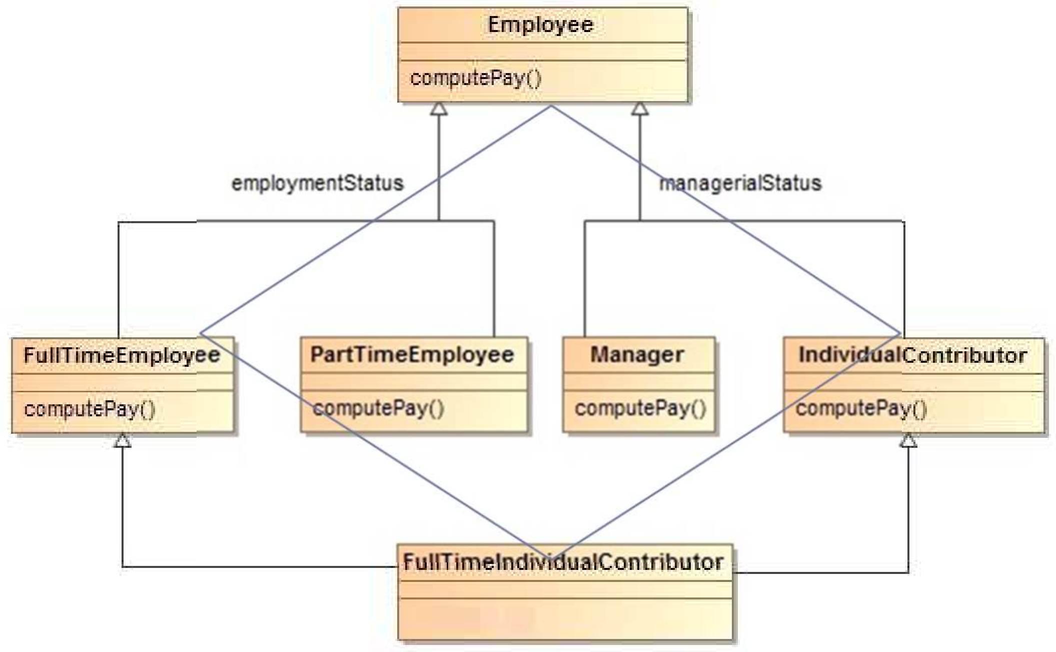
Multiple Inheritance

- 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*?



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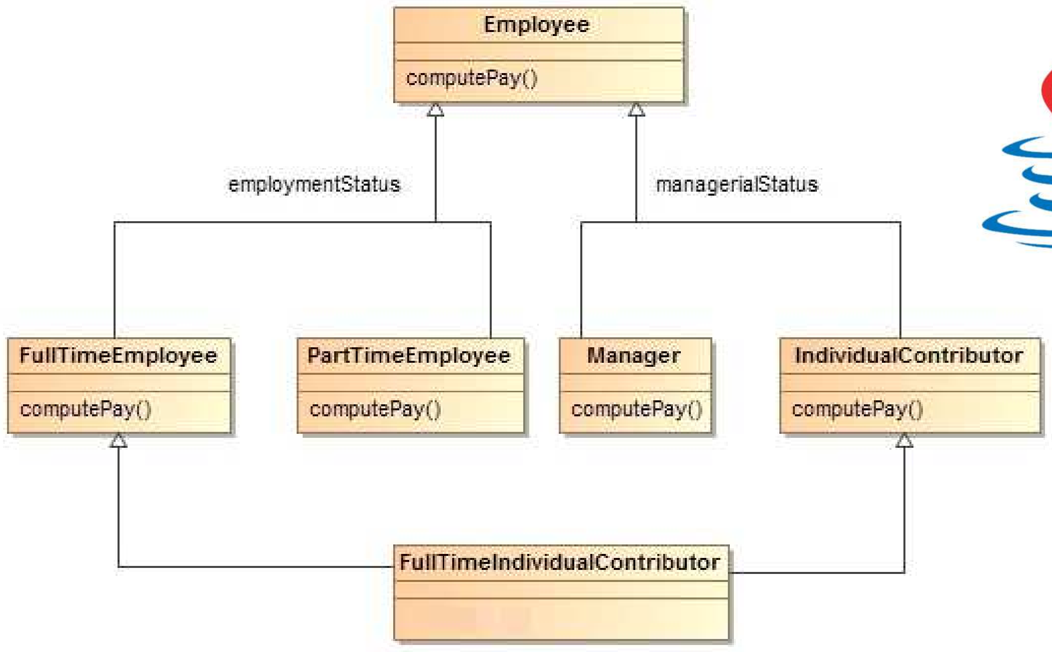
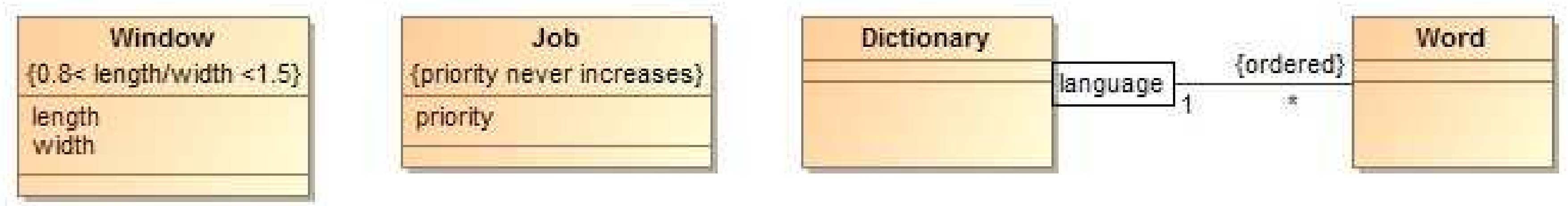


