

# Introduction to Java for C++ Programmers

Segment – 2

JAC 444

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# Inheritance

## Definition:

A *subclass* is a class that extends another class.

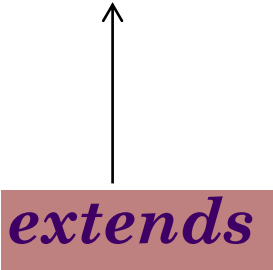
A subclass inherits state and behavior from all its ancestors.

The *superclass* refers to a direct ancestor.

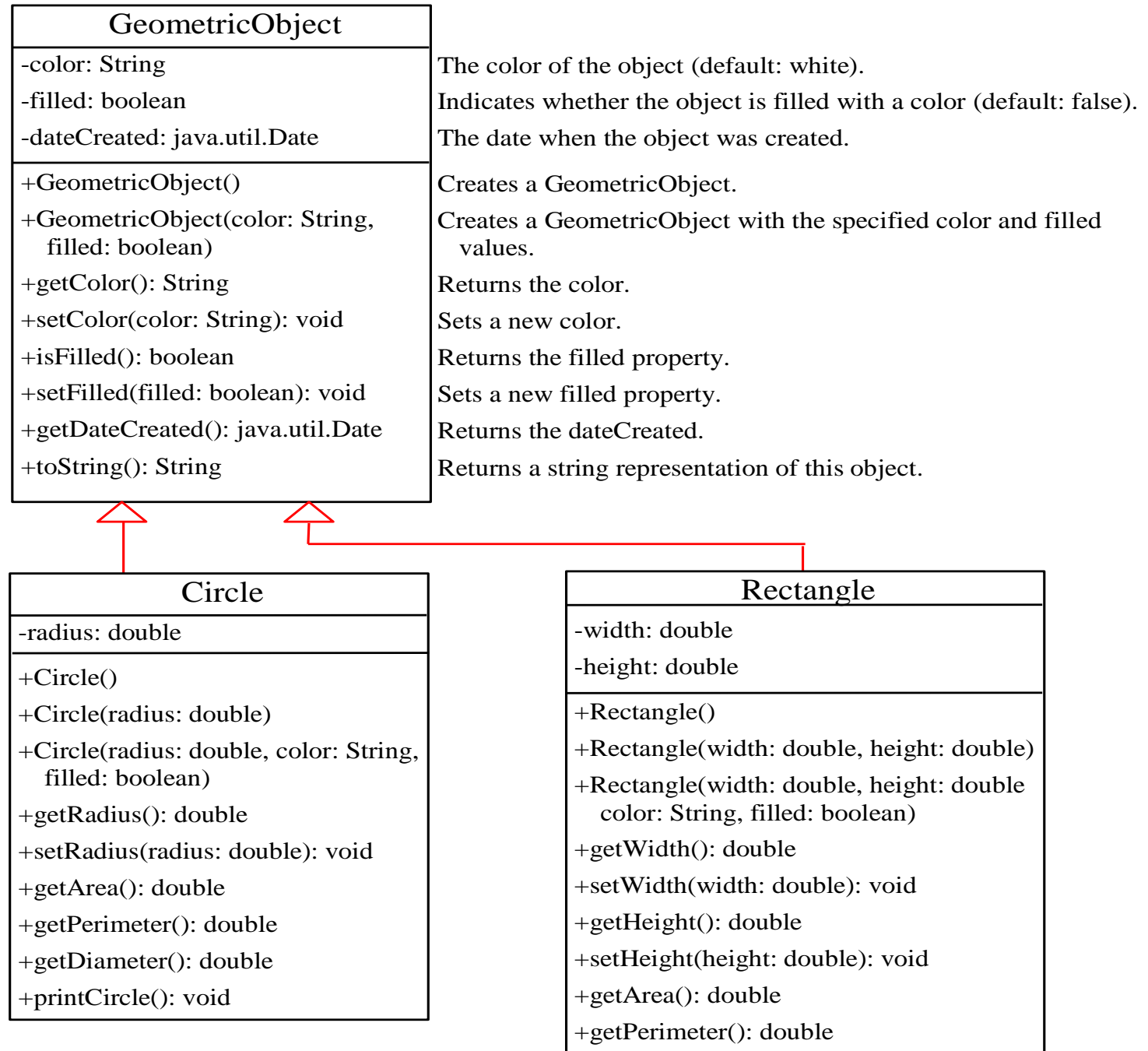
Subclass inherits all, but private superclasses members

```
public class SuperClass
{ ... }

public class SubClass extends SuperClass {
    ...
}
```

A vertical arrow points from the word 'extends' in the SubClass definition to the SuperClass definition, indicating that SubClass inherits from SuperClass.

