OBJECT-ORIENTED PROGRAMMING

7. ABSTRACT CLASS AND INTERFACE

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Outline

1. Redefine/Overiding
2. Abstract class
3. Single inheritance and multi-inheritance
4. Interface

2

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1. Re-definition or Overriding

- A child class can define a method with the **same name** of a method in its parent class:
  - If the new method has the same name but different signature (number or data types of method's arguments)

  → Method Overloading
  - If the new method has the same name and signature

  → Re-definition or Overriding

  (Method Redefine/Override)

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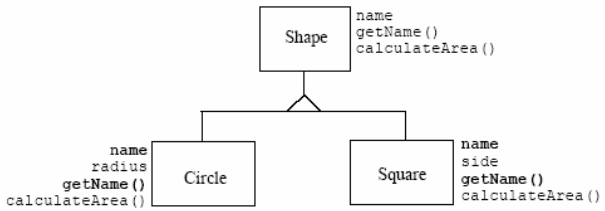
1. Re-definition or Overriding (2)

- Overriding method will replace or add more details to the overriden method in the parent class
- Objects of child class will use the re-defined method



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`this` and `super`

- **this** and **super** can use non-static methods/attributes and constructors
  - **this**: searching for methods/attributes in the current class
  - **super**: searching for methods/attributes in the direct parent class
- Keyword **super** allows re-using the source-code of a parent class in its child classes

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```
class Shape {
 protected String name;
 Shape(String n) { name = n; }
 public String getName() { return name; }
 public float calculateArea() { return 0.0f; }
}
class Circle extends Shape {
 private int radius;
 Circle(String n, int r){
   super(n);
   radius = r;
 }

 public float calculateArea() {
   float area = (float) (3.14 * radius * radius);
   return area;
 }
}
```

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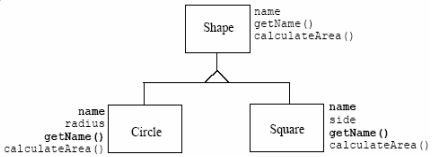
```
class Square extends Shape {
 private int side;
 Square(String n, int s) {
      super(n);
      side = s;
 }
 public float calculateArea() {
      float area = (float) side * side;
      return area;
 }
}
```



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Class `Triangle`

```
class Triangle extends Shape {
 private int base, height;
 Triangle(String n, int b, int h) {
      super(n);
      base = b; height = h;
 }
 public float calculateArea() {
      float area = 0.5f * base * height;
      return area;
 }
}
```

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```
package abc;
public class Person {
 private String name;
 private int age;
 public String getDetail() {
      String s = name + "," + age;
      return s;
 }
 private void pM(){}
}

import abc.Person;
public class Employee extends Person {
  double salary;
  public String getDetail() {
   String s = super.getDetail() + "," + salary
   return s;
 }
}
```

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Overriding Rules

- Overriding methods must have:
  - An argument list that is the same as the overriden method in the parent class => signature
  - The same return data types as the overriden method in the parent class
- Can not override:
  - Constant (final) methods in the parent class
  - Static methods in the parent class
  - Private methods in the parent class

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Overriding Rules (2)

- Accessibility can not be more restricted in a child class (compared to in its parent class)
  - For example, if overriding a protected method, the new overriding method can only be protected or public, and can not be private.

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Example

```
class Parent {
 public void doSomething() {}
 protected int doSomething2() {
     return 0;
 }
}
class Child extends Parent {
 protected void doSomething() {}
 protected void doSomething2() {}
}
```

cannot override: attempting to use incompatible return type

cannot override: attempting to assign weaker access privileges; was public

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Example: private

```
class Parent {
 public void doSomething() {}
 private int doSomething2() {
     return 0;
 }
}
class Child extends Parent {
 public void doSomething() {}
 private void doSomething2() {}
}
```

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Abstract Class

- An abstract class is a class that we can not create its objects. Abstract classes are often used to define "Generic concepts", playing the role of a basic class for others "detailed" classes.
- Using keyword abstract

```
public abstract class Product
{
    // contents
}
```

…Product aProduct = new Product(); //error

concrete class vs. abstract class

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2. Abstract Class

- Can not create objects of an abstract class
- Is not complete, is often used as a parent class. Its children will complement the un-completed parts.

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Abstract Class

- Abstract class can contain un-defined abstract methods
- Derived classes must re-define (overriding) these abstract methods
- Using abstract class plays an important role in software design. It defines common objects in inheritance tree, but these objects are too abstract to create their instances.

