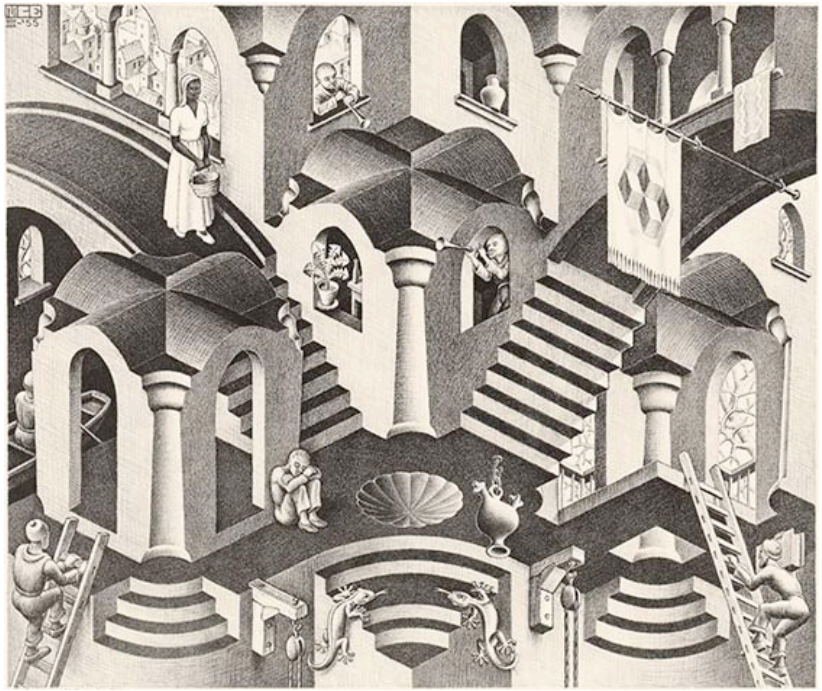


Software Architectures

Part 1: Modeling and Design Principles

Knowledge

- What is architecture?
- Architectural objectives in software design
- UML structural modeling elements

Skills

- Can detect violations of object oriented design principles
- Can explain all object oriented design principles using UML diagrams

The Parthenon in Athens, Greece

Some Genius Improvising

The Houses of Parliament, London

The Bauhaus in Dessau, Germany

The Taj Mahal, India

The National Congress of Brazil

The Carpenter did the Design

The Gare de Oriente in Lisbon, Portugal

The Golden Pavilion in Kyoto, Japan

Notre Dame de Paris, France

MI6 Headquarter in London

Shantytown, New Orleans

The Opera House in Sydney, Australia

Architecture

- A general term to describe buildings and other physical and some non-physical structures.
- The art and science of designing buildings and (some) nonbuilding structures (”Baukunst”).
- The style of design and method of construction of buildings and other physical and non-physical structures.

Architecture has to consider

- functional
- technical
- aesthetic

aspects in the planning, designing, and construction of its artefacts.

We use **models** to describe *things* in the real world.

Models are abstractions of the real world, simplifying reality.

