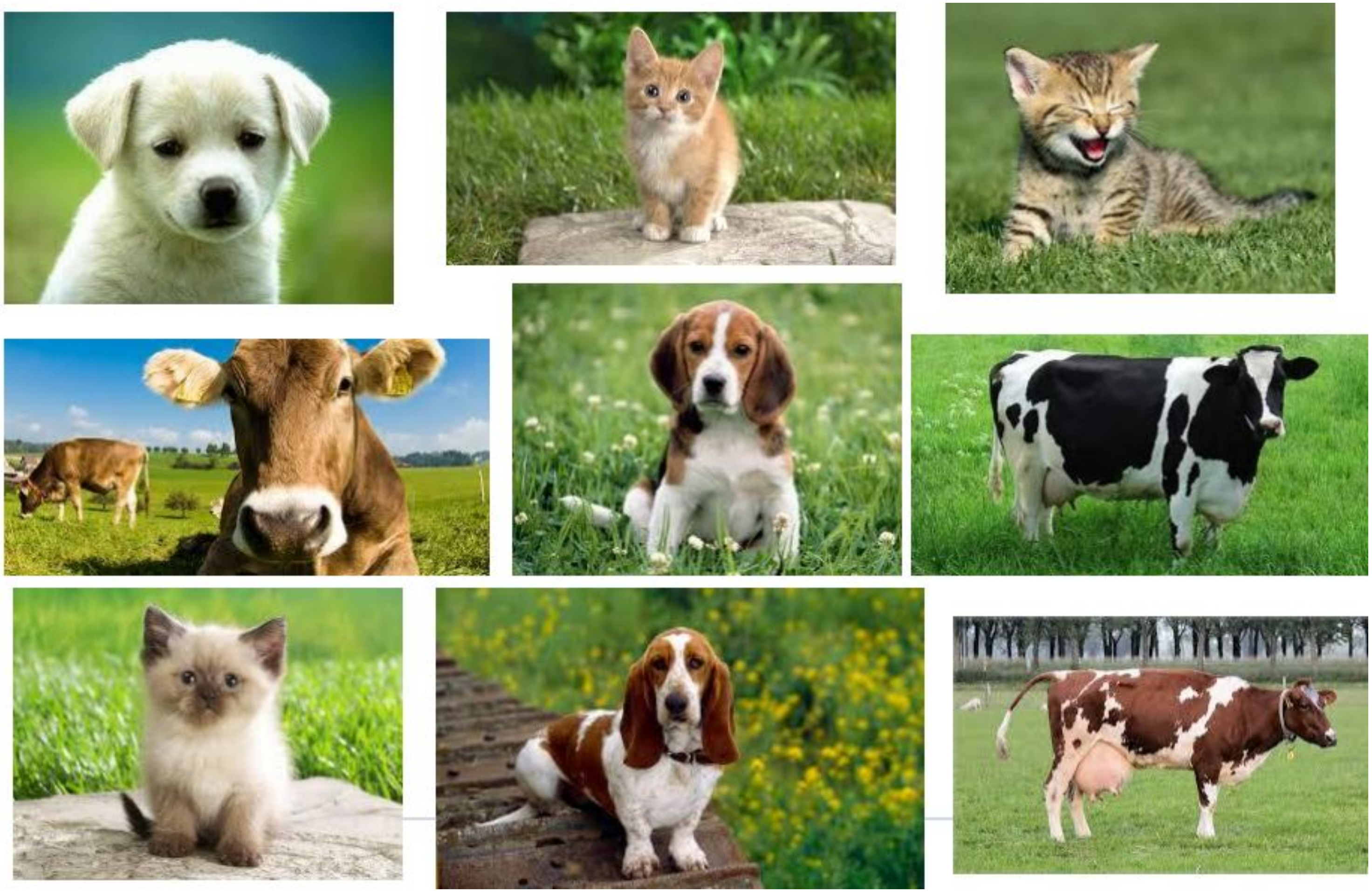
Class Modeling in UML

How many classes? and instances?



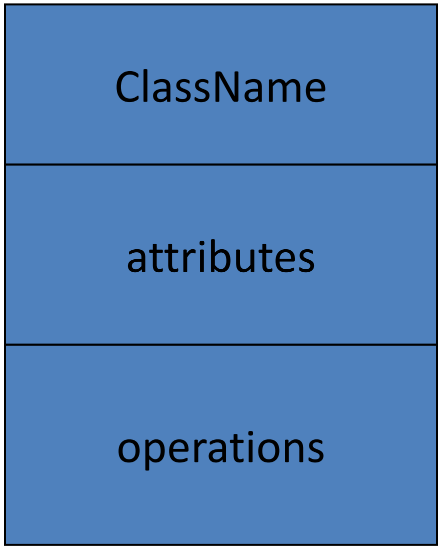
What is modeling?

- Modeling consists of building an abstraction of reality.
- Abstractions are simplifications because:
  - They ignore irrelevant details and
  - They only represent the relevant details.
- What is *relevant* or *irrelevant* depends on the purpose of the model.
- UML (Unified Modeling Language)
  - An emerging standard for modeling object-oriented software.

Class Diagram

- Describes the **static structure** of the system: Objects, Attributes, Associations.
- Used
  - during requirements analysis to model problem domain concepts
  - during system design to model subsystems and interfaces
  - during object design to model classes
- A class represent a concept
- A class encapsulates state (attributes) and behavior (operations)
- Each attribute has a type
- Each operation has a signature
- The class name is the only mandatory information

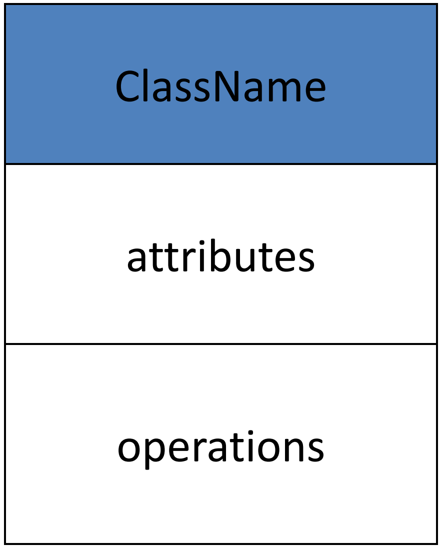
Classes



A *class* is a description of a set of objects that share the same attributes, operations, relationships, and semantics.

Graphically, a class is rendered as a rectangle, usually including its name, attributes, and operations in separate, designated compartments.

