# LESSON VI.
# Inheritance

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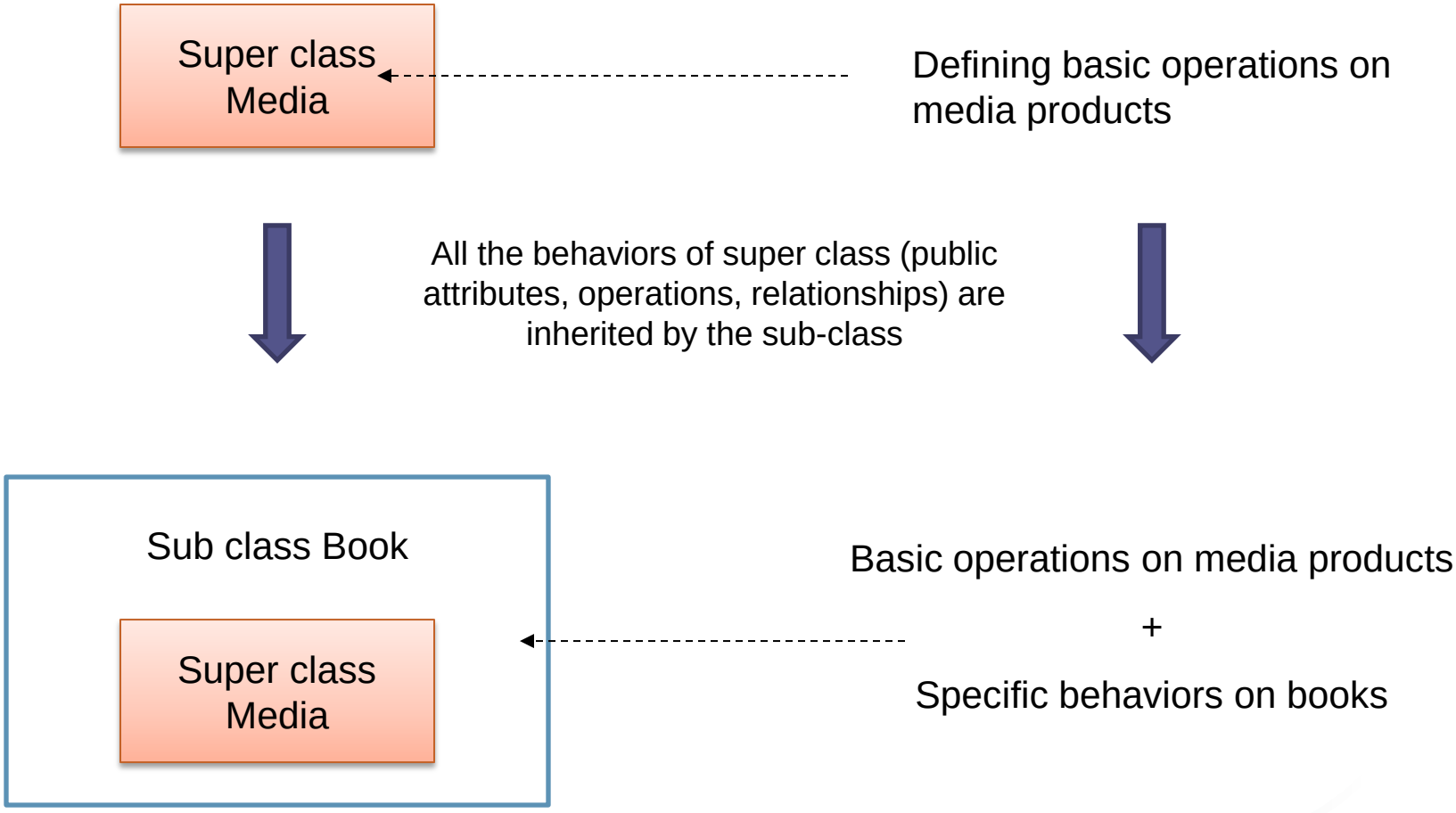
# 1. Principles

- Reusing through class: create a new class by extending the functionality of an existing class
  - The existing class is called the parent class, or super class, or base class
  - The new class is called the child class, or subclass, or derived class
- Relation: New class is a kind of existing class
  - A subclass inherits the operations, attributes and hierarchical relationships of its super class
    - If a method is defined in a super class, all of its sub class inherit automatically this method
    - If a set of member variables are defined in a super class, all of its sub classes inherit the same set of member variables
- To provide new functionality to a subclass, we can
  - Define new methods and variables for this subclass only
  - Override (execute instead of) methods of the super class in this subclass

