

# CS112

## Inheritance Lecture 05

Spring 2022 - 1443

College of Computer Science and Engineering



جامعة طيبة

# Superclasses and Subclasses

GeometricObject	
-color: String	The color of the object (default: white).
-filled: boolean	Indicates whether the object is filled with a color (default: false).
-dateCreated: java.util.Date	The date when the object was created.
+GeometricObject()	Creates a GeometricObject.
+GeometricObject(color: String, filled: boolean)	Creates a GeometricObject with the specified color and filled values.
+getColor(): String	Returns the color.
+setColor(color: String): void	Sets a new color.
+isFilled(): boolean	Returns the filled property.
+setFilled(filled: boolean): void	Sets a new filled property.
+getDateCreated(): java.util.Date	Returns the dateCreated.
+toString(): String	Returns a string representation of this object.

What is the relation between the three classes if there is no inheritance?

Circle	
-radius: double	
+Circle()	
+Circle(radius: double)	
+Circle(radius: double, color: String, filled: boolean)	
+getRadius(): double	
+setRadius(radius: double): void	
+getArea(): double	
+getPerimeter(): double	
+getDiameter(): double	
+printCircle(): void	

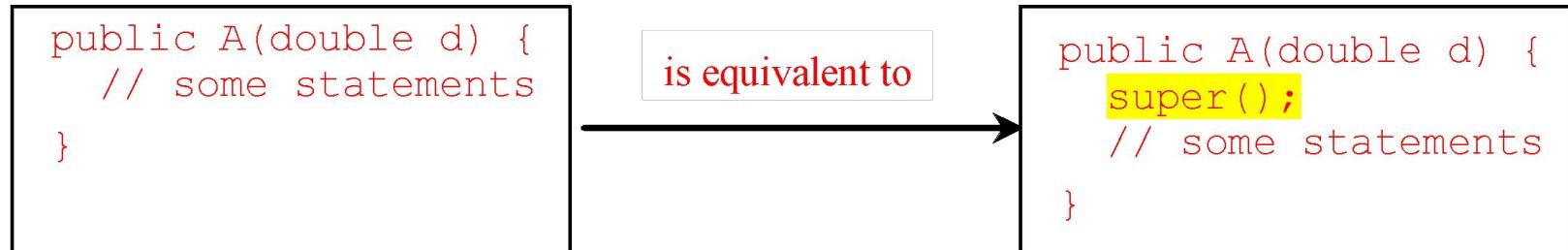
Rectangle	
-width: double	
-height: double	
+Rectangle()	
+Rectangle(width: double, height: double)	
+Rectangle(width: double, height: double, color: String, filled: boolean)	
+getWidth(): double	
+setWidth(width: double): void	
+getHeight(): double	
+setHeight(height: double): void	
+getArea(): double	
+getPerimeter(): double	

# Are superclass's Constructor Inherited?

- No. They are not inherited
- They are invoked explicitly or implicitly
- Explicitly using the `super` keyword
- A constructor is used to construct an instance of a class.
- Unlike properties and methods, a superclass's constructors are not inherited in the subclass.
- They can only be invoked from the subclasses' constructors, using the keyword `super`. *If the keyword `super` is not explicitly used, the superclass's no-arg constructor is automatically invoked.*

# Superclass's Constructor Is Always Invoked

- A constructor may invoke an overloaded constructor or its superclass's constructor. If none of them is invoked explicitly, the compiler puts super() as the first statement in the constructor. For example,



# Using the Keyword `super`

- The keyword `super` refers to the superclass of the class in which `super` appears. This keyword can be used in two ways:
  - To call a superclass constructor
  - To call a superclass method

# CAUTION

You must use the keyword super to call the superclass constructor. Invoking a superclass constructor's name in a subclass causes a syntax error. Java requires that the statement that uses the keyword super appear first in the constructor.

# Constructor Chaining

- Constructing an instance of a class invokes all the superclasses' constructors along the inheritance chain.

This is known as *constructor chaining*.