Class Names



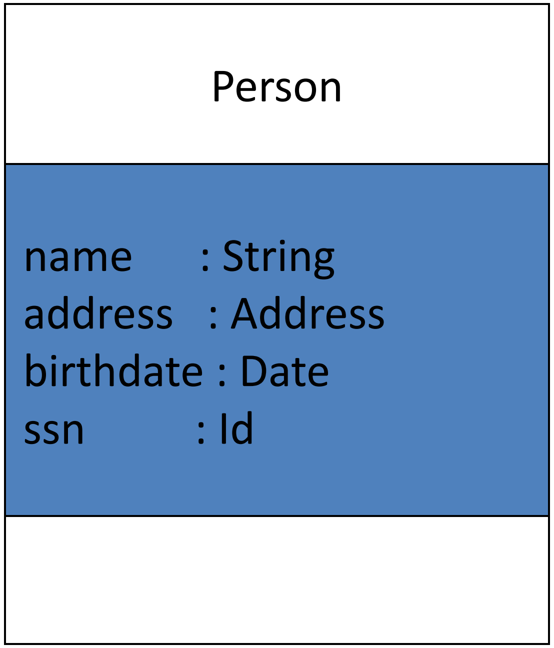
ClassName

attributes

operations

The name of the class is the only required tag in the graphical representation of a class. It always appears in the top-most compartment.

Class Attributes

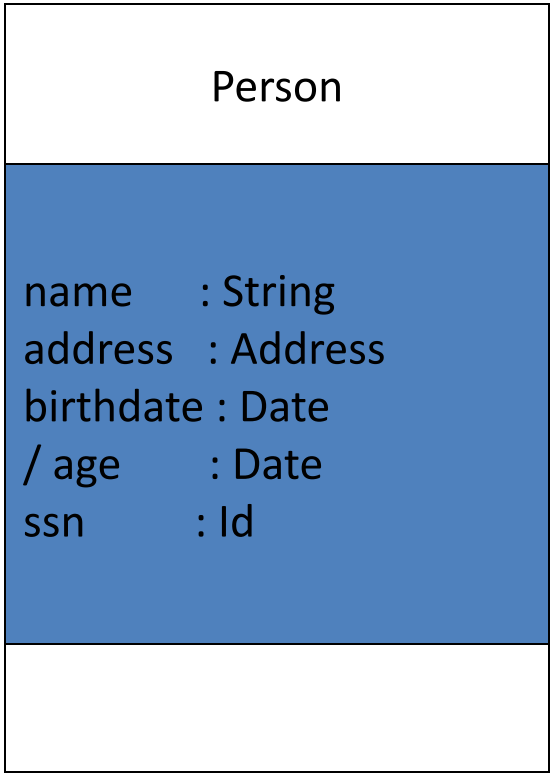


Person

name : String
address : Address
birthdate : Date
ssn : Id

An *attribute* is a named property of a class that describes the object being modeled. In the class diagram, attributes appear in the second compartment just below the name-compartment.

Class Attributes (Cont’d)



Person

name : String
address : Address
birthdate : Date
/ age : Date
ssn : Id

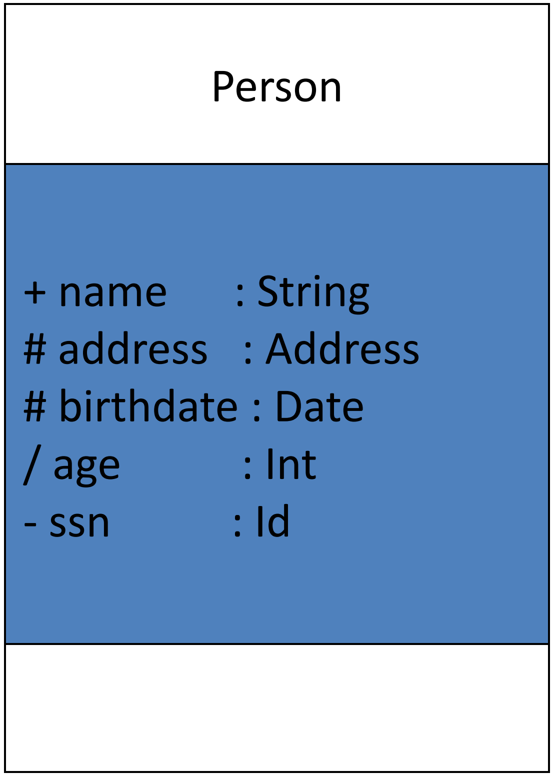
Attributes are usually listed in the form:

attributeName : Type

A *derived* attribute is one that can be computed from other attributes, but doesn’t actually exist. For example, a Person’s age can be computed from his birth date. A derived attribute is designated by a preceding ‘/’ as in:

/ age : Date

Class Attributes (Cont’d)



Person

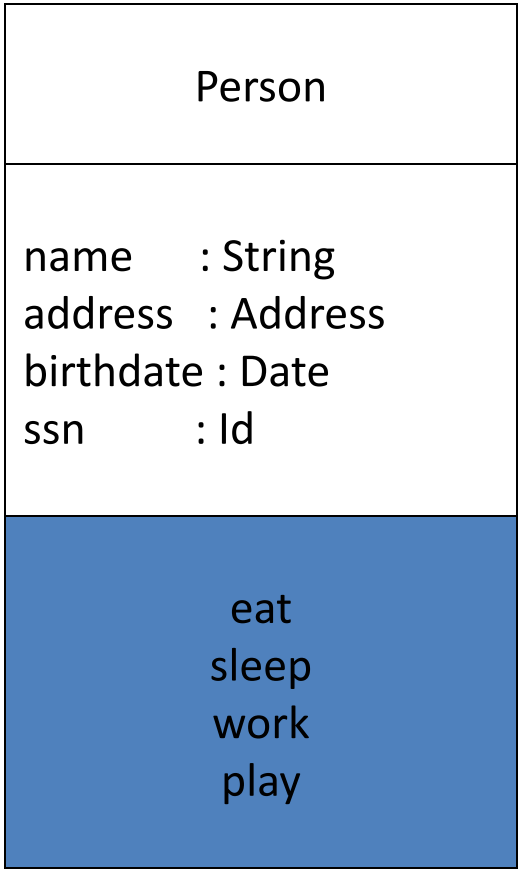
+ name : String
# address : Address
# birthdate : Date
/ age : Int
- ssn : Id

Attributes can be:

    + public
    # protected
    - private
    / derived

underline static attributes

Class Operations



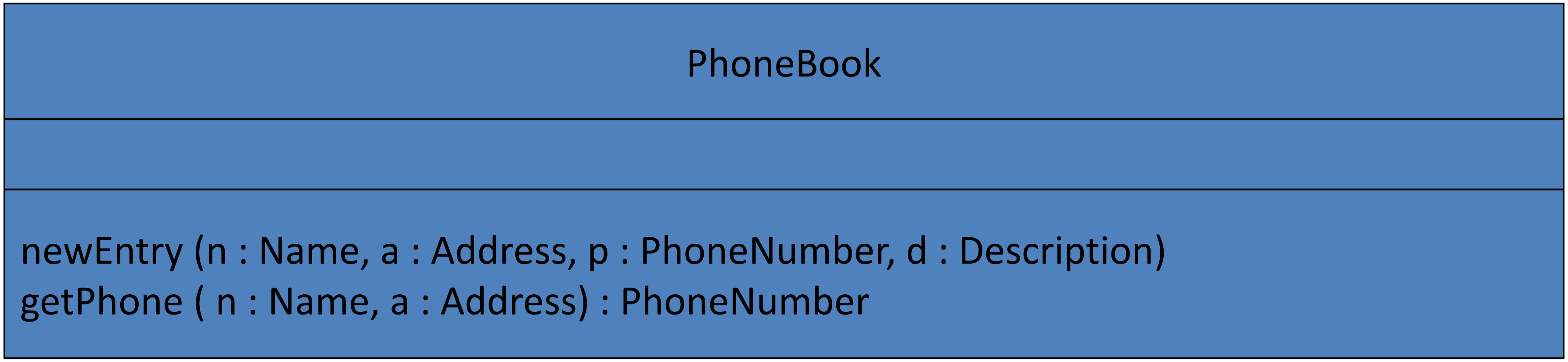
Person

name : String
address : Address
birthdate : Date
ssn : Id

eat
sleep
work
play

Operations describe the class behavior and appear in the third compartment.

Class Operations (Cont'd)



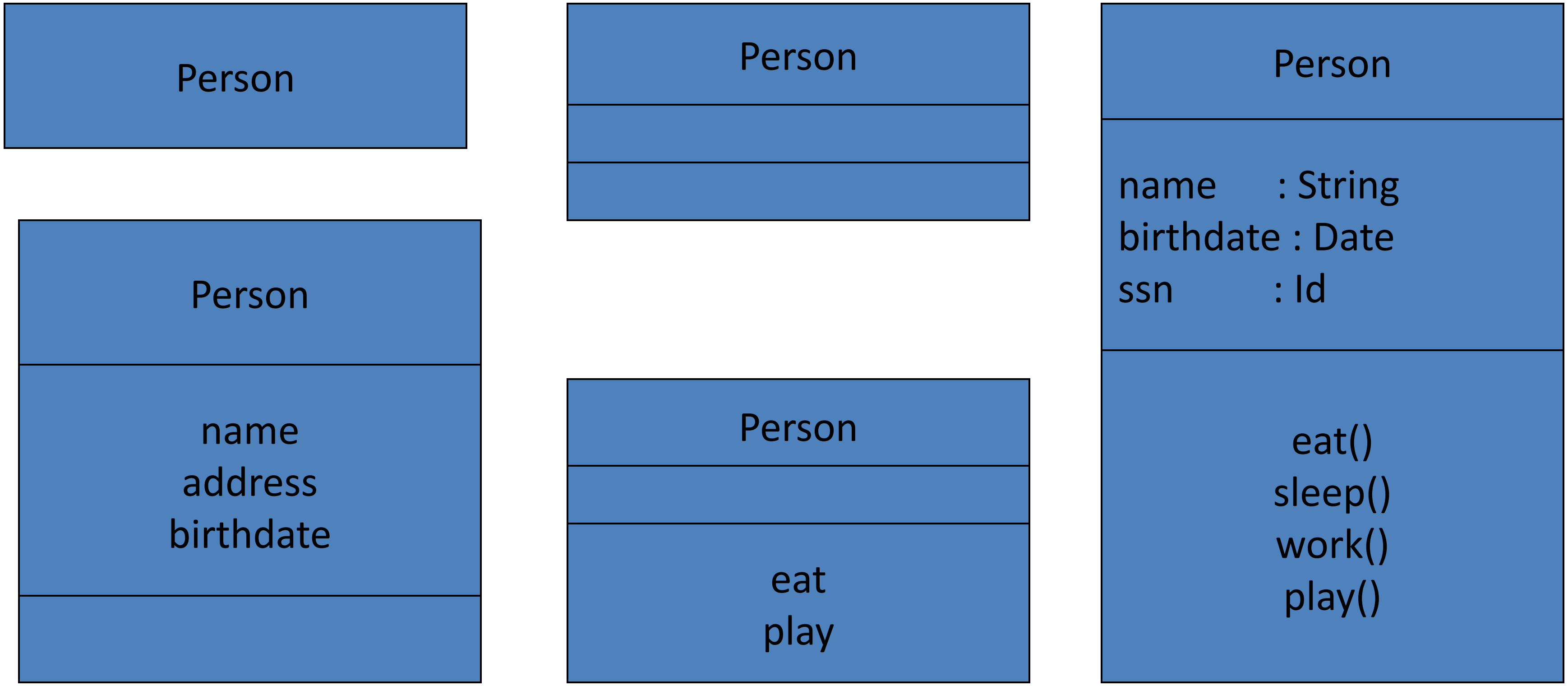
PhoneBook

newEntry (n : Name, a : Address, p : PhoneNumber, d : Description)
getPhone (n : Name, a : Address) : PhoneNumber

You can specify an operation by stating its signature: listing the name, type, and default value of all parameters, and, in the case of functions, a return type.

Depicting Classes

When drawing a class, you needn’t show attributes and operation in every diagram.



