OO concepts
UML representation

- Objects, Classes, Messages/Methods
- Inheritance, Polymorphism, Dynamic Binding
- Abstract Classes, Abstract Coupling

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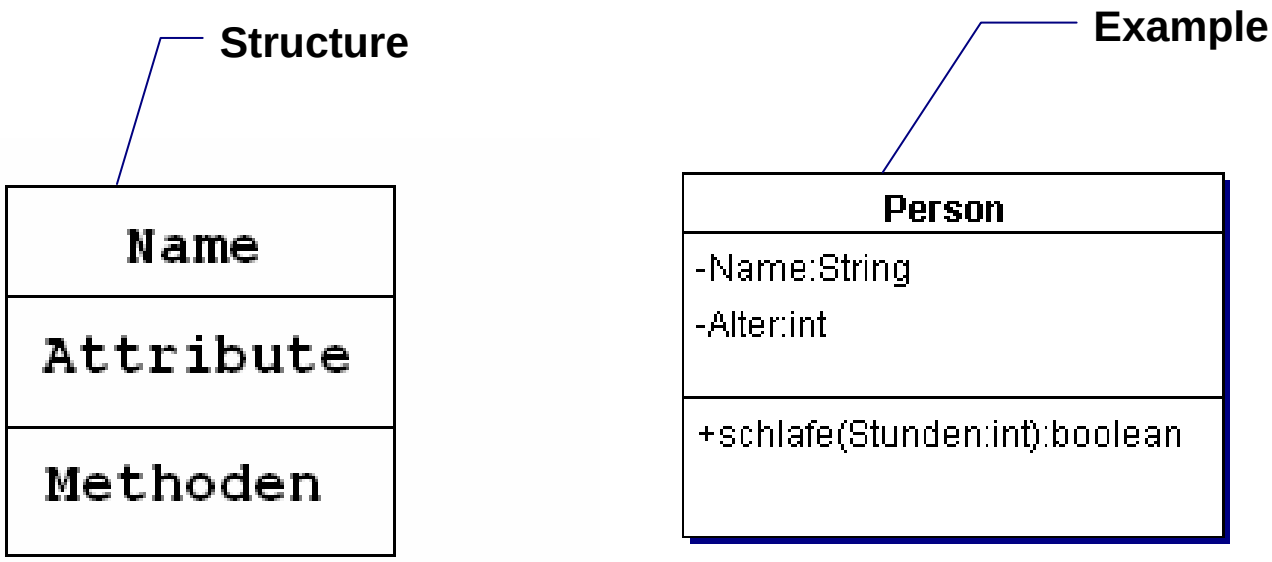
Classes in UML (I)

- UML notation for a class:



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Classes in UML (II)

Notation for attributes:

A	only the attribute name
: C	only the attribute class
A : C	attribute name and class
A : C = D	attribute default value

timeWhenStarted	$\rightarrow$ A
: Date	$\rightarrow$: C
timeWhenStarted : Date	$\rightarrow$ A : C
timeWhenStarted : Date = 1.1.1999	$\rightarrow$ A : C = D
timeWhenStarted = 1.1.1999	$\rightarrow$ A = D

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Classes in UML (III)

Notation for Methods/Operations:

m()	only the method name
m(arguments): R	method name, arguments type of returning parameter

Example:

printInvoice()	→ m()
printInvoice(itemNo: int): bool	→m(arguments): R

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Classes in UML (IV)

- Adornments (decorations) : additional graphical elements (represented by triangles in the Booch method)

- Methods and attributes have attached graphic symbols to express access rights: **`public, private, protected`**

  Example:

  `+sleep(Hours:int)`

- Standalone adornment: Note

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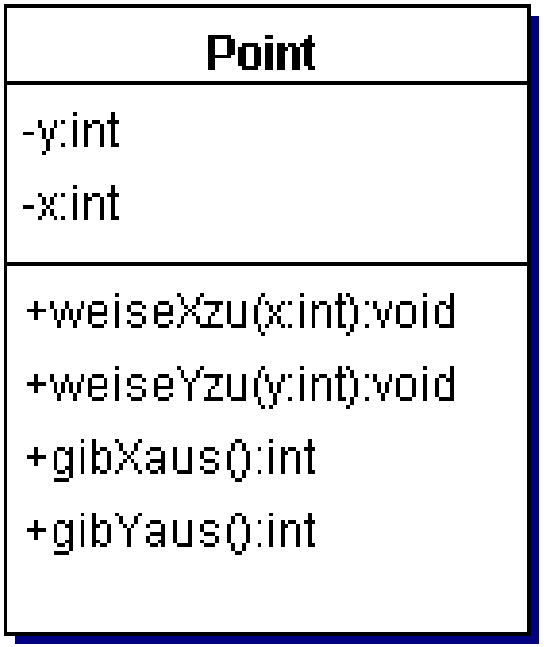
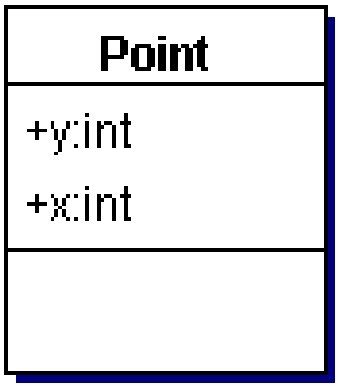
Example: access rights





Unnecessary complexity, since there is no dependency between x and y

Better alternative

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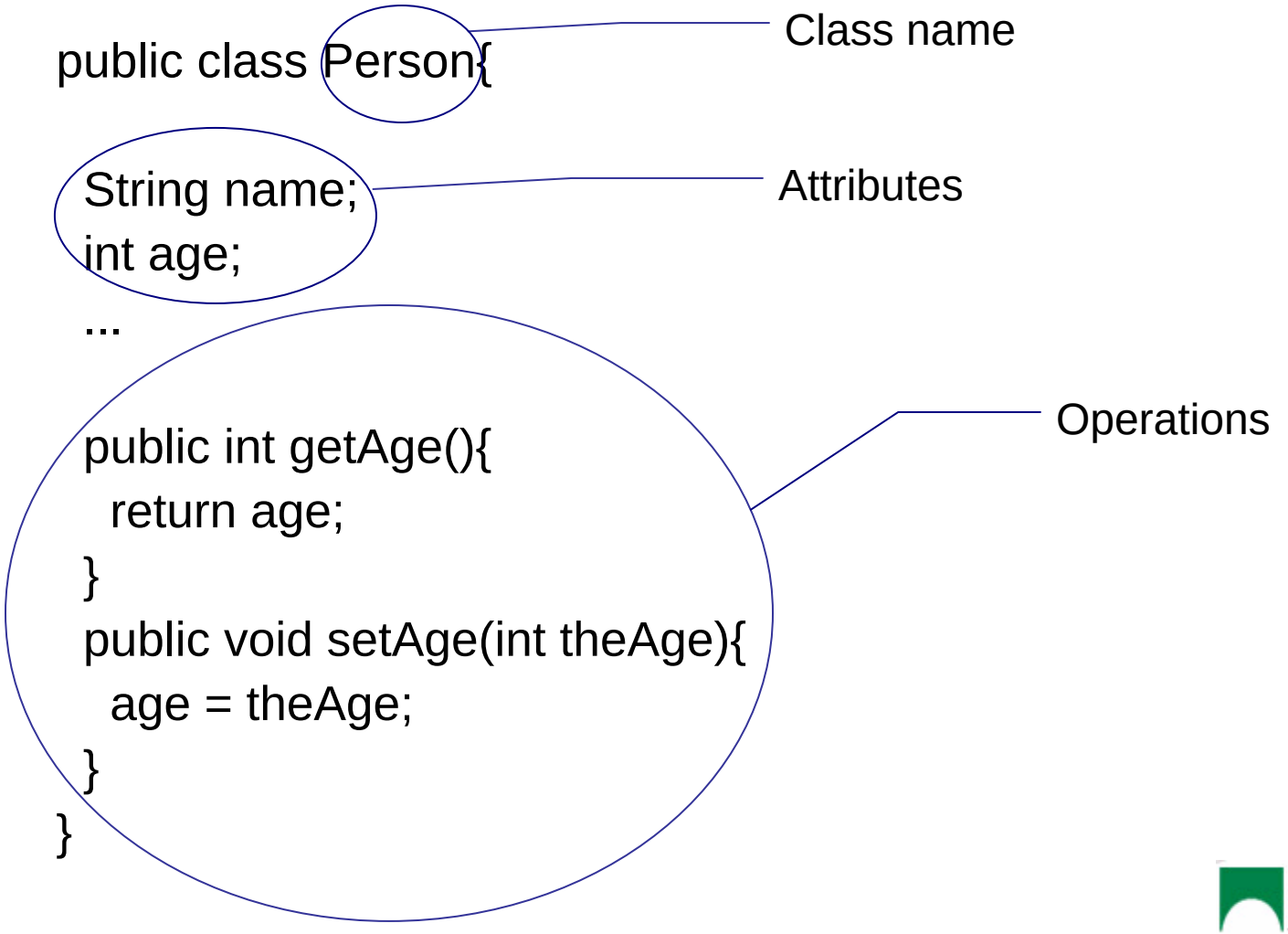
Classes in Java