Constraints

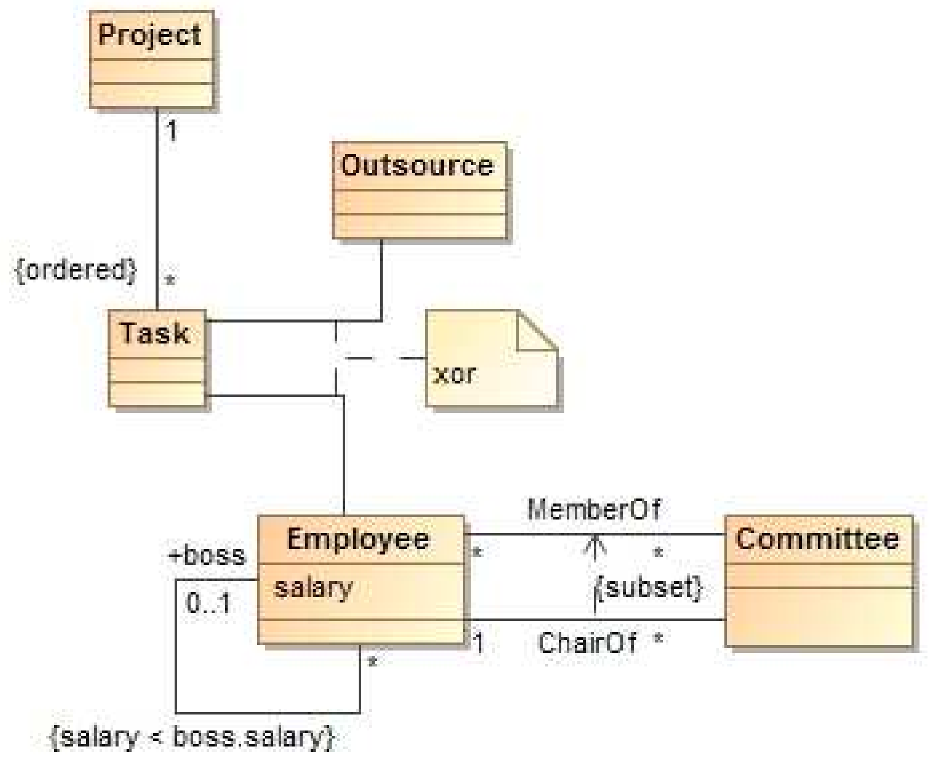
- A constraint is a condition involving model elements, such as objects, classes, attributes, links, associations and generalization sets.
  - A constraint restricts the values that elements can assume.
  - A constraint specifies limitations that implementers need to satisfy.