Person

Person

Person

name : String
birthdate : Date
ssn : Id

eat()
sleep()
work()
play()

Person

name
address
birthdate

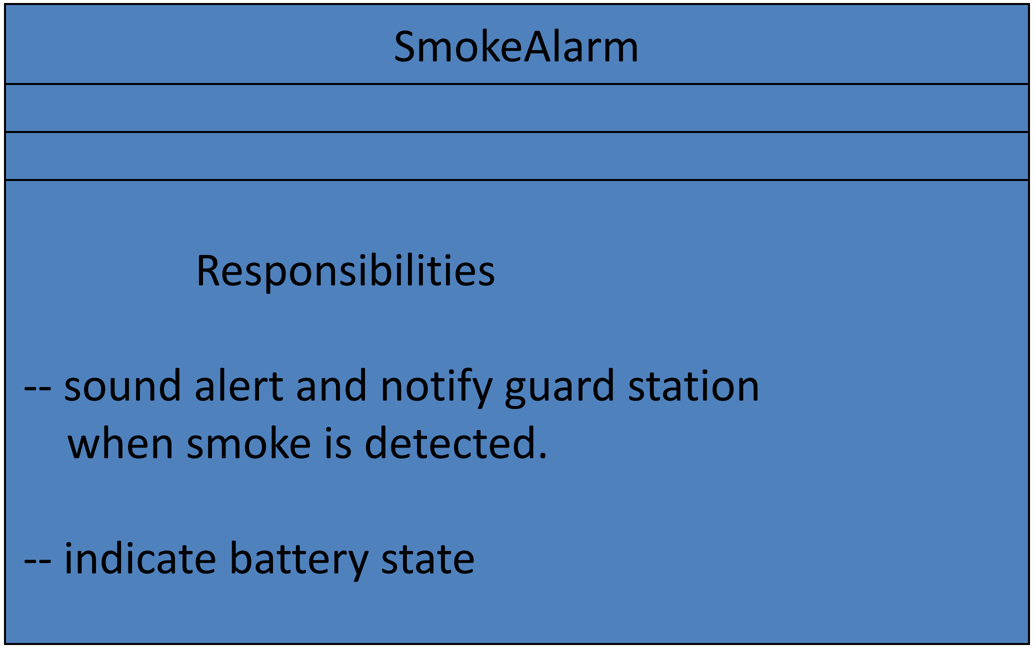
Person

eat
play

Class Responsibilities

A class may also include its responsibilities in a class diagram.

A responsibility is a contract or obligation of a class to perform a particular service.



SmokeAlarm

Responsibilities

-- sound alert and notify guard station
when smoke is detected.

-- indicate battery state

Relationships

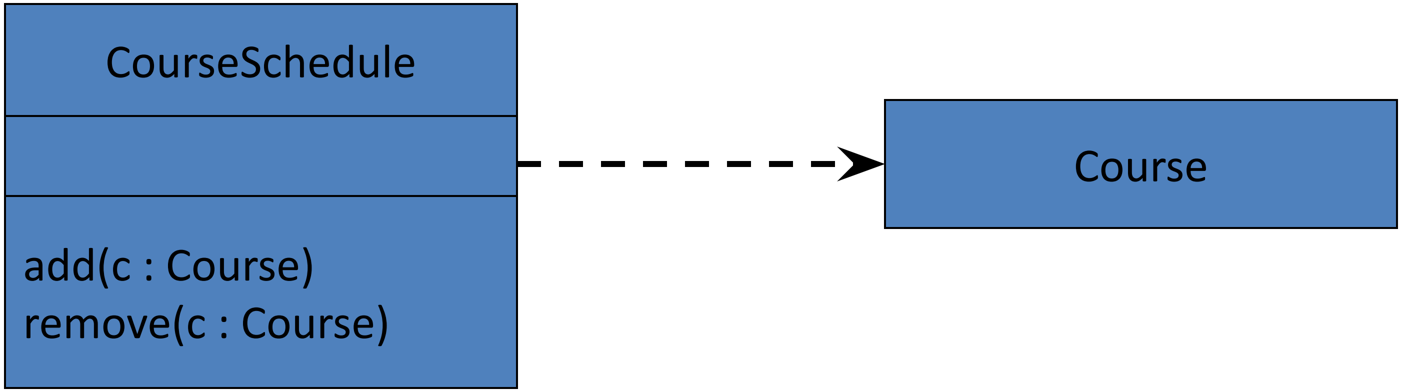
In UML, object interconnections (logical or physical), are modeled as relationships.

There are three kinds of relationships in UML:

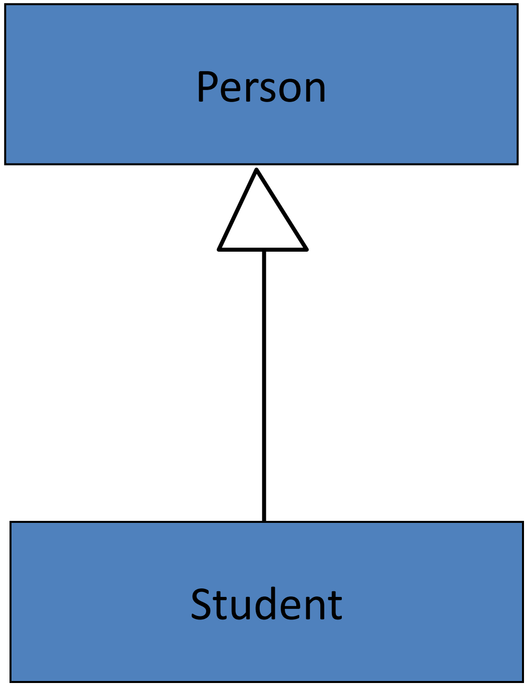
- dependencies
- generalizations
- associations

Dependency Relationships

A *dependency* indicates a semantic relationship between two or more elements. The dependency from *CourseSchedule* to *Course* exists because *Course* is used in both the **add** and **remove** operations of *CourseSchedule*.