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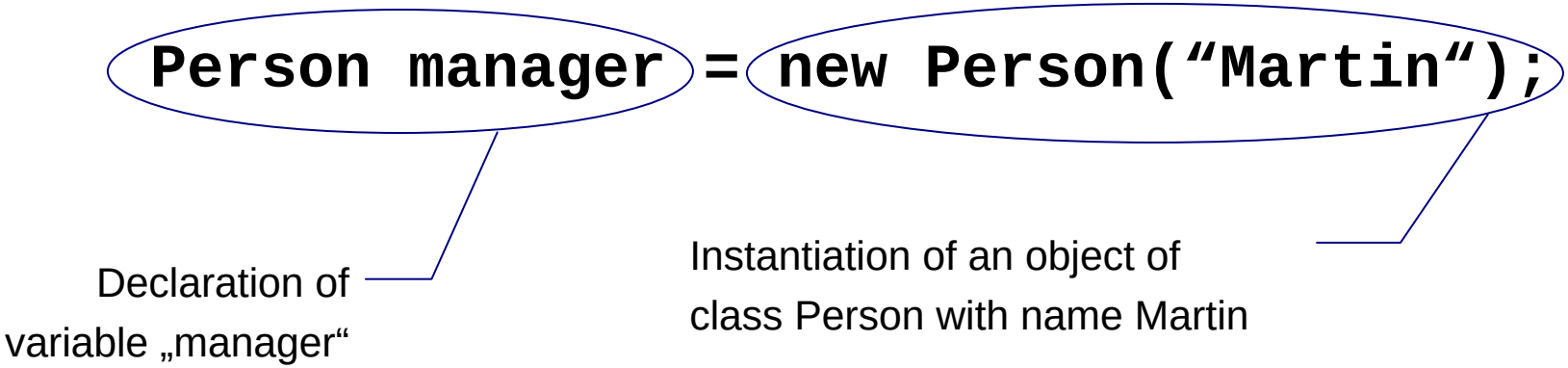
Using classes in Java

- Classes are used in Java to specify the type of variables and to instantiate objects
- Keyword: new
- Example:



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Example: Hotel reservation

- What can be modeled as classes in a hotel reservation system?
- What attributes will the classes have?
- What operations?
- Which instances (objects) of these classes will there be?
- What sorts of relations will take place between the objects/classes?