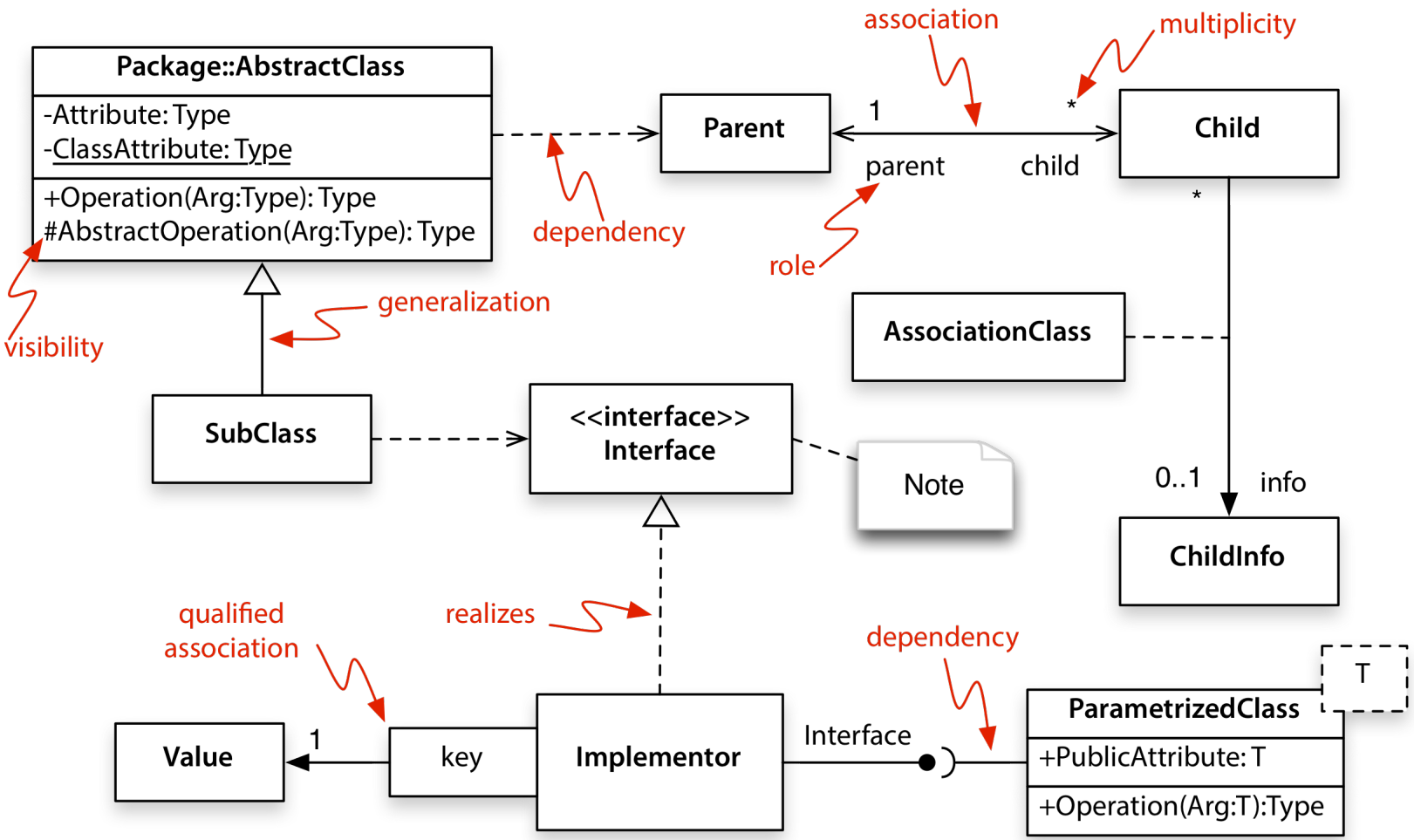
Models describe

- **Structure**
- **Behaviour**

Examples

- Buildings (structure)
- Elevators (structure and behaviour)
- Buying something from an online-shop (behaviour)
- Cars (structure and behaviour)

Describing architecture we focus on structure.
For software systems we use the **Unified Modelling Language** (**UML**).