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2. Abstract Class (2)

- To be abstract, a class needs:
  - To be declared with **abstract** keyword
  - May contain abstract methods – that have only signatures without implementation
    - public abstract float calculateArea();
  - Child classes must implement the details of abstract methods of their parent class → Abstract classes can not be declared as final or static.
- If a class has one or more abstract methods, it must be an abstract class

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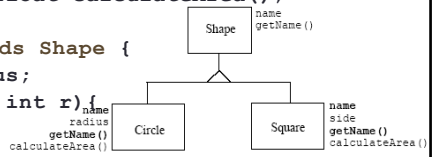
```
abstract class Shape {
  protected String name;
  Shape(String n) { name = n; }
  public String getName() { return name; }
  public abstract float calculateArea();
}
class Circle extends Shape {
  private int radius;
  Circle(String n, int r){
    super(n);
    radius = r;
  }
  public float calculateArea() {
    float area = (float) (3.14 * radius * radius);
    return area;
  }
}
```



Child class must override all the abstract methods of its parent class

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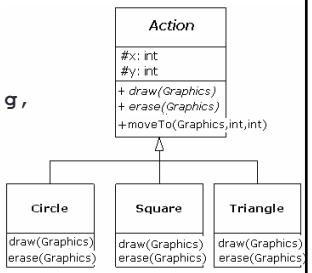
Example of abstract class

```
import java.awt.Graphics;
abstract class Action {
  protected int x, y;
  public void moveTo(Graphics g,
           int x1, int y1) {
    erase(g);
    x = x1; y = y1;
    draw(g);
   }

  public abstract void erase(Graphics g);
  public abstract void draw(Graphics g);
}

..Circle c = new Circle();
c.moveTo(...);
```



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Example of abstract class (2)

```
class Circle extends Action {
  int radius;
  public Circle(int x, int y, int r) {
    super(x, y); radius = r;
  }
  public void draw(Graphics g) {
    System out println("Draw circle at ("
                              + x + "," + y + ")");
    g.drawOval(x-radius, y-radius,
                  2*radius, 2*radius);
  }
  public void erase(Graphics g) {
     System.out.println("Erase circle at ("
                               + x + "," + y + ")");
     // paint the circle with background color...
  }
}
```

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Abstract Class

```
abstract class Point {
  private int x, y;
  public Point(int x, int y) {
    this.x = x;
    this.y = y;
  }
  public void move(int dx, int dy) {
    x += dx; y += dy;
    plot();
  }
  public abstract void plot();
}
```

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Abstract Class

```
abstract class ColoredPoint extends Point {
 int color;
 public ColoredPoint(int x, int y, int color) {
      super(x, y); this.color = color;
 }
}

class SimpleColoredPoint extends ColoredPoint {
 public SimpleColoredPoint(int x, int y, int color){
      super(x,y,color);
 }
 public void plot() {
      ...
      // code to plot a SimplePoint
 }
}
```

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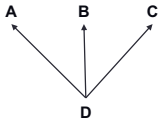
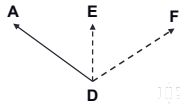
Multiple and Single Inheritances

- Multiple Inheritance
  - A class can inherit several other classes
  - C++ supports multiple inheritance
- Single Inheritance
  - A class can inherit only one other class
  - Java supports only single inheritance
  - → Need to add the notion of Interface





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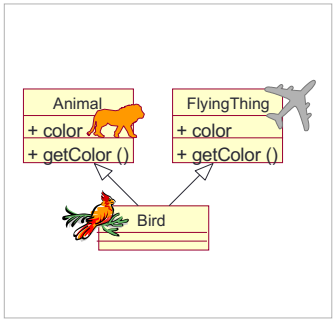
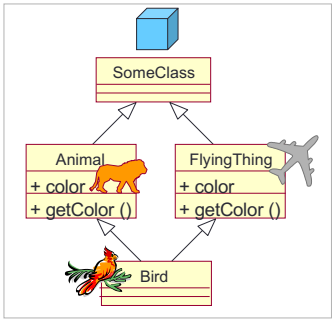
Problems in Multiple Inheritance

Name clashes on attributes or operations



Repeated inheritance



Resolution of these problems is implementation-dependent

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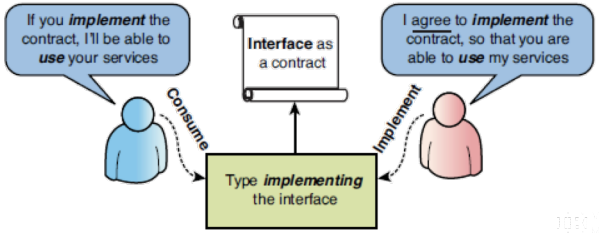
What Is an Interface?

- A declaration of a coherent set of public features and obligations
  - A contract between providers and consumers of services



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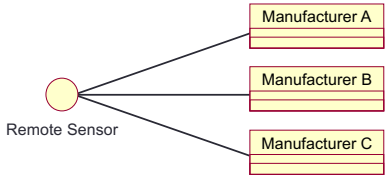
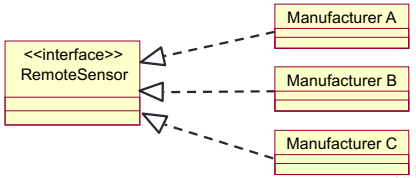
Interface Representation in UML

Elided/Iconic Representation ("ball")