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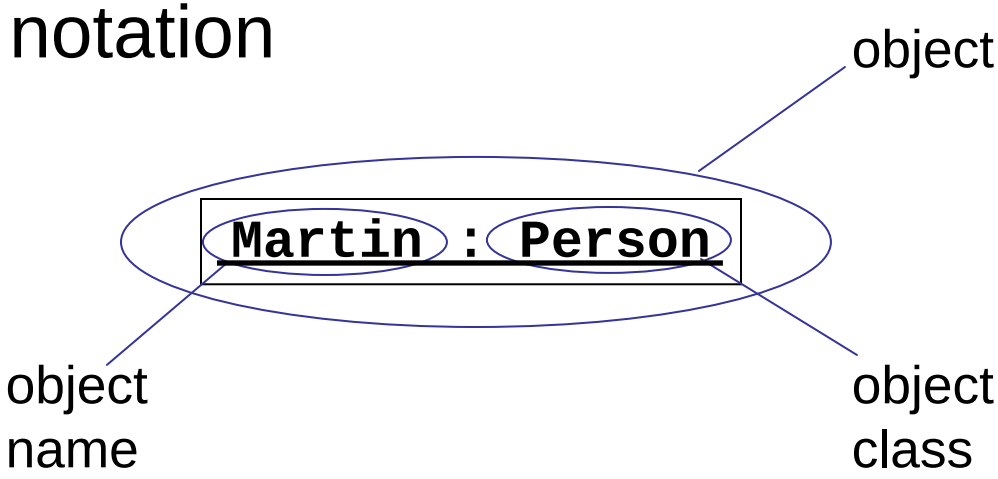
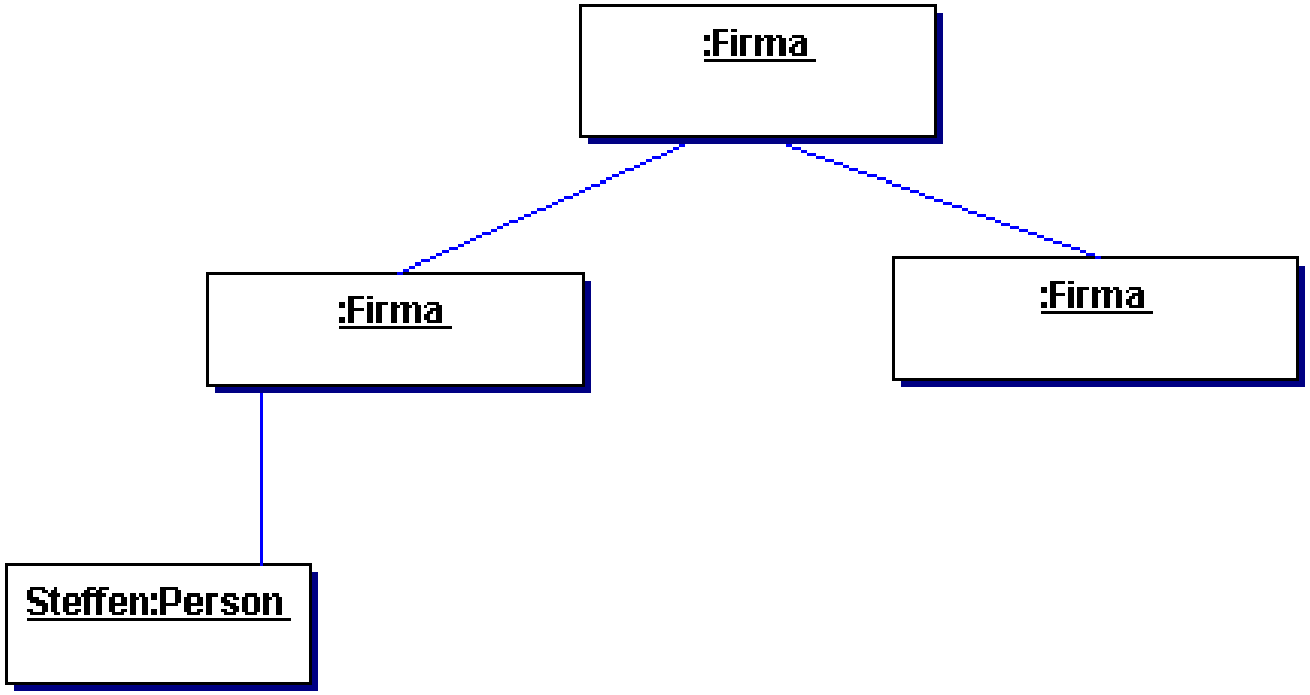
Objects in UML