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("(2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

# Trace Execution (1)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("(2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

1. Start from the main method

# Trace Execution (2)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("(2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

2. Invoke Faculty  
constructor

# Trace Execution (3)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

3. Invoke Employee's  
no-arg constructor

# Trace Execution (4)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

4. Invoke Employee(String)  
constructor

# Trace Execution (5)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("(2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

5. Invoke Person() constructor

# Trace Execution (6)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("(2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

6. Execute println

# Trace Execution (7)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg con  
    }  
}
```

The diagram illustrates the execution flow. It starts with the main method, which creates a new Faculty object. This triggers the execution of the Faculty's no-arg constructor. Inside this constructor, it calls the Employee's overloaded constructor (with a string argument). This triggers the execution of the Employee's no-arg constructor. Finally, it executes the println statement within the Employee's no-arg constructor.

7. Execute println

# Trace Execution (8)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("(2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg con  
    }  
}
```

8. Execute println

# Trace Execution (9)

```
public class Faculty extends Employee {  
    public static void main(String[] args) {  
        new Faculty();  
    }  
  
    public Faculty() {  
        System.out.println("(4) Faculty's no-arg constructor is invoked");  
    }  
}  
  
class Employee extends Person {  
    public Employee() {  
        this("(2) Invoke Employee's overloaded constructor");  
        System.out.println("(3) Employee's no-arg constructor is invoked");  
    }  
  
    public Employee(String s) {  
        System.out.println(s);  
    }  
}  
  
class Person {  
    public Person() {  
        System.out.println("(1) Person's no-arg constructor is invoked");  
    }  
}
```

9. Execute println

# Example on the Impact of a Superclass without no-arg Constructor

- Find out the errors in the program:

```
public class Apple extends Fruit {  
}  
  
class Fruit {  
    public Fruit(String name) {  
        System.out.println("Fruit's constructor is invoked");  
    }  
}
```

# Defining a Subclass

- A subclass inherits from a superclass.
- You can also:
  - Add new properties
  - Add new methods
  - Override the methods of the superclass

# Calling Superclass Methods

- You could rewrite the printCircle() method in the Circle class as follows:

```
public void printCircle() {  
    System.out.println("The circle is created " +  
        super.getDateCreated() + " and the radius is " + radius);  
}
```

# Overriding Methods in the Superclass

- A subclass inherits methods from a superclass. Sometimes it is necessary for the subclass to modify the implementation of a method defined in the superclass. This is referred to as *method overriding*.

```
public class Circle extends GeometricObject {  
    // Other methods are omitted  
  
    /** Override the toString method defined in GeometricObject */  
    public String toString() {  
        return super.toString() + "\nradius is " + radius;  
    }  
}
```

# NOTE

An instance method can be overridden only if it is accessible. Thus a private method cannot be overridden, because it is not accessible outside its own class. If a method defined in a subclass is private in its superclass, the two methods are completely unrelated.

# NOTE

Like an instance method, a static method can be inherited. However, a static method cannot be overridden. If a static method defined in the superclass is redefined in a subclass, the method defined in the superclass is hidden.

# Overriding vs. Overloading

```
public class Test {
    public static void main(String[] args) {
        A a = new A();
        a.p(10);
        a.p(10.0);
    }
}

class B {
    public void p(double i) {
        System.out.println(i * 2);
    }
}

class A extends B {
    // This method overrides the method in B
    public void p(double i) {
        System.out.println(i);
    }
}
```

```
public class Test {
    public static void main(String[] args) {
        A a = new A();
        a.p(10);
        a.p(10.0);
    }
}

class B {
    public void p(double i) {
        System.out.println(i * 2);
    }
}

class A extends B {
    // This method overloads the method in B
    public void p(int i) {
        System.out.println(i);
    }
}
```

# The Object Class and Its Methods

- Every class in Java is descended from the `java.lang.Object` class. If no inheritance is specified when a class is defined, the superclass of the class is `Object`.

```
public class Circle {  
    ...  
}
```

Equivalent

---

---

```
public class Circle extends Object {  
    ...  
}
```

# The `toString()` method in Object

- The `toString()` method returns a string representation of the object. The default implementation returns a string consisting of a class name of which the object is an instance, the at sign (@), and a number representing this object.

```
Loan loan = new Loan();
System.out.println(loan.toString());
```

- The code displays something like `Loan@15037e5`. This message is not very helpful or informative. Usually you should override the `toString` method so that it returns a digestible string representation of the object.