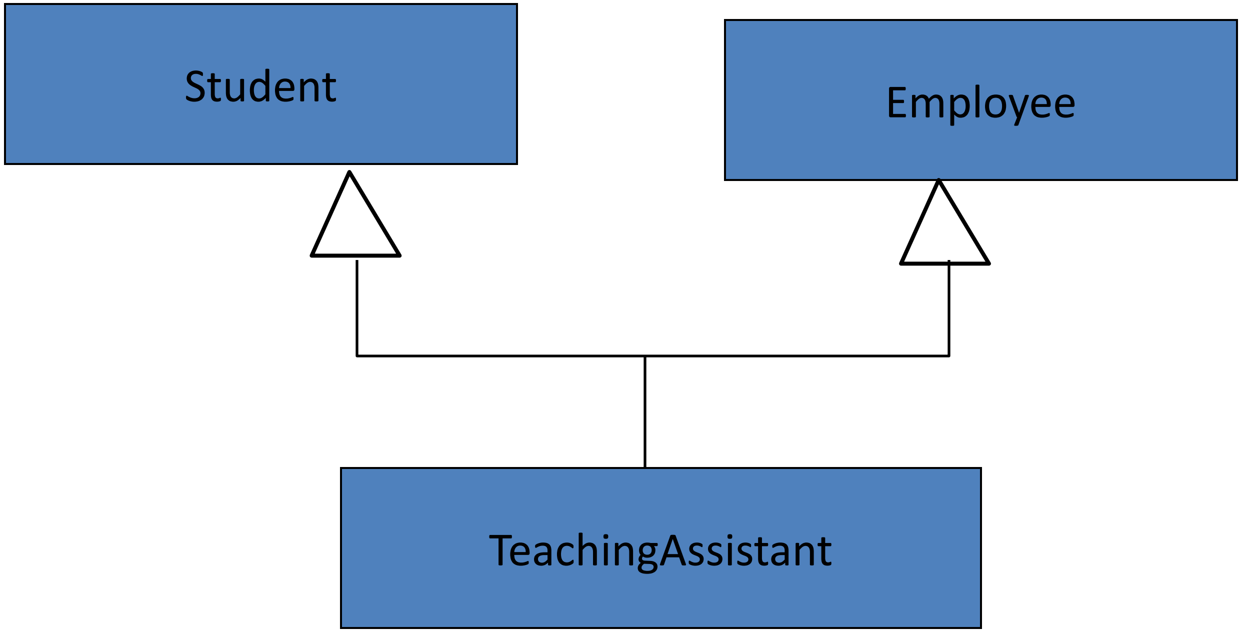
Generalization Relationships



A *generalization* connects a subclass to its superclass. It denotes an inheritance of attributes and behavior from the superclass to the subclass and indicates a specialization in the subclass of the more general superclass.

Generalization Relationships (Cont’d)

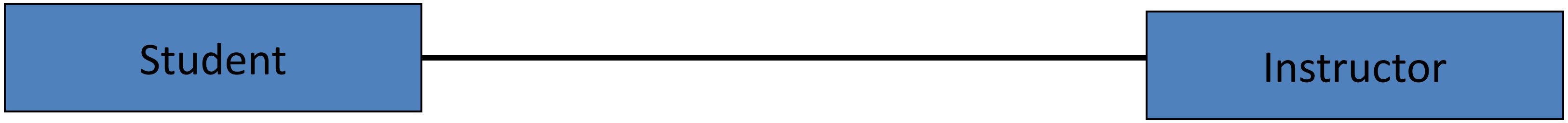
UML permits a class to inherit from multiple superclasses, although some programming languages (*e.g.,* Java) do not permit multiple inheritance.



Association Relationships

If two classes in a model need to communicate with each other, there must be link between them.

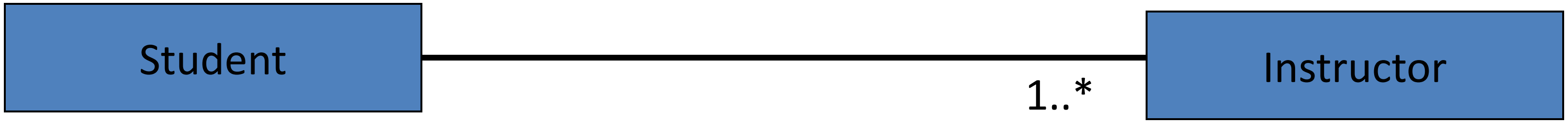
An *association* denotes that link.



Association Relationships (Cont’d)

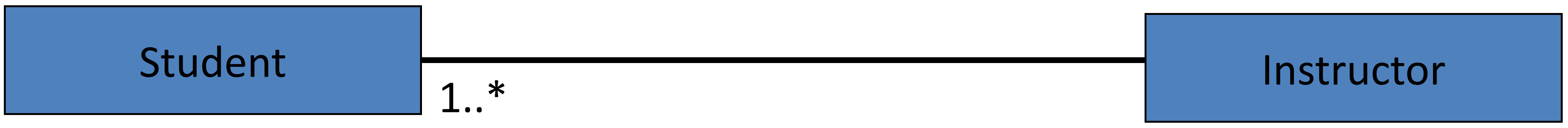
We can indicate the *multiplicity* of an association by adding *multiplicity adornments* to the line denoting the association.

The example indicates that a *Student* has one or more *Instructors*:



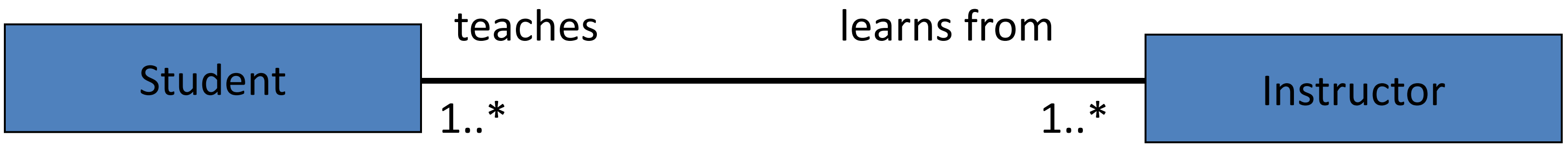
Association Relationships (Cont’d)

The example indicates that every *Instructor* has one or more *Students*:



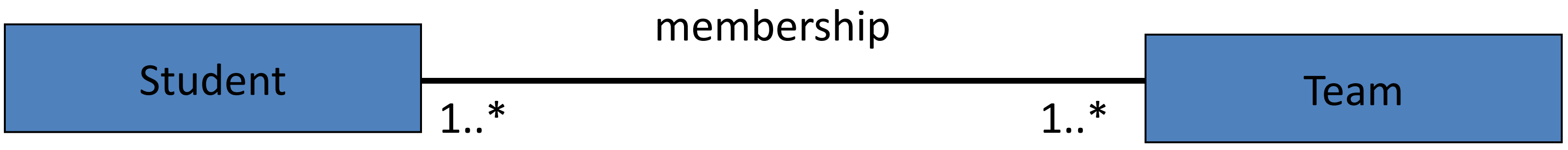
Association Relationships (Cont’d)

We can also indicate the behavior of an object in an association (*i.e.,* the *role* of an object) using *rolenames.*