Canonical (Class/Stereotype) Representation



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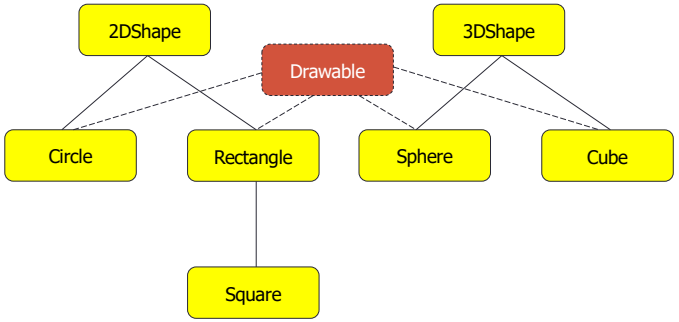
Example: Interface



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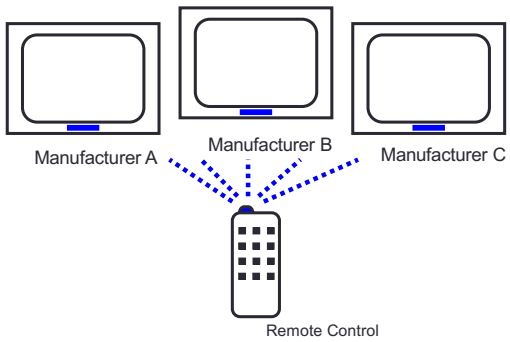
Example: TV Interface

- A single interface for different concrete TVs



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Interface – Technique view (JAVA)

- An interface can be considered as a "class" that
  - Its methods and attributes are implicitly public
  - Its attributes are static and final (implicitly)
  - Its methods are abstract

```
interface TVInterface {
        public void turnOn();
        public void turnOff();
        public void changeChannel(int i);
}
class PanasonicTV implements TVInterface{
        public void turnOn() { …. }
}
```

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Interface in Java

- Allows a class to inherit (implement) multiple interfaces at the same time
- Can not directly instantiate
- To become an interface, we need
  - To use interface keyword to define
  - To write only:
    - method signature
    - static & final attributes
- Implementation class of interface
  - Abstract class
  - Concrete class: Must implement all the methods of the interface

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Interface in Java

- Java syntax:
  - `SubClass extends SuperClass implements ListOfIntefaces`
  - `SubInterface extends SuperInterface`
- Example:

```
public interface Symmetrical {…}
public interface Movable {…}
public class Square extends Shape
                implements Symmetrical, Movable {
  ...
}
```

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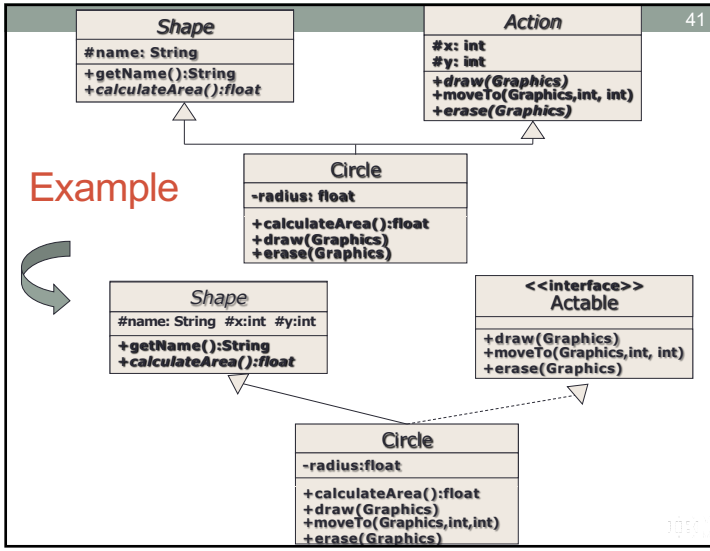
Example



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```
import java.awt.Graphics;
abstract class Shape {
 protected String name;
  protected int x, y;
 Shape(String n, int x, int y) {
      name = n; this.x = x; this.y = y;
  }
 public String getName() {
      return name;
 }
 public abstract float calculateArea();
}
interface Actable {
 public void draw(Graphics g);
  public void moveTo(Graphics g, int x1, int y1);
  public void erase(Graphics g);
}
```

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```
class Circle extends Shape implements Actable {
 private int radius;
  public Circle(String n, int x, int y, int r){
      super(n, x, y); radius = r;
  }
 public float calculateArea() {
      float area = (float) (3.14 * radius * radius);
      return area;
 }
 public void draw(Graphics g) {
    System out println("Draw circle at ("
                          + x + "," + y + ")");
    g.drawOval(x-radius,y-radius,2*radius,2*radius);
 }
 public void moveTo(Graphics g, int x1, int y1){
      erase(g); x = x1; y = y1; draw(g);
 }
 public void erase(Graphics g) {
       System out println("Erase circle at ("
                          + x + "," + y + ")");
      // paint the region with background color...
 }
}
```

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Reading Assignment

- Compare Abstract Class and Interface
- Why can Interface resolve the problems of Multi-Inheritance?

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