# Example

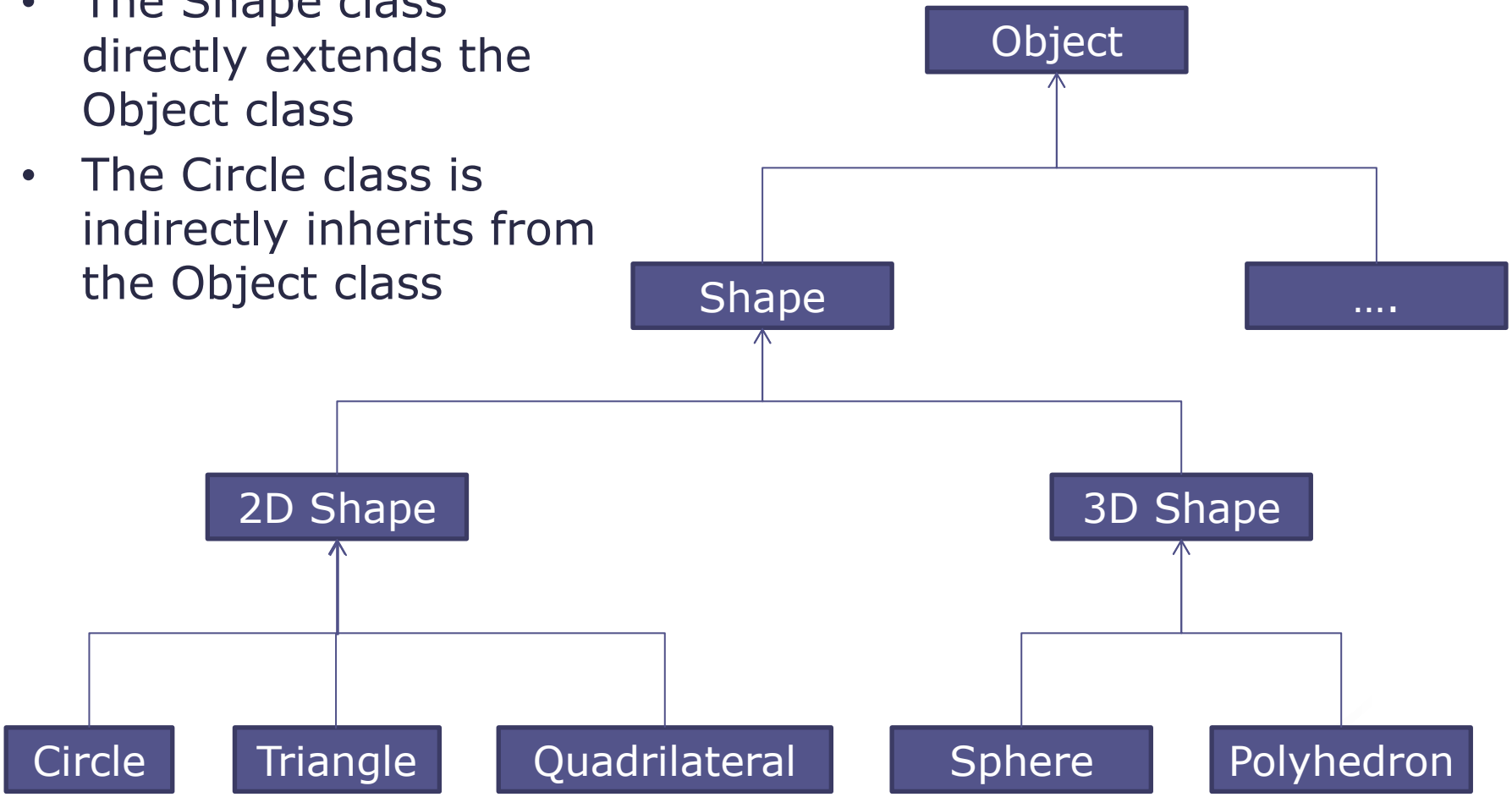

Super class
Media
Defining basic operations on
media products
All the behaviors of super class (public
attributes, operations, relationships) are
inherited by the sub-class
Sub class Book
Super class
Media
Basic operations on media products
+
Specific behaviors on books

# 2. Class hierarchy

- The class hierarchy defines the inheritance relationship between classes.
  - The root of the class hierarchy is the class Object.
  - Every class in Java directly or indirectly extends (inherits from) this class.
- Direct super class: the super class from which a subclass explicitly inherits.
  - Java: a class can only have one direct super class (single inheritance)
- Indirect super class: any class above the direct super class in the class hierarchy
- The constructors and destructors are not inherited.