- Object notation



An object diagram provide a run time snapshot of the system, representing objects and the connections between them

Object diagram



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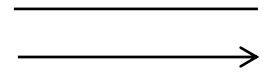
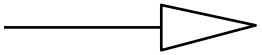
Class relationships (I)

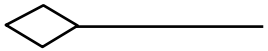


Association

Dependence



Inheritance



Aggregation (has-a)

An association can be refined by other relations

Often one models first only the fact that two classes are related and refines later this general notation element

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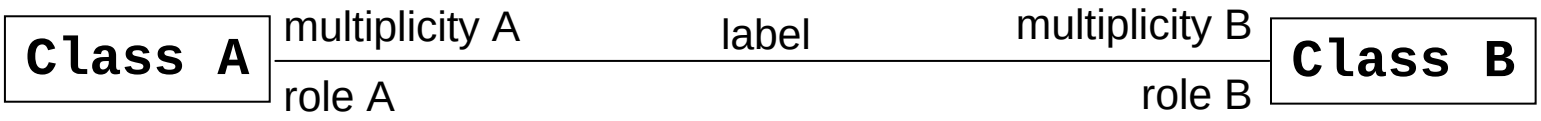
Class relationships (II)



- Each association can be named with a text label (like in the ER-model)
- Role names can be specified at association ends
- Multiplicity can be marked at association ends
- A class can have an association with itself, expressing a relationship between objects of the same class

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Class relationships (III)

Multiplicity specification:

1	exactly one
*	any (0 or more)
0..*	any (0 or more)
1..*	1 or more
0..1	0 or 1
2..5	range of values
1..5, 9	range of values or nine

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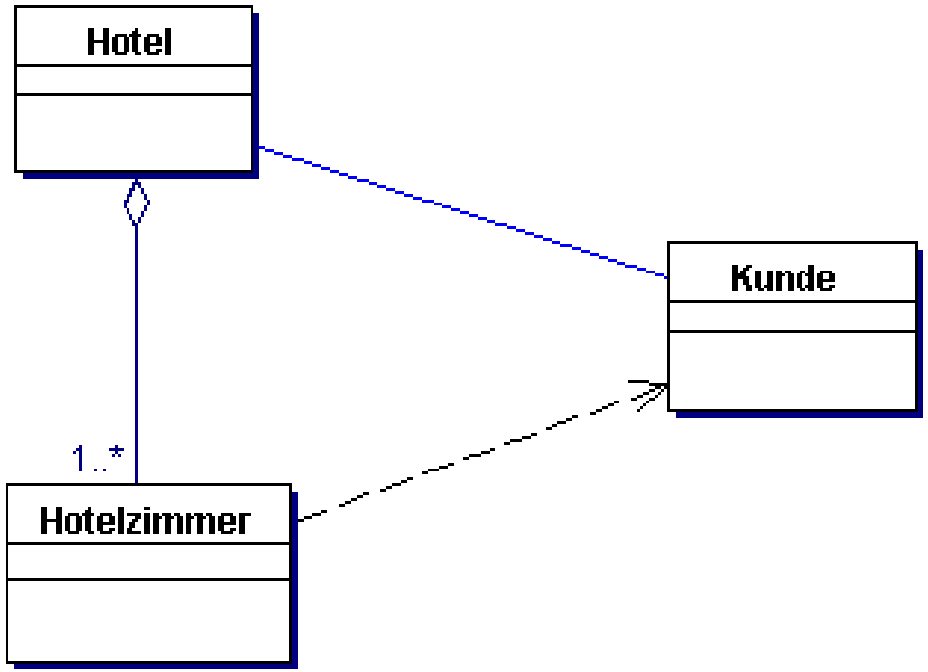
Class relationships (IV)

Example:



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Inheritance
Polymorphism
Dynamic Binding

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Inheritance (I)

- A class defines the type of an object
- If one models for example a class **Customer** and a class **CorporateCustomer**, one expects that each object of type **CorporateCustomer** to be also of type **Customer**. The type **CorporateCustomer** is a subtype of **Customer**.