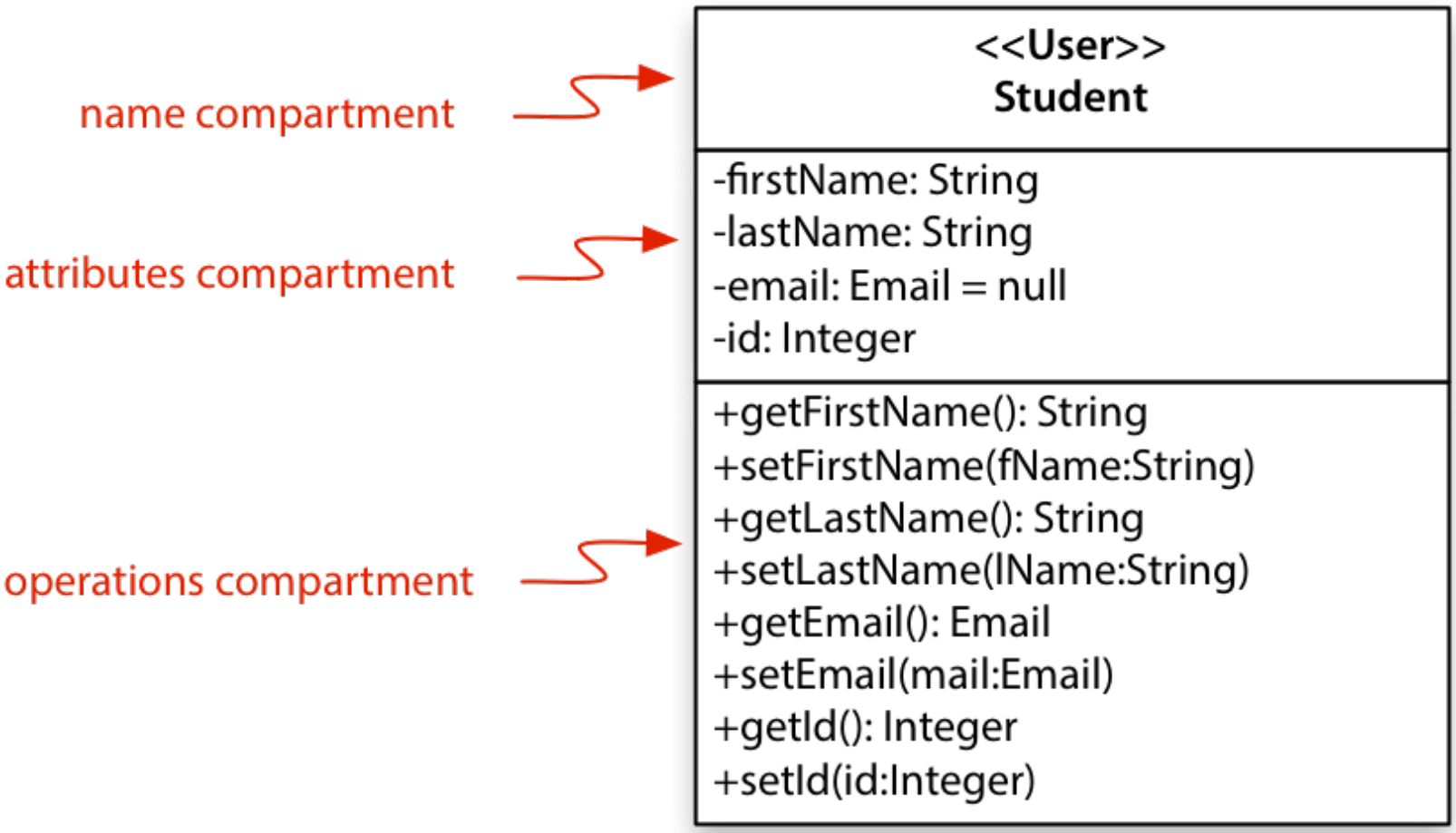


The UML offers a rich set of diagram types to describe structure and behaviour.

- **Class diagrams** ← this is what we use here
- Component diagrams
- Activity diagrams ← covered in "Real-Time Systems"
- State charts ← covered in "Real-Time Systems"
- Sequence diagrams
- Use case diagrams
- and eight more ...

- **Attributes** describe the appearance and knowledge of a class of objects.
- **Operations** define the behavior that a class of objects can manifest.
- **Stereotypes** help you understand this type of object in the context of other classes of objects with similar roles within the system's design.
- **Properties** provide a way to track the maintenance and status of the class definition.
- **Association** is just a formal term for a type of relationship that this type of object may participate in. Associations may come in many variations, including simple, aggregate and composite, qualified, and reflexive.
- **Inheritance** allows you to organize the class definitions to simplify and facilitate their implementation.