# Example

- The Shape class directly extends the Object class
- The Circle class is indirectly inherits from the Object class



# Visibility of inherited members

- A public member is accessed from any class
- A super classes protected members can be accessed by members of its subclasses and by members of classes in the same package.
- A private member is only accessible from inside the class in which it was declared.

| | Public member | Protected member | Default member | Private member |
|---|---|---|---|---|
| Inside class | Yes | Yes | Yes | Yes |
| subclasses inside package | Yes | Yes | Yes | No |
| subclasses outside package | Yes | Yes | No | No |
| classes with non-inheritance relationship outside package | Yes | No | No | No |

# 3. Subclass definition

```
[access-modifier] class Subclass-name
       extends Superclass-name{
           //        New added variables
           //        New methods
           //        Overridden methods
}
```

# Example

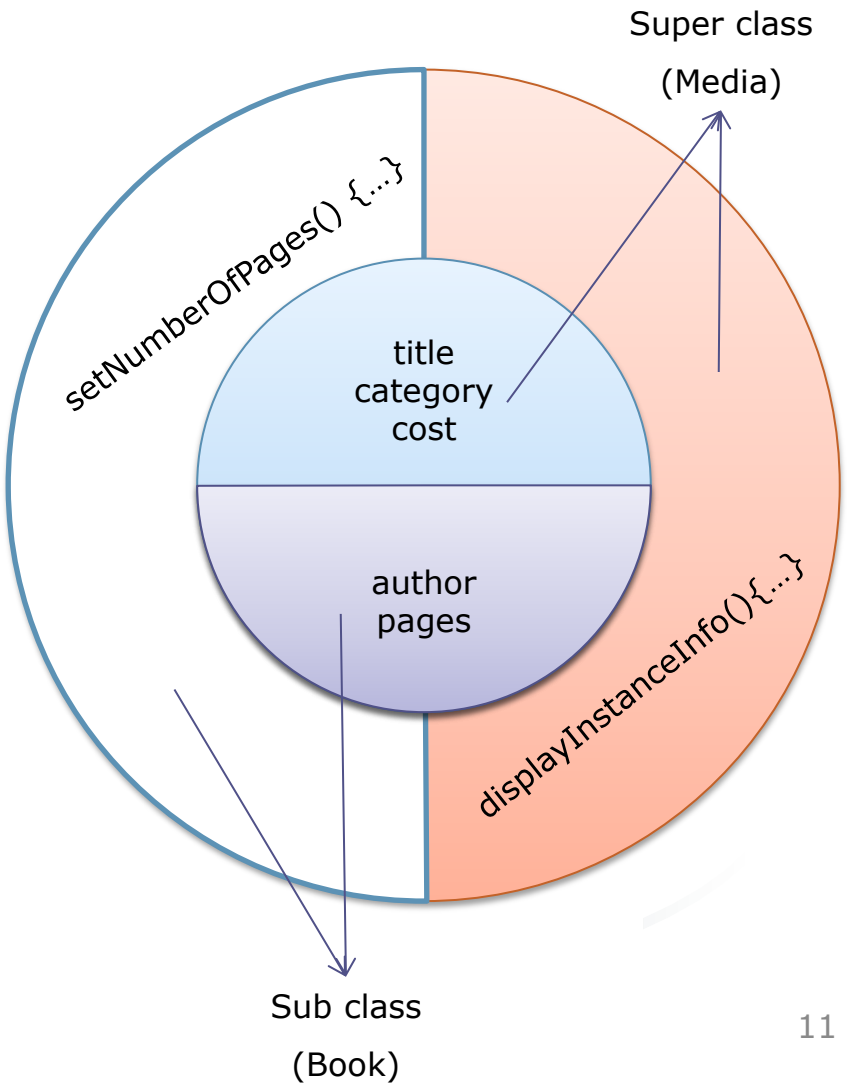
```
// Media class (super class)
public class Media {
    protected String title;
    protected String category;
    protected float cost;
...
    public void  displayInstanceInfo() {
    ...
    }
...
}
```

```
// Book class (sub-class)
public class Book extends Media {
    protected String author[];
    protected int pages;
    public Book() {
    }
// new methods
    public void setNumberofPages(int pages){
    this.pages = pages;
    }
// overridden method
    public void displayInstanceInfo() {
    //....
    }
}
```

```
// Usage
public class BookClassUsage {
public static void main(String[] args) {
    Book obj = new Book();
    obj.displayInstanceInfo();
}
}
```

