Theory: Inheritance

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§1. Extending classes

Inheritance is a mechanism for deriving a new class from another class (base class). The new class acquires some fields and methods of the base class. Inheritance is one of the main principles of object-oriented programming. It allows developers to build convenient class hierarchies and reuse existing code.

When it comes to inheritance, there are several terms. A class **derived** from another class is called a **subclass** (it's also known as a **derived class**, **extended class** or **child class**). The class from which the subclass is derived is called a **superclass** (also a **base class** or a **parent class**).

To derive a new class from another the keyword `extends` is used. The common syntax is shown below.

```
class SuperClass { }

class SubClassA extends SuperClass { }

class SubClassB extends SuperClass { }

class SubClassC extends SubClassA { }
```

There are main points about inheritance in Java:

- Java doesn't support multiple-classes inheritance meaning that a class can only inherit from a single superclass;
- a class hierarchy can have multiple levels (class `C` can extend class `B` that extends class `A`);
- a superclass can have more than one subclasses.

A subclass inherits all public and protected fields and methods from the superclass. A subclass can also add new fields and methods. The inherited and added members will be used in the same way.

A subclass doesn't inherit private fields and methods from the superclass. However, if the superclass has public or protected methods for accessing its private fields, these members can be used inside the subclasses.

Constructors are not inherited, but the superclass's constructor can be invoked from the subclass using the special keyword `super`. This keyword is discussed in more detail in another topic.

If you'd like the base class members to be accessible from all subclasses but not from the outside code (excluding the same package), use the access modifier `protected`.

Inheritance represents the **IS-A** relationship. A base class represents the general and a subclass represents the particular or specific.

§2. An example of a class hierarchy

Let's consider a more graphic example. A telecommunication company serves clients. It has a small staff consisting only of managers and programmers. Let's consider a class hierarchy for people associated with the company's activities (including clients).

At first, we present the hierarchy as a figure. An arrow indicates that one class extends another one.

Current topic:
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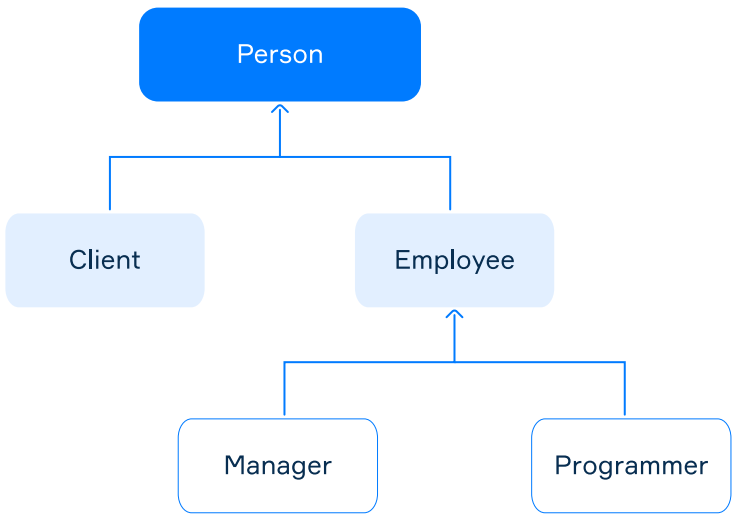

The class hierarchy for the telecommunication company

- the base class `Person` has fields for storing common data: name, year of birth, and address;
- the class `Client` has additional fields to store contract number and status (gold or not);
- the class `Employee` stores the start date of work for the company and the salary;
- the class `Programmer` has an array of the programming languages a programmer uses;
- the class `Manager` may have a dazzling smile.

Let's see the code:

```
class Person {
    protected String name;
    protected int yearOfBirth;
    protected String address;

    // public getters and setters for all fields here
}

class Client extends Person {

    protected String contractNumber;

    protected boolean gold;



    // public getters and setters for all fields here

}



class Employee extends Person {

    protected Date startDate;

    protected Long salary;



    // public getters and setters for all fields here

}



class Programmer extends Employee {

    protected String[] programmingLanguages;



    public String[] getProgrammingLanguages() {

        return programmingLanguages;

    }



    public void setProgrammingLanguages(String[] programmingLanguages) {

        this.programmingLanguages = programmingLanguages;

    }

}



class Manager extends Employee {

    protected boolean smile;



    public boolean isSmile() {

        return smile;

    }



    public void setSmile(boolean smile) {

        this.smile = smile;
```

```
4
4       }
4
5   }
```

This hierarchy has two levels and five classes overall. All fields are `protected` which means they are visible to subclasses. Each class also has public getters and setters but some are skipped in the code.

Let's create an object of the `Programmer` class and fill the inherited fields using the inherited setters. To read the values of the fields we can use inherited getters.

```
1   Programmer p = new Programmer();
2
3   p.setName("John Elephant");
4   p.setYearOfBirth(1985);
5   p.setAddress("Some street, 15");
6   p.setStartDate(new Date());
7   p.setSalary(500_000L);
8   p.setProgrammingLanguages(new String[] { "Java", "Scala", "Kotlin" });
9
1
0   System.out.println(p.getName()); // John Elephant
1
1   System.out.println(p.getSalary()); // 500000
1
2
System.out.println(Arrays.toString(p.getProgrammingLanguages())); // [Java, Scala,
 Kotlin]
```

We also can create an instance of any class included in the considered hierarchy.

So, **inheritance** provides a powerful mechanism for code reuse and writing convenient hierarchies. Many things of the real world can be simulated like hierarchies from a more general to a more particular concept.

§3. Final classes

If the class is declared with the keyword `final`, it cannot have subclasses at all.

```
1   final class SuperClass { }
```

If you'll try to extend the class, the compile-time error will happen.

Some standard classes are declared as final: `Integer`, `Long`, `String`, `Math`. They cannot be extended.

§4. Conclusion

Inheritance allows you to build class hierarchies when subclasses (children) take some fields and methods of the superclass (parent). Such a hierarchy can have multiple levels, but every class should inherit only a single superclass. A good class hierarchy helps to avoid code duplication and make your program more modular. If a class should not have subclasses, it should be marked as `final`.

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