

Inheritance 2

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Method Overriding

Methods in Superclasses

```
public class Article
{
    public int number;
    public String title;
    public int price;
    ...
    public void printInfo()
    {
        System.out.print("Article '" + title);
        System.out.print("' (" + number + ") costs ");
        System.out.println(price/100 + "." + price%100 + " Euro.");
    }
}
```

Method `printInfo` may be used by any subclass of `Article`.

Application

Book and CD may use `printInfo`.

```
Book book = new Book(...);  
CD cd = new CD(...);  
book.printInfo();  
cd.printInfo();
```

- Problem: `printInfo` is too general.
 - Books and CDs have special information that should be printed as well.

We want special versions of `printInfo` for the subclasses.

Method Overriding

A method declaration may be overridden in a subclass.

```
public class Book extends Article
{
    public String author;
    public String publisher;
    public String ISBN;
    ...
    public void printInfo()
    {
        System.out.print("Article '" + title);
        System.out.print("' (" + number + ") costs ");
        System.out.println(price/100 + "." + price%100 + " Euro.");
        System.out.print("This is a book written by " + author);
        System.out.print(" and published by " + publisher);
        System.out.println(" with ISBN number " + ISBN + ".");
    }
}
```

Application

```
Book book = new Book(...);  
book.printInfo();
```

- Method `printInfo` of class `Book` is called.
 - The corresponding method declaration in class `Article` has been overridden.

Problem: a lot of code has been duplicated in the new declaration.

Calling Methods in Superclasses

```
public class Book extends Article
{
    public String author;
    public String publisher;
    public String ISBN;
    ...
    public void printInfo()
    {
        super.printInfo();
        System.out.print("This is a book written by " + author);
        System.out.print(" and published by " + publisher);
        System.out.println(" with ISBN number " + ISBN + ".");
    }
}
```

super refers to this object as an object of the superclass.

Calling Methods in Superclasses

```
public class Book extends Article
{
    ...
    public void printInfo() { ... }
    ...
    public void printArticleInfo()
    {
        super.printInfo();
    }
}
```

```
Book book = new Book(...);
book.printArticleInfo();
```

Any method may refer to an overridden method.

Shadowing Variables

```
public class Article
{
    public int price;
    ...
}
```

```
public class Book extends Article
{
    public String price; // shadows int declaration
    ...
}
```

Do not shadow variable declarations of superclasses.

Final Methods and Classes

We may prevent unwanted extensions.

- A `final` method can not be overridden:

```
public final type method(...)  
{  
    ...  
}
```

- A `final` class is not the parent of any other class:

```
public final class Class  
{  
    ...  
}
```

The compiler can create more efficient code for method calls.

Abstract Classes and Frameworks

Abstract Classes

- A class C can serve two purposes:
 - For creating objects: `c = new C(...)`
 - For inheritance: `public class D extends C { ... }`
- Sometimes we want a class only for the second purpose.
 - Class provides functionality for use and extension by subclasses.
 - Class itself is not intended for instantiation.

Abstract classes are only used for extension by other classes.

Example

A method demands that an object provides a String representation.

```
public static void printNice(Printable o)
{
    System.out.println("-- begin object ----- ");
    System.out.println(o.getString());
    System.out.println("-- end object ----- ");
}

public abstract class Printable
{
    public abstract String getString();
}
```

A concrete subclass of the abstract class provides the implementation.

Example

```
public class MyInteger extends Printable
{
    public int i;
    public MyInteger(int i) { this.i = i; }

    public String getString()
    {
        return Integer.toString(i);
    }
}
```

```
MyInteger i = new MyInteger(7);
printNice(i);
```

```
Printable i = new MyInteger(7);
printNice(i);
```

Abstract Classes versus Interfaces

Abstract classes are in some respect similar to interfaces.

- Two main differences:

- A class may only inherit from **one** abstract class but it may implement **multiple** interfaces.