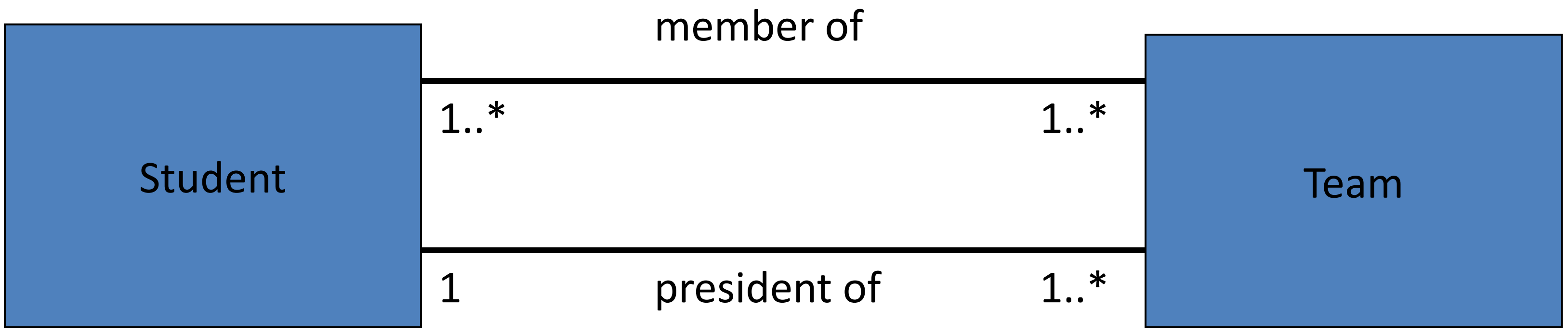
Association Relationships (Cont’d)

We can also name the association.



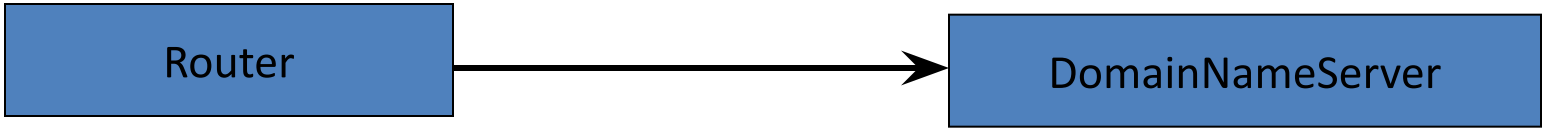
Association Relationships (Cont’d)

We can specify dual associations.



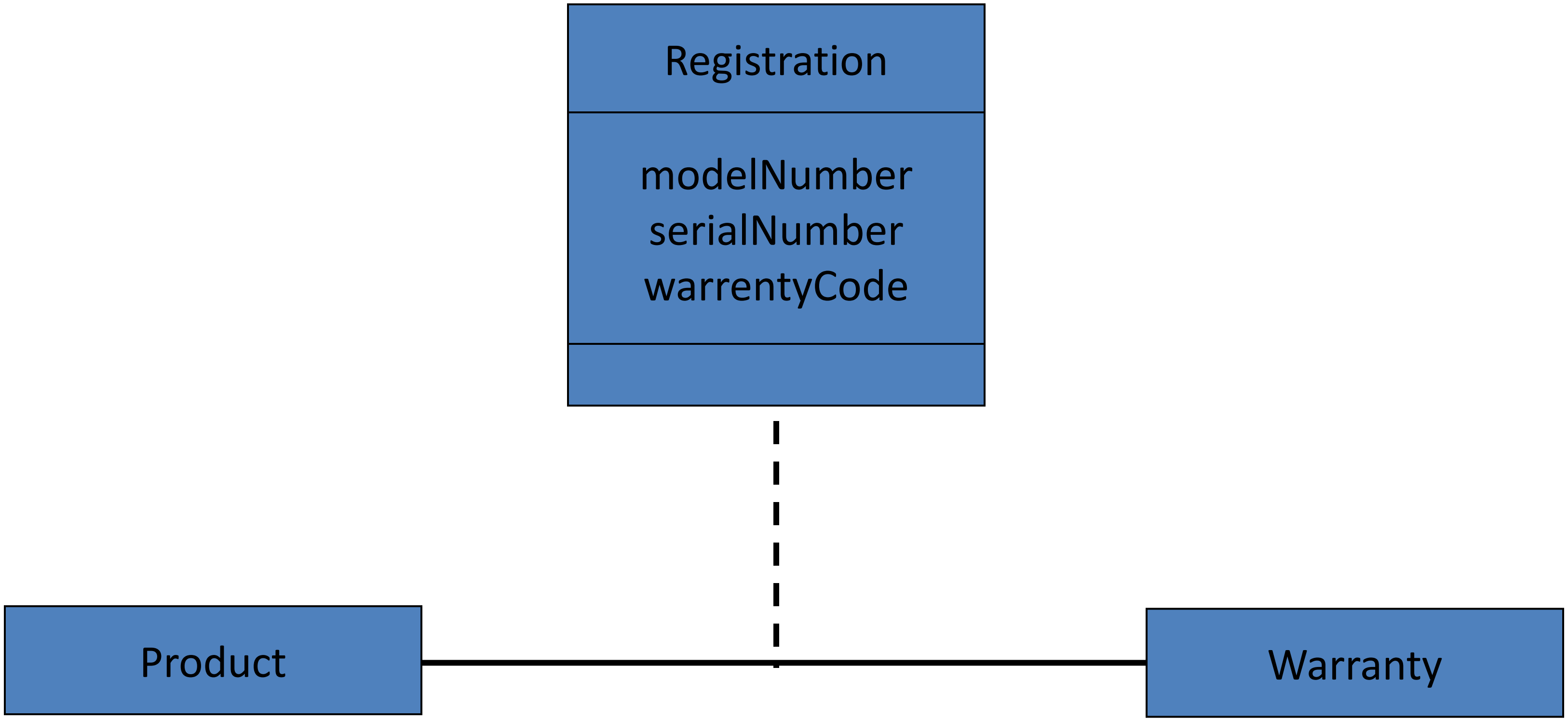
Association Relationships (Cont’d)

We can constrain the association relationship by defining the *navigability* of the association. Here, a *Router* object requests services from a *DNS* object by sending messages to (invoking the operations of) the server. The direction of the association indicates that the server has no knowledge of the *Router*.



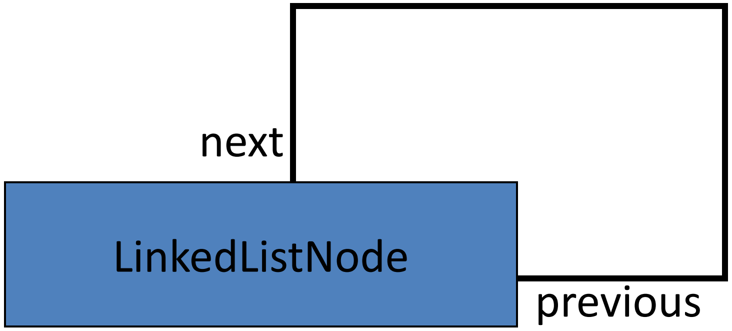
Association Relationships (Cont'd)

Associations can also be objects themselves, called *link classes* or an *association classes*.