# Instance of subclass

- An instance of a subclass comprises of:
  - member variables and methods that were defined by the super class
  - member variables and methods that were added by the subclass



# Example: Account – super class

```
class Account {
    // Member variables
    protected String owner; // Account name
    protected long balance; // Balance
    // value setting Methods
    public void setData(String name, long init_balance) {
      owner = name;
      balance = init_balance;
    }
    public void display() {
      System.out.print("Owner:" + owner);
      System.out.println("\t Balance:" + balance);
    }
}
```

# Example: ChargeAccount - subclass

```
public class ChargeAccount extends
    Account{
    // Additional member variables
    private int overdraft;
    // borrowing amount
    private int overdraft_limit;
    /* limit to the amount withdrawn
    * from an account even though
    * there is zero balance */

    // Additional methods
     public void setOverdraftLimit(int
        overdraft_limit) {
          this.overdraft_limit =
            overdraft_limit;
          this.overdraft = 0;
    }
    public void loan(int overdraft) {
         int current_overdraft =
           this.overdraft + overdraft;
         if (current_overdraft <=
           overdraft_limit)
         this.overdraft += overdraft;
         else System.out.println("The
           limit to the amount
           withdrawn is exceeded !!!
           ");
    }
    // overridden method
    public void display() {
         System.out.println("\t\t
           Borrowing amount limit:"+
           overdraft_limit);
         System.out.println("\t\t
           Borrowing amount:" +
           overdraft);
    }
}
```

# Example: ChargeAccountClassUsage

```
public class ChargeAccountClassUsage {
     public static void main(String[] args) {
          // creat a super class object
          Account account = new Account();
          // create a sub class object
          ChargeAccount chargeacc = new ChargeAccount();
          // sub class object calls methods from its super class: ok
          chargeacc.setData("Giang", 1000000);
          chargeacc.setOverdraftLimit(1000);
          chargeacc.loan(2000);
          // super class object calls methods from its own class: ok
          account.setData("Tuan", 2000000);
          // super class object calls methods from its sub class: no
          account.setOverdraftLimit(1000);
          // can not call method from its super class, once it is overridden
          chargeacc.display();
          ((Account) chargeacc).display();
     }
}
```

# 4. Initialization order

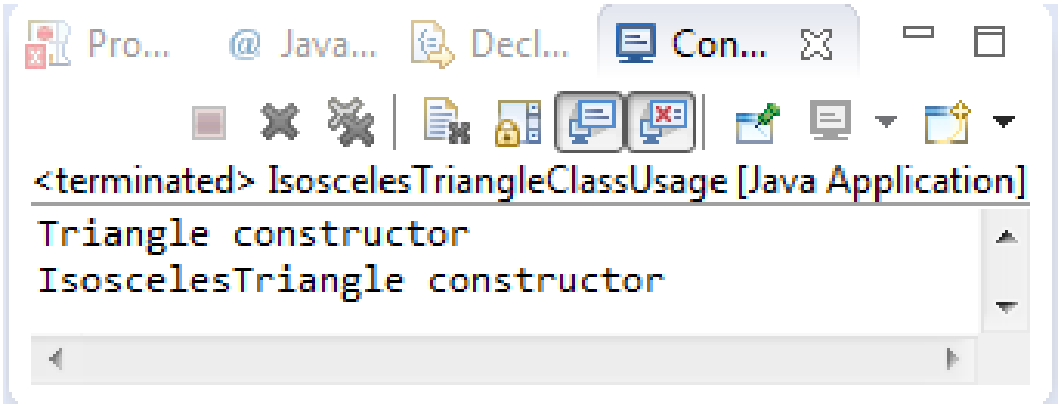
- Objects are constructed top-down under inheritance.
- Super class is initialized before its subclass
  - first call super-class constructors
  - then call sub-class constructors
- The constructors of the direct super class are always called
  - Explicit call: call the super class constructor from the sub class constructor code
  - Implicit call: call the parameter-less or default constructor of the super class (if present); no call is written in the code
- Each super class' constructor manipulates the instance variables that the subclass will inherit

# Implicitly call of super class constructor: Example 1

```
public class Triangle {
    private Point d1, d2, d3;
    public Triangle
        (Point p1, Point p2, Point p3){
        d1 = p1; d2 = p2; d3 = p3;
    }
    public Triangle(){
        System.out.println("Triangle constructor");
        d1 = new Point();
        d2 = new Point(0,1);
        d3 = new Point (1,1);
    }
    public void displayTriangle(){
        d1.displayPoint();
        d2.displayPoint();
        d3.displayPoint();
        System.out.println();
    }
}
```