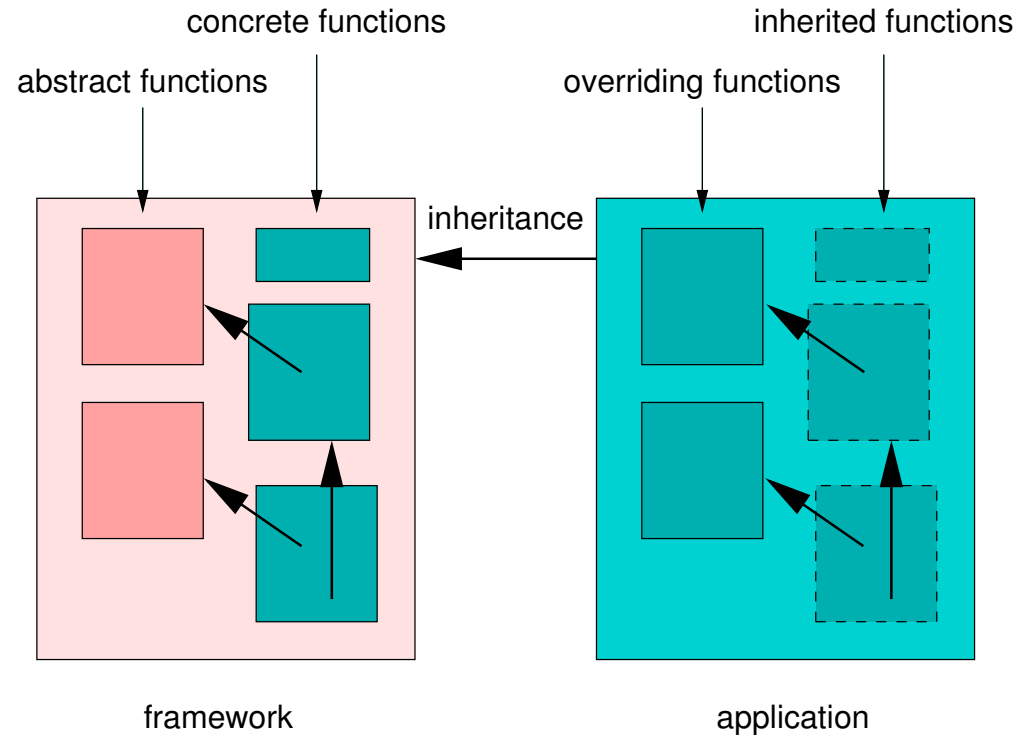
```
public class B extends A { ... }
```

```
public class B implements I1, I2, ... { ... }
```

- In an interface, all methods are abstract; in an abstract class (a **framework**), some methods may be **not** abstract.
 - * Non-abstract methods provide skeleton functionality to subclasses.
 - * Abstract methods are “gaps” to be filled by subclasses.
 - Subclass must fill skeleton with “flesh”.

Use abstract classes, if you also want to provide some functionality.

Framework



A framework is an abstract class that provides some functionality.

Frameworks

```
public abstract class Printable
{
    public abstract String getString();
    public void printNice()
    {
        System.out.println("-- begin object ----- ");
        System.out.println(getString());
        System.out.println("-- end object ----- ");
    }
}
```

```
Printable i = new MyInteger(7);
i.printNice();
```

MyInteger provides getString and inherits printNice.

Frameworks

A framework may give default implementations of methods.

```
public abstract class Printable
{
    public String getString()
    {
        return "This object has no string representation."
    }

    public void printNice(Printable o)
    {
        System.out.println("-- begin object ----- ");
        System.out.println(getString());
        System.out.println("-- end object ----- ");
    }
}
```

Example: The Applet Class

```
java.lang.Object
|
+--java.awt.Component
    |
    +--java.awt.Container
        |
        +--java.awt.Panel
            |
            +--java.applet.Applet
```

```
public class Name extends Applet
{
    public void paint(Graphics graph)
    {
        paint operations on graph
    }
}
```

The Component Class

```
public abstract class Component implements ...
{
    ...
    public void update(Graphics g)
    {
        if (...)
        {
            g.setColor(getBackground());
            g.fillRect(0, 0, width, height);
            g.setColor(getForeground());
        }
        paint(g);
    }

    public void paint(Graphics g) { }
}
```

Visibility Modifiers

Visibility Modifiers

Classes, fields, and methods may be hidden from users.

- No visibility modifier: “default visibility”
 - Entities are visible to classes within the current package.
 - * No class in other package can refer to these entities.
- Visibility modifiers: change visibility status.
 - public, private, protected.
 - * Multiple visibility levels.

Use visibility modifiers to protect entities from unintended use.

Class Visibility

```
public class Class
{
    ...
}
```

Class becomes visible outside the current package.

Field and Method Visibility

Three different protection levels.

1. private:

- Field/method can be only used within the current class.

2. protected:

- Field/method can be used within the current class and its subclasses.
- Field/method can be used by all classes in the current package.

3. public:

- Field/method can be used without restriction by anyone.

Rules of Thumb

How are the visibility modifiers typically used?

- Make all classes `public`
 - Unless you want to restrict access to the current package.
- Make all class fields `private`
 - Fields are local to the class.
- Make all methods that are part of the class specification `public`.
 - Methods provide functionality of interest.
- Make all other methods `private`.
 - Methods are for internal use only.

Good rules in most situations.

Typical Class Structure

```
// class can be used by any other class
public class Class
{
    // the private fields
    private type field;

    // the public constructors
    public Class (...) { ... }

    // the public methods for the user
    public type method (...) { ... }

    // the private methods for the class
    private type method (...) { ... }
}
```