Association Relationships (Cont’d)

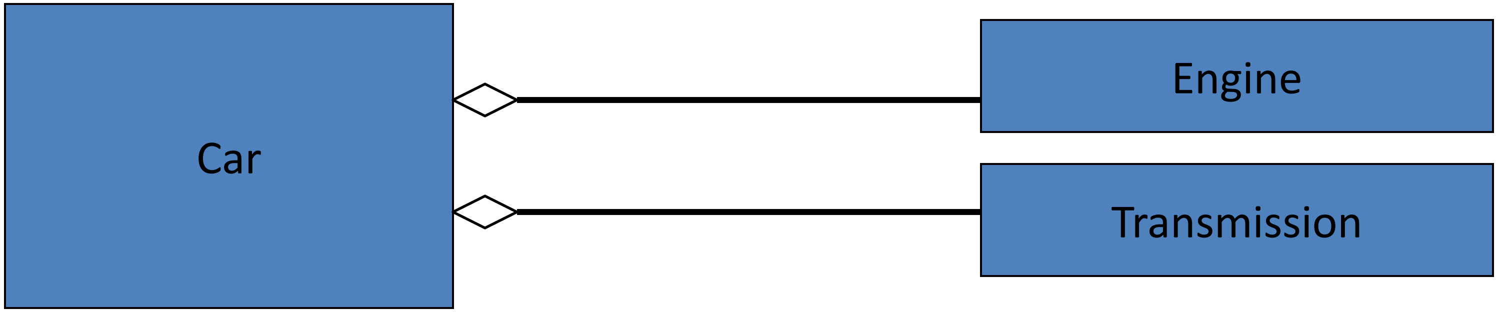
A class can have a *self association*.



Association Relationships (Cont'd)

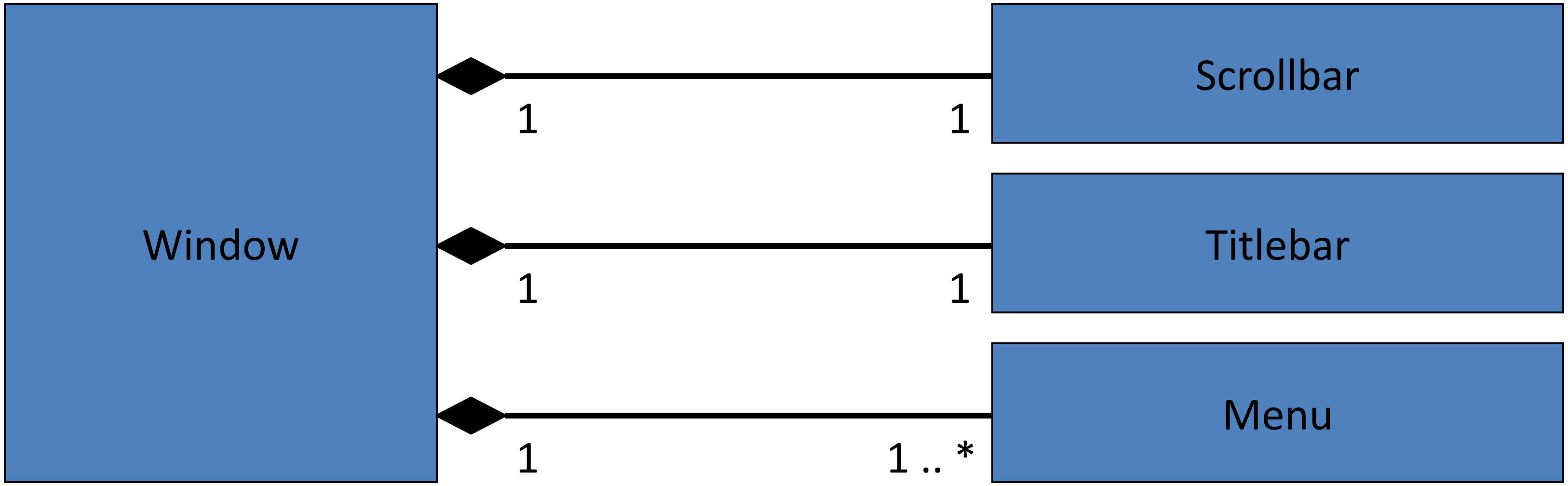
We can model objects that contain other objects by way of special associations called *aggregations* and *compositions.*

An *aggregation* specifies a whole-part relationship between an aggregate (a whole) and a constituent part, where the part can exist independently from the aggregate. Aggregations are denoted by a hollow-diamond adornment on the association.

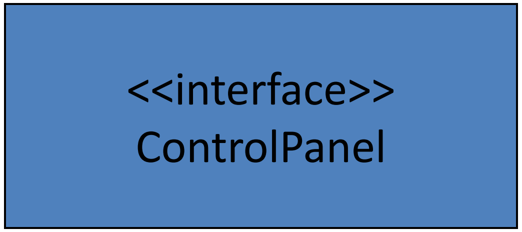


Association Relationships (Cont'd)

A *composition* indicates a strong ownership and coincident lifetime of parts by the whole (*i.e.,* they live and die as a whole). Compositions are denoted by a filled-diamond adornment on the association.

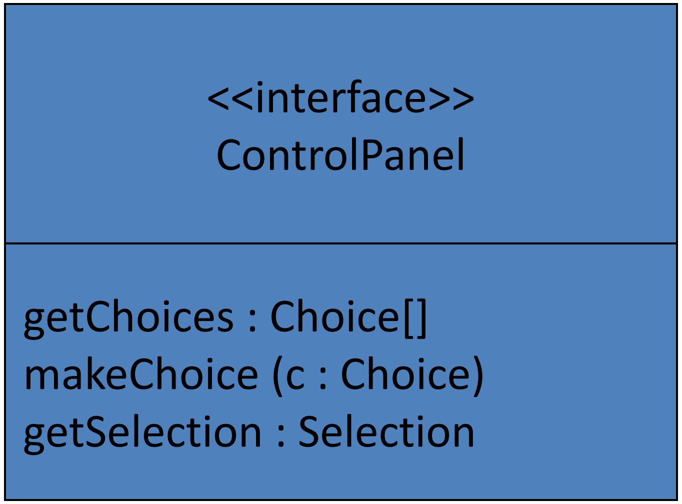


Interfaces


<<interface>>
ControlPanel

An *interface* is a named set of operations that specifies the behavior of objects without showing their inner structure. It can be rendered in the model by a one- or two-compartment rectangle, with the *stereotype* <<interface>> above the interface name.