# Implicitly call of super class constructor: Example 1

```
public class IsoscelesTriangles extends Triangle{
    public IsoscelesTriangles() {
        // automatic call Triangle()
        System.out.println("IsoscelesTriangle constructor");
    }
}

public class IsoscelesTriangleClassUsage {
    public static void main(String[] args) {
         IsoscelesTriangles obj = new IsoscelesTriangles();
    }
}
```



# Implicitly call of super class constructor: Example 2

```
public class Triangle {
    private Point d1, d2, d3;
    public void displayTriangle(){
        d1.displayPoint();
        d2.displayPoint();
        d3.displayPoint();
        System.out.println();
    }
}
```

```
public class IsoscelesTriangles extends
Triangle{
    public IsoscelesTriangles() {
        // automatic call Triangle();
        System.out.println
        ("IsoscelesTriangle constructor");
    }
}

public class IsoscelesTriangleClassUsage {
    public static void main(String[] args) {
          IsoscelesTriangles obj =
          new IsoscelesTriangles();
    }
}
```

# Implicitly call of super class constructor: Example 3

```
public class Triangle {
    private Point d1, d2, d3;
    public Triangle
        (Point p1, Point p2, Point p3){
        System.out.println
            ("Triangle constructor");
        d1 = p1; d2 = p2; d3 = p3;
    }
    public void displayTriangle(){
        d1.displayPoint();
        d2.displayPoint();
        d3.displayPoint();
        System.out.println();
    }
}
```

```
public class IsoscelesTriangles extends
Triangle{
    public IsoscelesTriangles() {
        // automatic call Triangle();
        System.out.println
        ("IsoscelesTriangle constructor");
    }
}

public class IsoscelesTriangleClassUsage {
    public static void main(String[] args) {
          IsoscelesTriangles obj =
          new IsoscelesTriangles();
    }
}
```

Failed, because class Triangle has user-defined constructor, but no constructor Triangle() is found in the super class.

# Explicit call of super class constructor

- If the super class defines explicitly his constructors with parameter, the sub class must call them explicitly
  - Sub class constructor (either with or without parameters) calls the super class constructor in his first statement using **super** keyword.
- The sub class could also call explicitly the constructor without parameter of its super class
- Depending on the passed argument when a constructor make a super call, the relevant constructor of super class is executed.

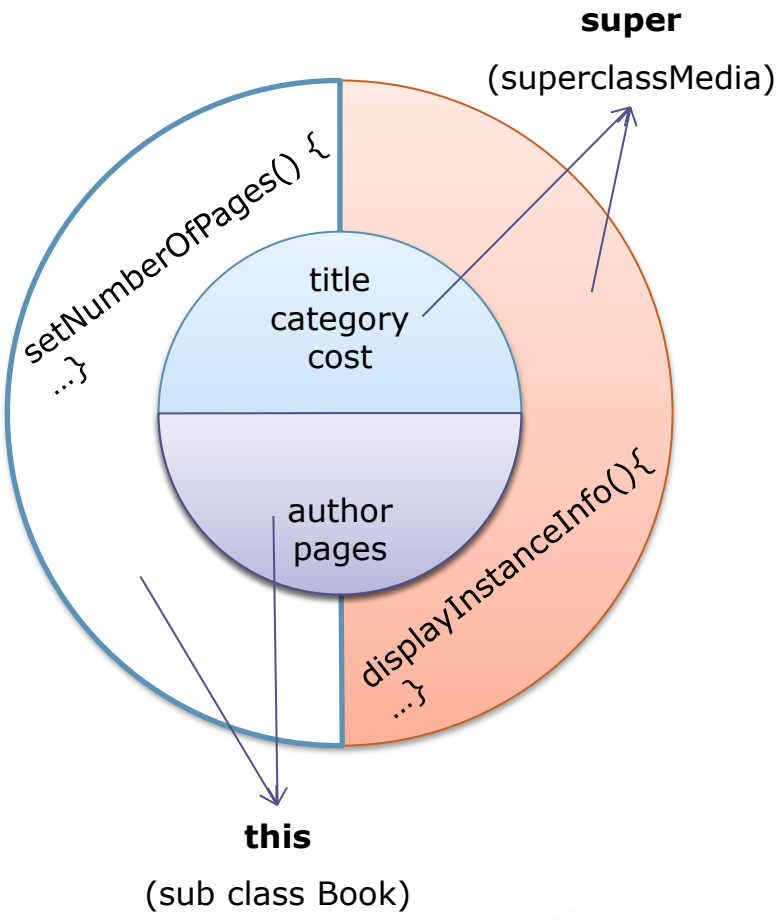
# 5. super keyword

- This keyword is used to indicate the super class of the caller class
- Two usages of **super**:
  - to call the super-class constructor