Class Diagram: Class Element Compartments

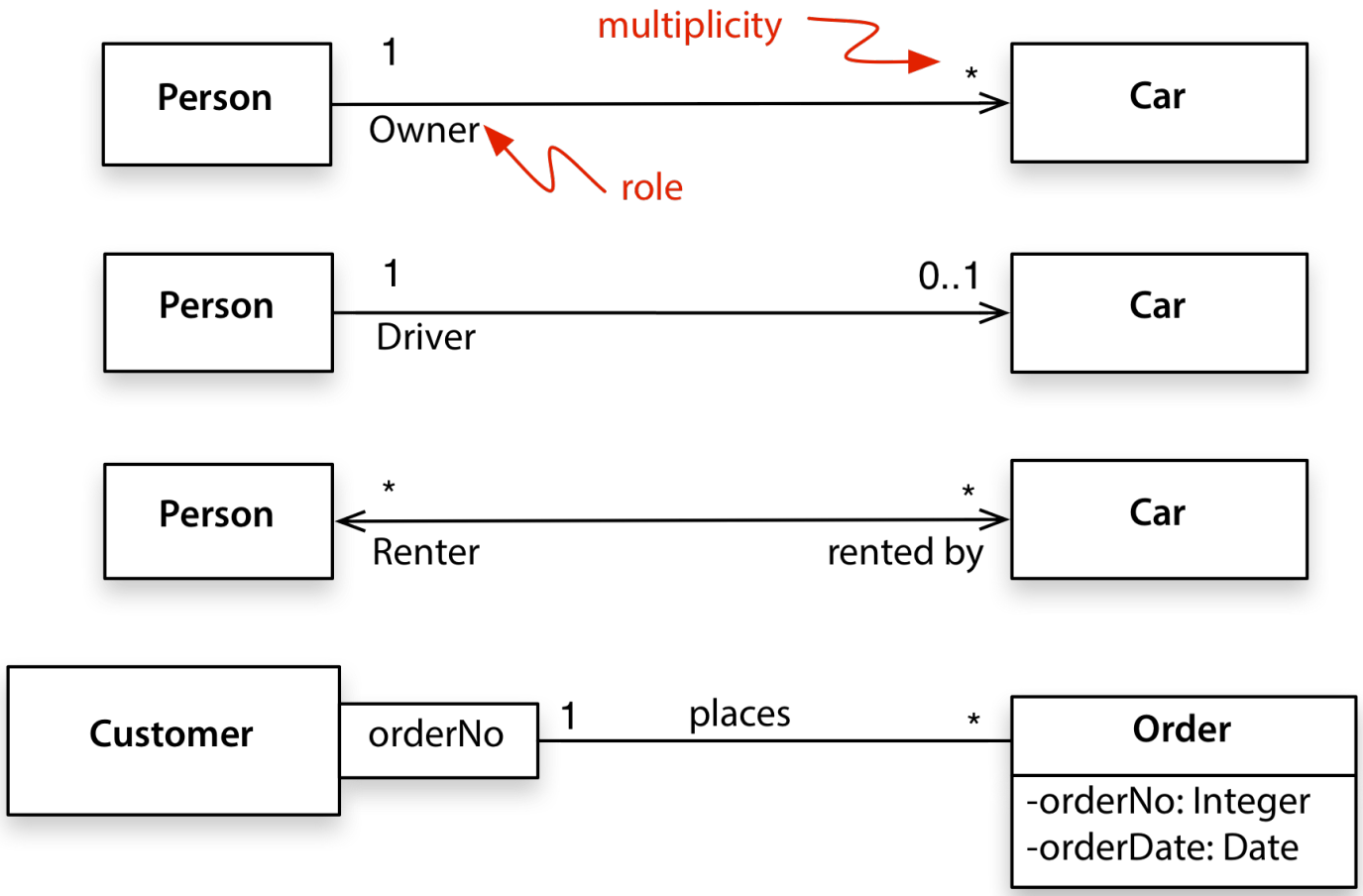


Each attribute definition must specify what other objects are allowed to see the attribute – that is its visibility. Visibility is defined as follows:

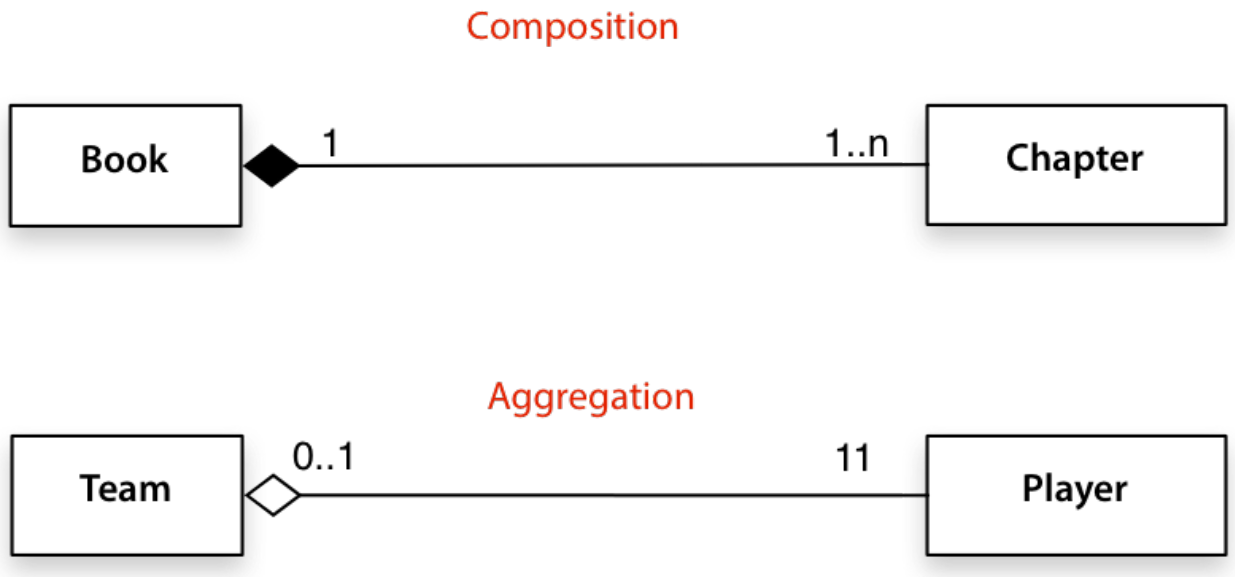
- Public (+) visibility allows access to objects of all other classes.
- Private (-) visibility limits access to within the class itself. For example, only operations of the class have access to a private attribute.
- Protected (#) visibility allows access by subclasses. In the case of generalizations (inheritance), subclasses must have access to the attributes and operations of the superclass or they cannot be inherited.
- Package (~) visibility allows access to other objects in the same package.

Attribute Element Description	Attribute Element Example
Create an attribute name	company
Add the attribute data type	company:character
Add the attribute's default value, if any	company:character = spaces
Set the constraints on the attribute value. For this example, first identify the field length.	company:character = spaces {1 to 30 characters}
Next identify the types of data that can be used in the attribute. Add this information within the brackets.	company:character = spaces {1 to 30 characters including alphabetic, spaces, and punctuation characters; no special characters allowed}
Set the attribute visibility (designate private visibility with a minus (-) sign in front of the attribute).	- company:character = spaces {1 to 30 characters including alphabetic, spaces, and punctuation characters; no special characters allowed}