Constraints

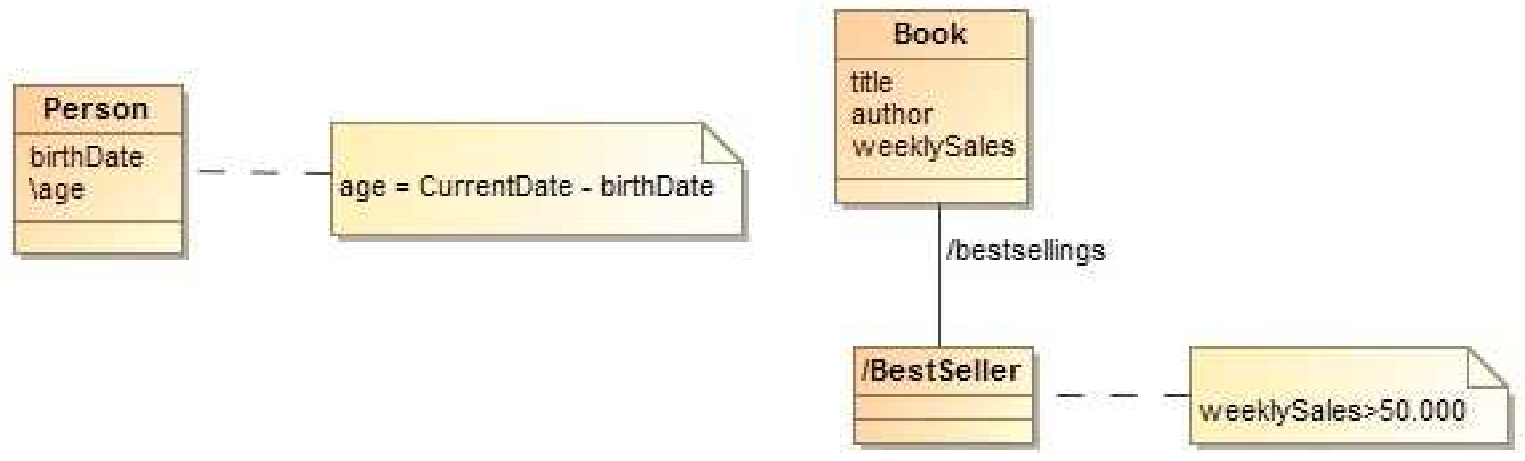
- Multiplicity is a constraint:
  - Multiplicity for an association restricts the number of objects associated to a given object.
  - Multiplicity for an attribute specifies the number of values that are possible for each instantiation of an attribute.
- Qualification is a constraint:
  - A qualifier 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



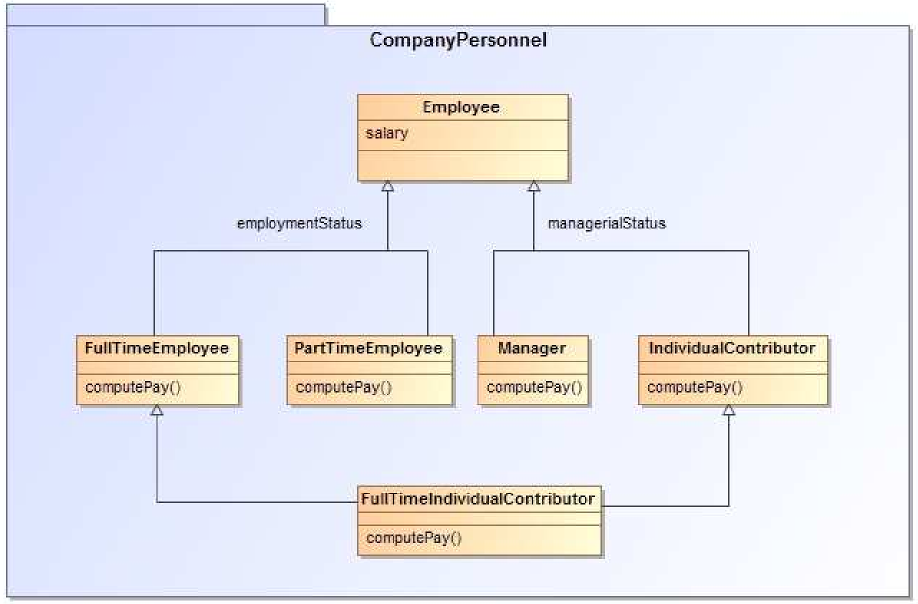
Derived data

- 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.


CompanyPersonnel
Employee
salary
employmentStatus
managerialStatus
FullTimeEmployee
computePay()
PartTimeEmployee
computePay()
Manager
computePay()
IndividualContributor
computePay()
FullTimeIndividualContributor
computePay()