    **super(parameter list);**
  - to access super-class members

    **super.variable;**

    **super.method(parameter list);**

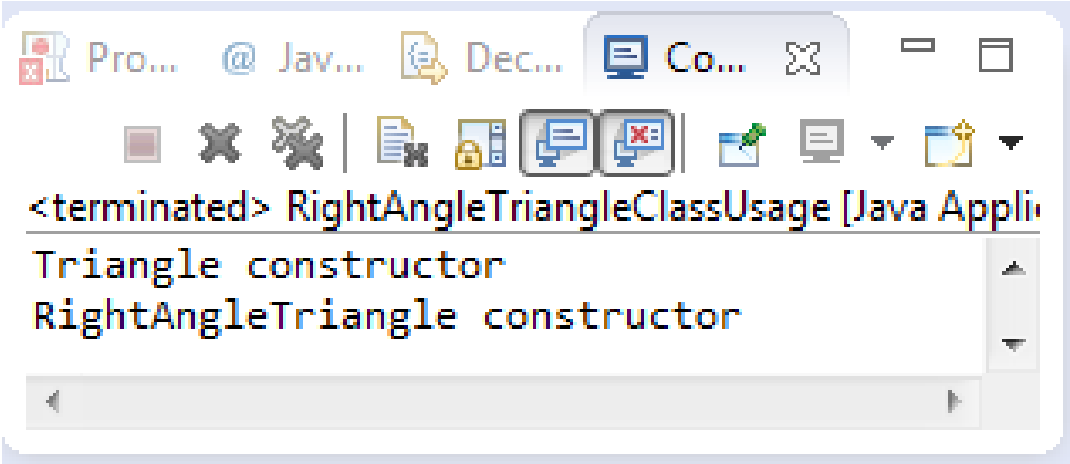


# Call super class' constructor from a constructor without parameter

```
public class Triangle {
    private Point d1, d2, d3;
    public Triangle(){
        d1 = new Point(); d2 = new Point(0,1);
        d3 = new Point (1,1);
    }
    public Triangle(Point p1, Point p2, Point p3){
        System.out.println("Triangle constructor");
        d1 = p1; d2 = p2; d3 = p3;
    }
    public void displayTriangle(){
        d1.displayPoint();
        d2.displayPoint();
        d3.displayPoint();
        System.out.println();
    }
}
```

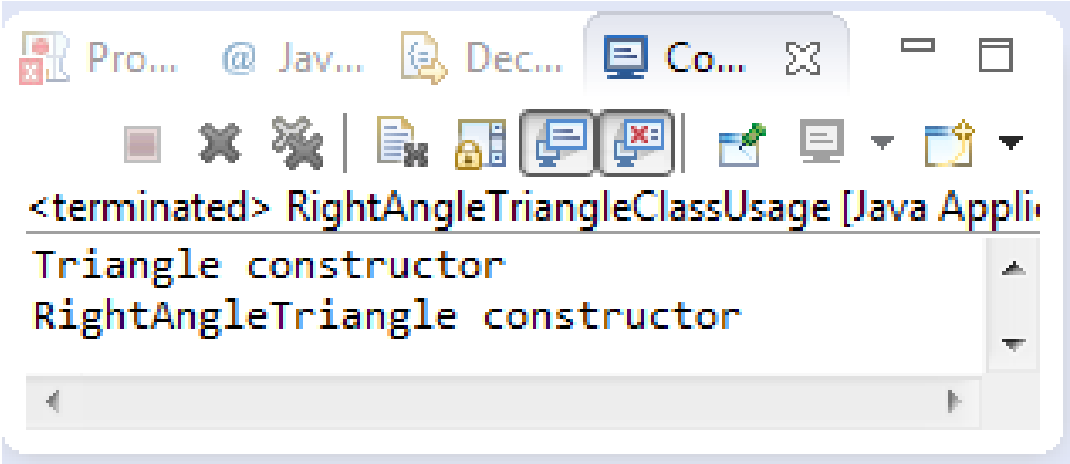
# Call super class' constructor from a constructor without parameter

```
public class RightAngleTriangle extends Triangle{
     public RightAngleTriangle() {
          // explicitly call the constructor with parameter
          // of super class
          super(new Point(0,0), new Point(1,0), new Point(0,2));
          System.out.println("RightAngleTriangle constructor");
     }
}
public class RightAngleTriangleClassUsage {
     public static void main(String[] args) {
           RightAngleTriangle obj = new RightAngleTriangle();
     }
}
```