# Superclasses and Subclasses

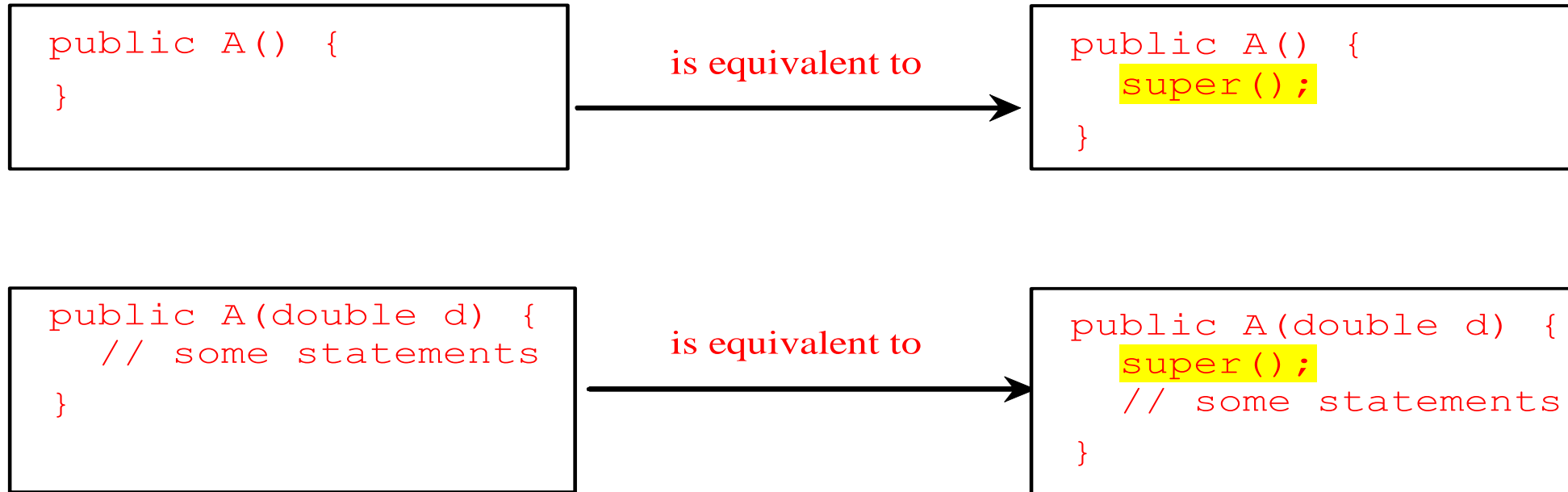


# Are Superclass's Constructor Inherited?

- No. They are not inherited.
- They are invoked explicitly or implicitly.
- Explicitly using the `super` keyword.
- Unlike properties and methods, a superclass's constructors are not inherited in the subclass.
- Superclass constructor 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`

Note:

- You must use keyword `super` to the superclass's constructor.
- Invoking the name of the superclass's constructor in a subclass causes an error.

`super` keyword must appear first in the constructor.

# Constructor Chaining

Constructing an instance of a class invokes all the superclasses' constructors along the inheritance chain. This is called *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

```
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

```
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

```
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

```
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)

# Trace Execution

```
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

```
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

```
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");
    }
}
```

7. Execute println

# Trace Execution

```
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");
    }
}
```



8. Execute println

# Trace Execution

```
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");  
    }  
}
```

# Declaring a Subclass

A subclass extends properties and methods from the superclass. You can also:

- Add new properties
- Add new methods
- Override the methods of the superclass

# Overriding

- Definition:

Replacing the superclass's implementation with a new method in a subclass is called *overriding*.

- The signature should be identical.
- Only accessible non-static method can be overridden.
- Access modifier could be different in overridden method as long as the subclass modifier is less restrictive than the superclass.

Can you Override Private methods from the super class?

No, a private method cannot be overridden, because it is not accessible outside its own class.

Can you Override Static methods from the super class?

- A static method can be inherited.
- However, a static method cannot be overridden.
- If you redefine the static method from the superclass into its subclass then the method of the superclass will be 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);  
    }  
}
```

# Final Methods and Classes

- A method could be declared as *final*
  - A final method **cannot be overridden.**
- A class could be declared as *final*
  - A final class **cannot be subclassed.**

Example: Immutable class like *String* class

# 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.



```
class Cards {  
  
    private String face;  
  
    private final String suit = "Diamond";  
  
public String toString() {  
return "Face " + face + " and Suit is " + suit;  
  
}  
  
}  
  
public class Test{  
  
    public static void main(String[] args) {  
  
        Cards c1 = new Cards();  
  
        System.out.print(c1); //is equal to c1.toString()  
  
    }  
  
}
```

**Output:**

Face null and Suit is Diamond