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Inheritance (II)

- A superclass generalizes a subclass
- A subclass specializes a superclass
- A subclass **inherits** methods and attributes of its superclass

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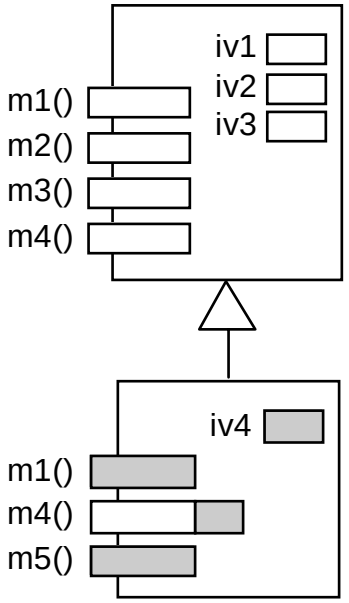
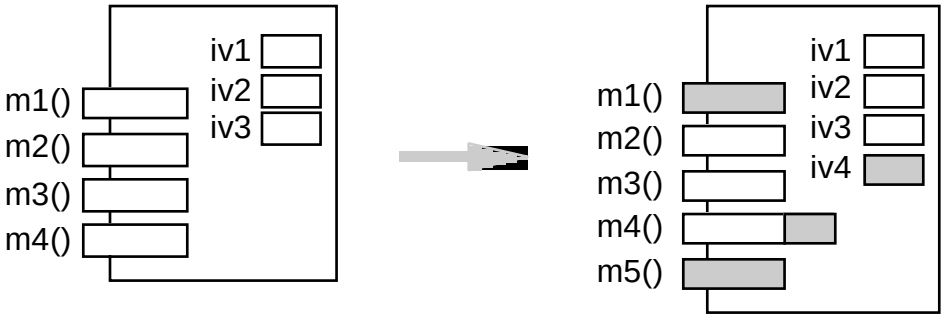
Inheritance(III)

- A subclass has the following possibilities to specialize its behavior:
  - Defining new operations and attributes
  - Modifying existing operations (overwriting methods of the superclass)



Flatten view:



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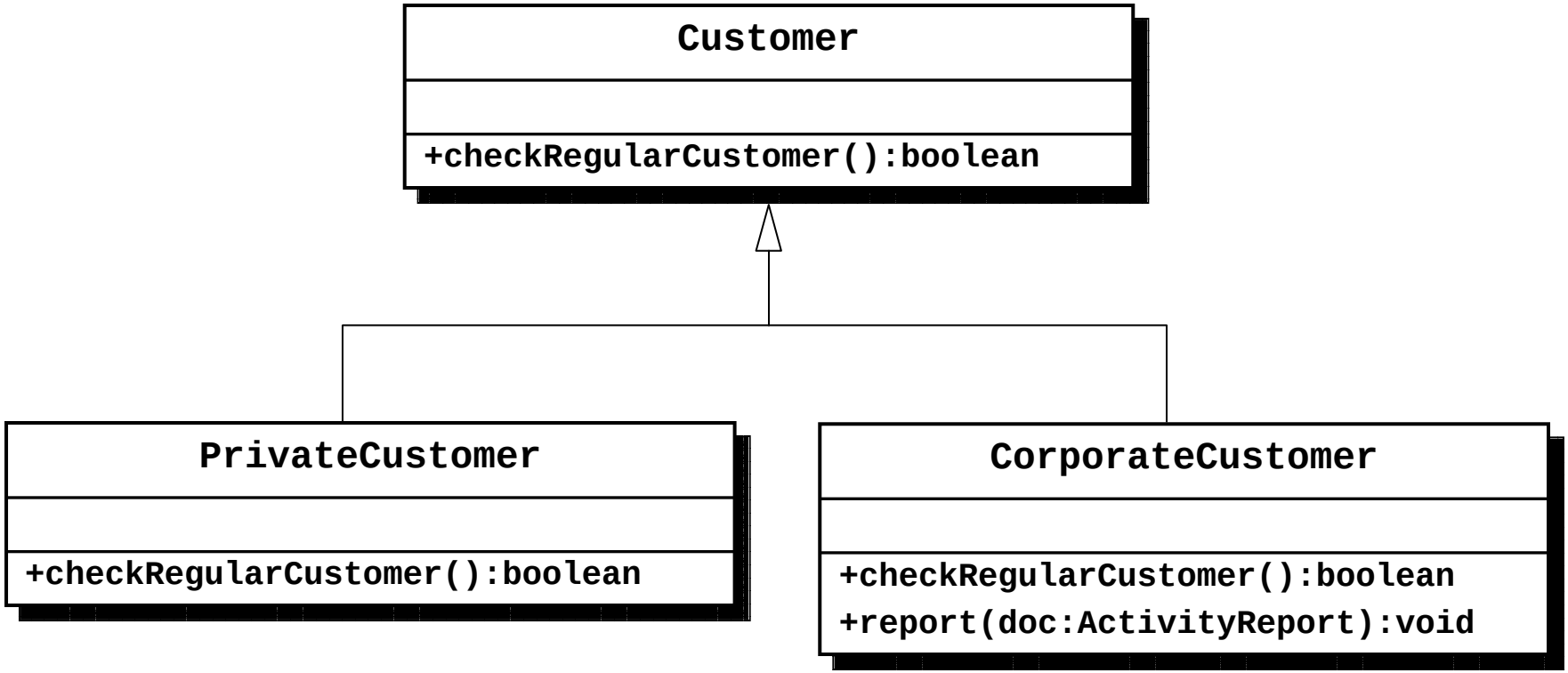
Inheritance (IV)

- UML Notation



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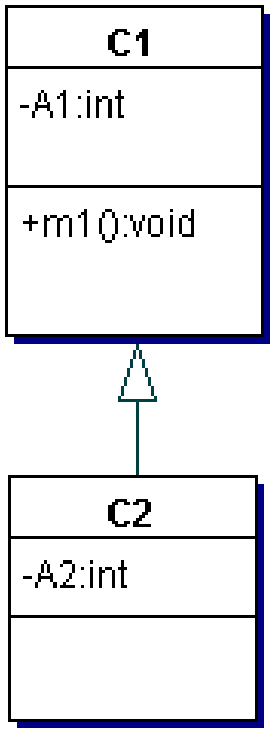
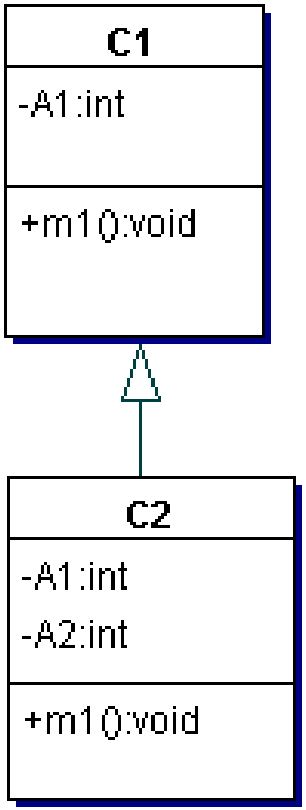
Inheritance (V)

„delta“ view



Flatten view

(not in standard UML!)



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Inheritance and access rights

- Private members of a superclass are **not accessible** in subclasses
- Protected members of a superclass are accessible **only** in subclasses
- Public members are accessible **everywhere**
- Access rights can be specified globally for a superclass (C++):

  class R : *private A*{ /* ... */ };

  class S : *protected A*{ /* ... */ };

  class T : *public A*{ /* ... */ };

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Inheritance in Java

- Java supports simple inheritance, where each class has at most one superclass

- The keyword is **`extends`**

Example:

```
public class CorporateCustomer extends Customer{
    ...
}
```

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