# Call super class' constructor from a constructor with parameter

```
public class RightAngleTriangle extends Triangle{
    public RightAngleTriangle(Point p1, Point p2, Point p3) {
        // explicitly call the constructor with parameter of super class
        super(p1, p2, p3);
        System.out.println("RightAngleTriangle constructor");
    }
}
public class RightAngleTriangleClassUsage {
     public static void main(String[] args) {
        RightAngleTriangle obj1 = new
            RightAngleTriangle(new Point(0,0), new Point(1,0), new Point(0,2));
     }
}
```



# Access super class’ members

- The super keyword allows accessing to the hidden variables or methods of the super-class
- When a sub-class declares the variables or methods with the same names and types as its super-class, the re-declared variables or methods hide those of the super-class.

# Access super class' method

```
// Account class
class Account {
     // Member variables
     protected String owner;
     protected long balance;

     //…

     public void display() {
     System.out.print("Owner:" + owner);
     System.out.println("\t Balance:" +
     balance);
     }
}
```

```
public class ChargeAccount extends Account{
     // Additional member variables
     private int overdraft;
     private int overdraft_limit;
     //…
     // access to the super class' member

     public void displayInfo() {
     // access super class method;
        super.displayInfo();

        System.out.println("\t\t Borrowing
        amount limit:“+ overdraft_limit);
        System.out.println("\t\t Borrowing
        amount:“+ overdraft);
     }
}
```

# Access super class' variable

```
// Account class
class Account {
     // Member variables
     protected String owner;
     protected long balance;

     //…

     public void display() {
     System.out.print("Owner:" + owner);
     System.out.println("\t Balance:" +
     balance);
     }
}
```

```
public class ChargeAccount extends Account{
     // Additional member variables
     private int overdraft;
     private int overdraft_limit;
     //…
     // access to the super class' member

     public void displayInfo() {
     // access super class method
     // super.displayInfo();

     // access directly to super class's variables
     // to do the same thing
//System.out.print("Owner:" + super.owner);
//System.out.println("\t Balance:" + super.balance);

        System.out.println("\t\t Borrowing
        amount limit:"+ overdraft_limit);
        System.out.println("\t\t Borrowing
        amount:"+ overdraft);
     }
}
```

# 6. Final modifier

- The final modifier indicates a class that can not be sub-classed.
  - Example

```
public final class EquilateralTriangle extends
  Triangle{
  //
  }
```

- If a method is declared with the final modifier, it can not be overridden
- If a variable is declared with the final modifier, it can not be changed after its initialization

# Quiz 1: Inheritance

- Use your previous Media class
- Create a new Book class derived from Media class, add the following attributes and their getters/setters:
  - Title
  - Author
  - Genre
- Write new constructors using *super* keyword
- Create new Book objects and assign their attribute values

# Quiz 2:
# call the constructor of its own class

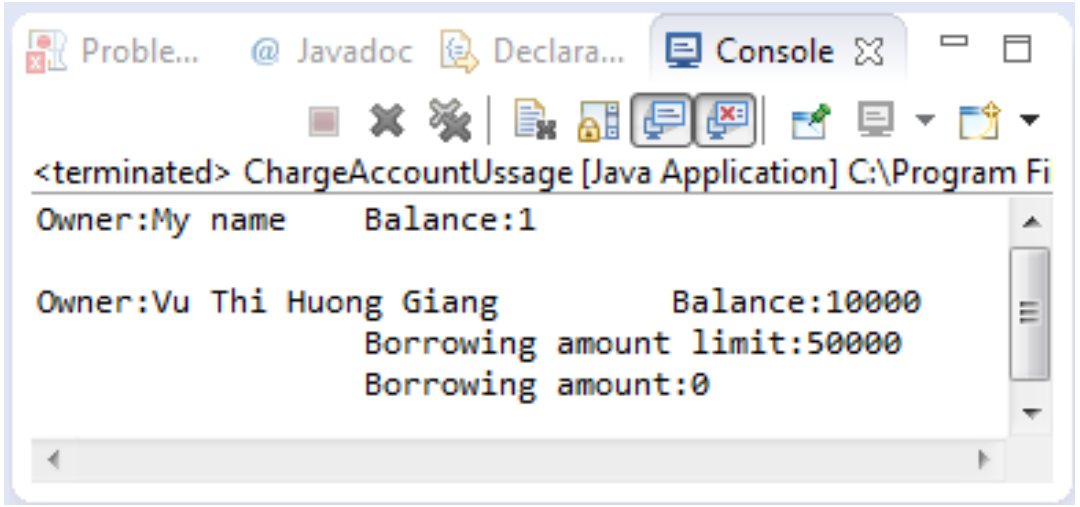
```
//Account class
public class Account {
	// Member variables
	private String owner; // Account name
	private long balance; // Balance

	// constructor with parameters
	public Account (String owner, long balance){
		this.owner = owner;
		this.balance = balance;
	}

	public Account() {
		// constructor call of own class
		this("My name", 1);
	}

	public void display() {
		System.out.print("Owner:" + owner);
		System.out.println("\t Balance:" + this.balance);
	}
}
```