Interface Services

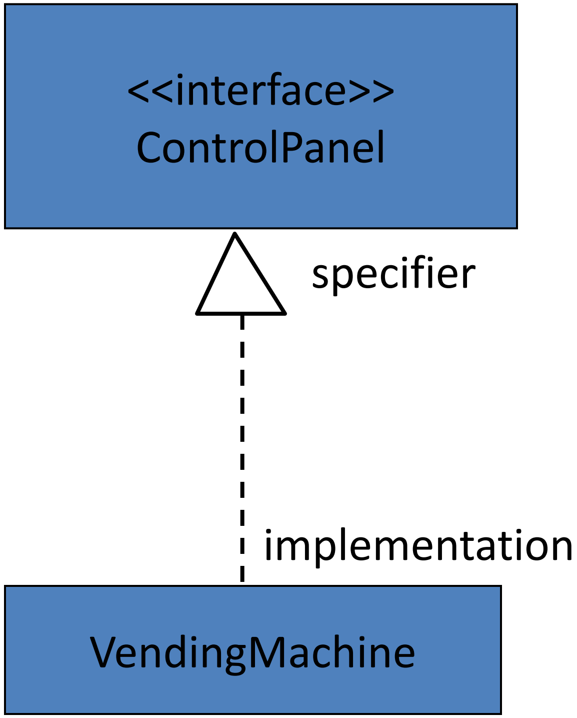


<<interface>>
ControlPanel

getChoices : Choice[]
makeChoice (c : Choice)
getSelection : Selection

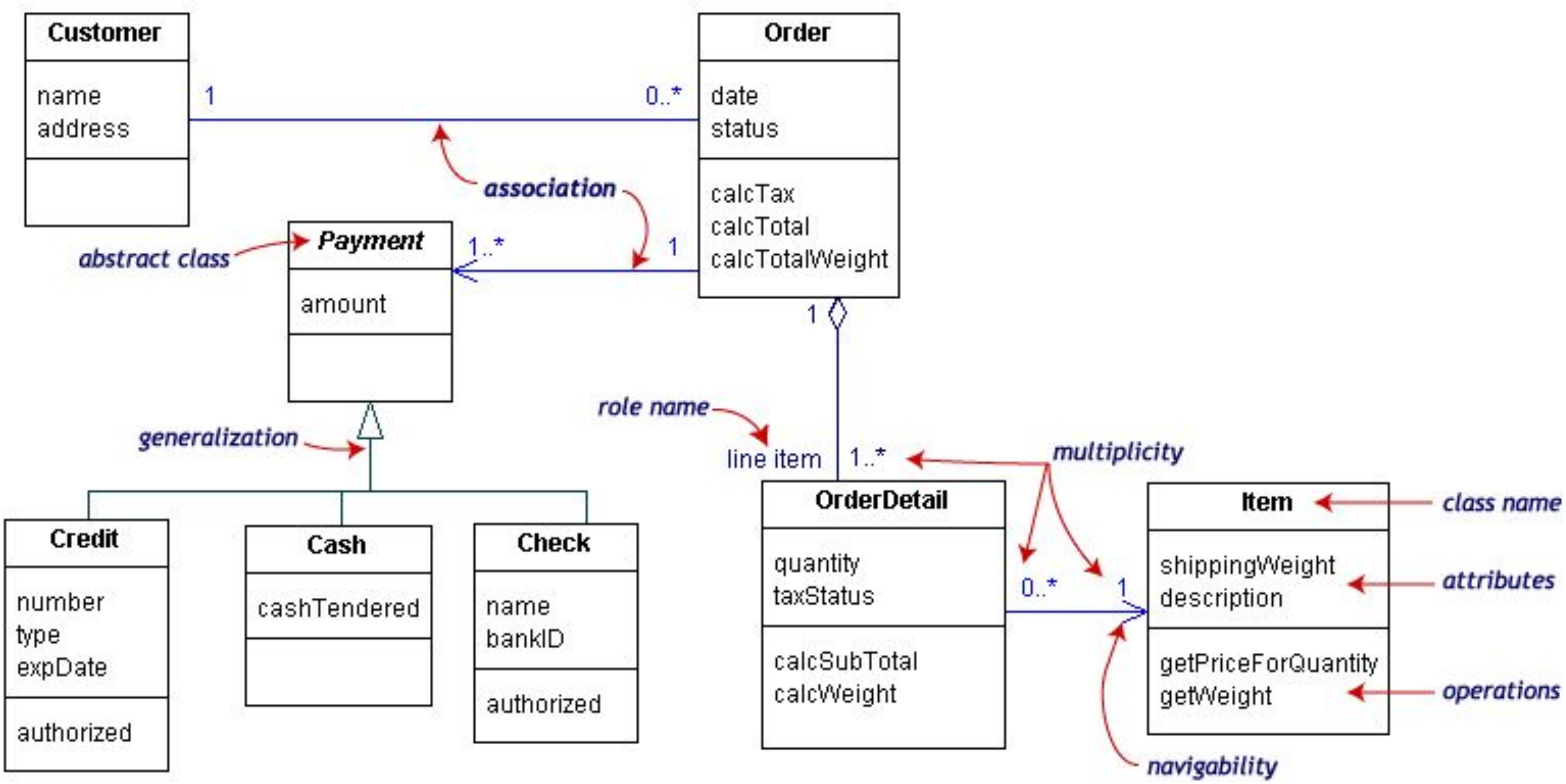
Interfaces do not get instantiated. They have no attributes or state. Rather, they specify the services offered by a related class.

Interface Realization Relationship



A *realization* relationship connects a class with an interface that supplies its behavioral specification. It is rendered by a dashed line with a hollow triangle towards the specifier.

UML Class Example



Self-Check

1. *Shape, Rectangle, Cuboid, Point*
2. *Book, Page*
3. *Person, Employee, Manager, Engineer, Customer*
4. *Problem Statement: A stock exchange lists many companies. Each company is uniquely identified by a ticker symbol*

5. *Country, CapitalCity – Association?*

1. What is the relationship between Department and Employee?

```
class Department

 { ...

private:

string name;

Employee* receptionist; };
```

```
class Date{.. public: void printDate();};
class Student
{
private:
Date dob;
…
};
main()
{Student obj;  ..}
```

uml-diagrams.org

Class diagram - reference