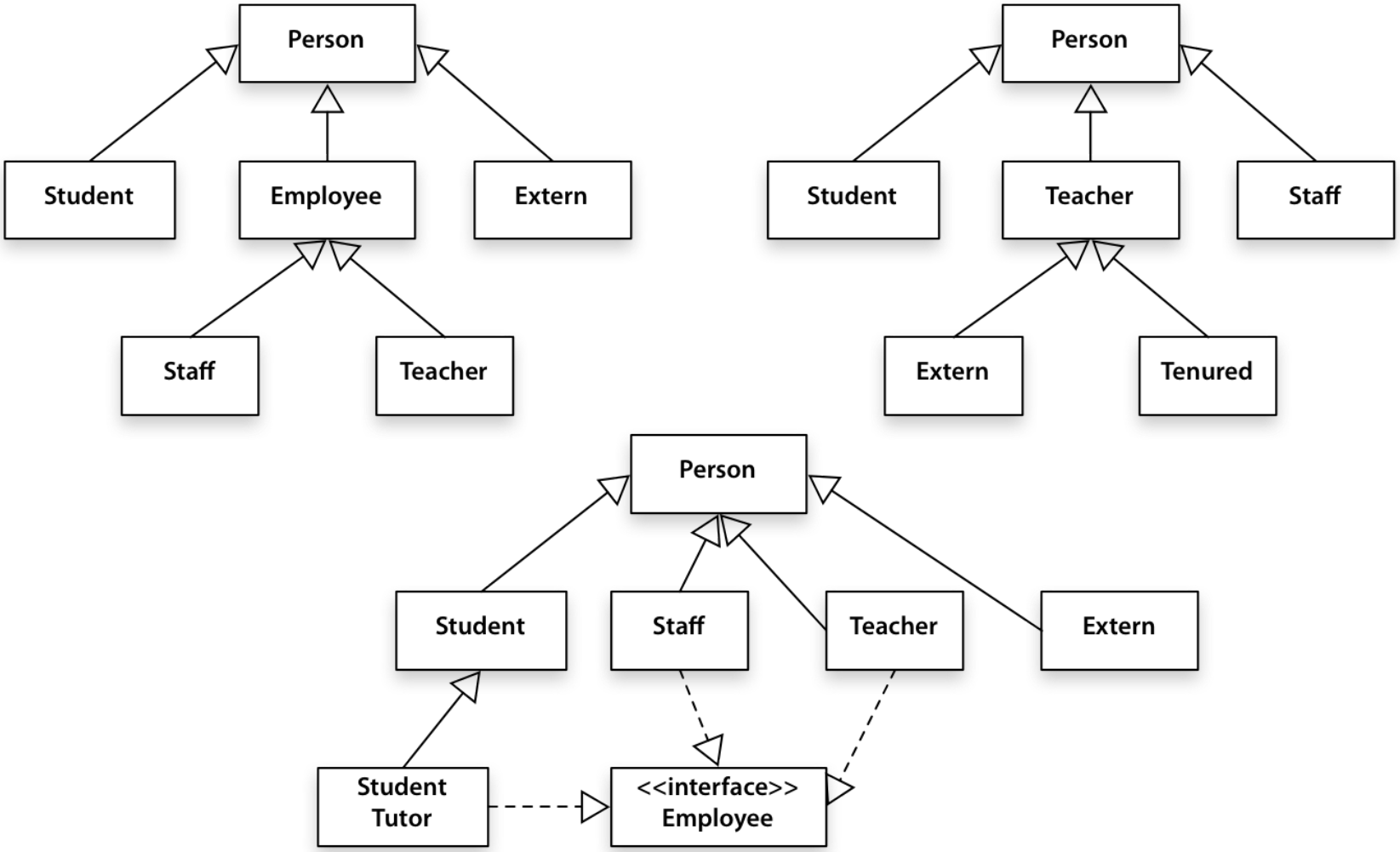
- Operation name: Required. The combination of name and parameters does need to be unique within a class.
- Arguments/parameters: Each argument requires an identifier and a data type.
- Return data type: Required for a return value, but return values are optional.
- Visibility (+, -, #, ~): Required before code generation.
- Class level operation (underlined operation declaration): Optional. In Java: static methods.
- Argument name: Required for each parameter, but parameters are optional. Any number of arguments is allowed.
- Argument data type: Required for each parameter, but parameters are optional.



Class Diagram: Aggregation and Composition



Class Diagram: Generalization



Architectural Objectives

The system to be designed must be

- correct
- extensible
- understandable

To that end we use object oriented design principles

Principles for Single Class Design

- Encapsulation, abstraction, and information hiding
- Separation of concerns and the single-responsibility principle
- Interface segregation principle

Principles for Design of Class Cooperation

- Loose Coupling
- Liskov substitution principle
- Design by contract
- Open-close principle
- Dependency inversion principle