# Quiz 2: call the constructor of its super class

```
public class ChargeAccount extends Account{
     // Additional member variables
     private int overdraft; // borrowing amount
     private int overdraft_limit;

     //constructor of sub-class
     public ChargeAccount(String name, long balance, int overdraft_limit){
          // explicit call to super class;
          super(name, balance);
          this.overdraft = 0;
          this.overdraft_limit = overdraft_limit;
     }

     public void display() {
          // access to the super class' method
          super.display();
          System.out.println("\t\t Borrowing amount limit:"+ overdraft_limit);
          System.out.println("\t\t Borrowing amount:" + overdraft);
     }
}
```

# Quiz 2: this and super

```
public class ChargeAccountUssage {
     public static void main(String[] args) {
          // Use the constructor without argument
          Account obj = new Account();
          obj.display();
          System.out.println();

          // For sub-class method, use superclass method
          ChargeAccount obj2 = new ChargeAccount("Vu Thi Huong Giang",10000,50000);
          obj2.display();
     }
}
```



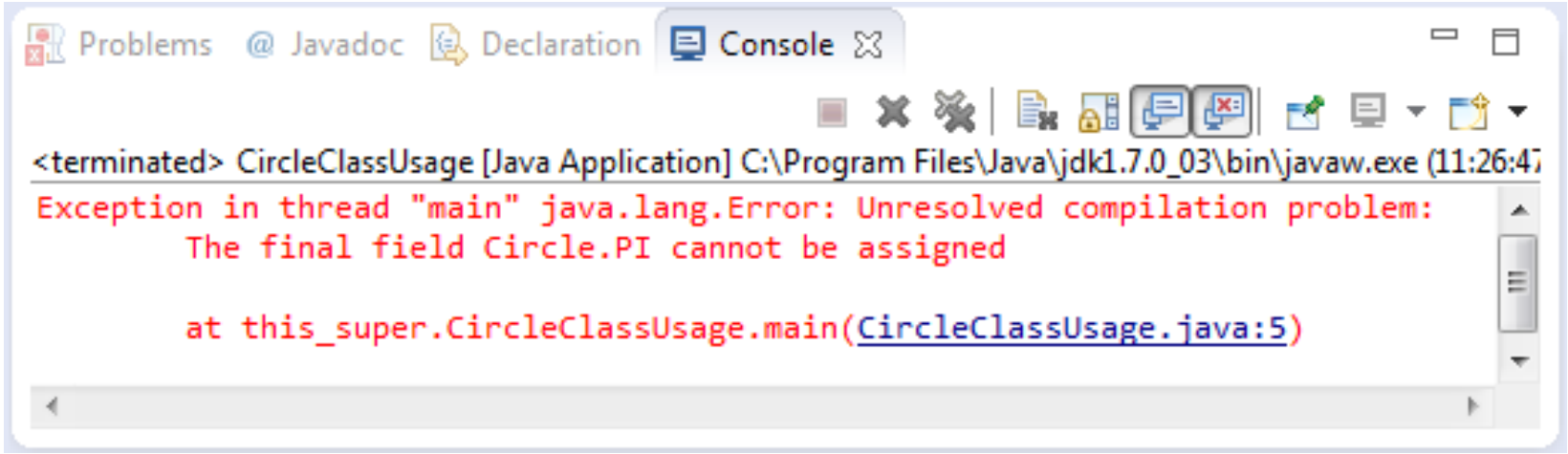
# Quiz 3: Final modifier

```
public class Circle {
    public static final double PI = 3.14159;
    public double x, y;
    public double r;
}


public class CircleClassUsage {
public static void main(String[] args) {
    Circle.PI = 4;
}
```

Is this correct ?

# Quiz 3: final

- The final keyword means that this variable can never be changed.



# Review

- Inheritance:
  - Extend the functionality of a class by creating a subclass.
  - Override super class members in the subclasses to provide new functionality