# Computer Language

OOP 4: Abstraction

# Agenda

- Abstract Class
- Interface

# Abstract Class

Interface

# Abstract Class: Goal

- Abstraction
  - Extraction of common features from a set of similar instances
    - Example 1) bird, insect, fish → animal (abstraction)
    - Example 2) Samsung, Hyundai, LG → company (abstraction)

- Abstract class
  - Class to define the common fields and methods of concrete classes
  - Act as a parent (base) class for concrete classes

# Abstract Class: Goal (cont'd)

- What's different? Compared to standard inheritance relationship?

```java
class Shape {
    public void draw() {
        System.out.println("Shape");
    }
}
```

```java
class Line extends Shape {
    public void draw() {
        System.out.println("Line");
    }
}
```

```java
class Rect extends Shape {
    public void draw() {
        System.out.println("Rect");
    }
}
```

```java
class Circle extends Shape {
    public void draw() {
        System.out.println("Circle");
    }
}
```

Overriding!

# Abstract Class: Goal (cont'd)

- Goal of Abstract class
  - Separate interface (design) from implementation!
- Abstract class
  - Define common concepts
  - Declare 'abstract' methods that MUST be implemented in the subclasses
    - Abstract method does not have implementations!
- Concrete classes
  - Implement class-specific behaviors

# Abstract Class: Goal (cont'd)

- Redefinition of superclass's method in the subclass
  - Same method signature, but different behaviors
  - Abstract method MUST be implemented/overridden

```
class Shape {
    public void draw() {
        System.out.println("Shape");
    }
}
```

```
abstract class Shape {
    public abstract void draw();
}
```

```
class Line extends Shape {
    @Override
    public void draw() {
        System.out.println("Line");
    }
}
```

```
class Rect extends Shape {
    @Override
    public void draw() {
        System.out.println("Rect");
    }
}
```

```
class Circle extends Shape {
    @Override
    public void draw() {
        System.out.println("Circle");
    }
}
```

# Abstract Class: Goal (cont'd)

- Redefinition of superclass's method in the subclass
  - Same method signature, but different behaviors
  - Abstract method MUST be implemented/overridden

- Achieves polymorphism with inheritance
  - Same interface, but different behaviors
    - Line class draws a line using draw() interface
    - Circle class draws a circle using draw() interface
    - Rect class draws a rectangle using draw() interface

# Abstract Class: Definition

- Use abstract keyword!
  - Abstract Class
  - Abstract method
    - Defined but not implemented method
    - MUST be overridden by subclasses

- Characteristics of abstract classes
  - Cannot be instantiated by new() keyword
  - May or may not include abstract methods
  - If a class includes abstract methods, then the class MUST be declared abstract

# Abstract Class: Definition (cont'd)

- Characteristics of abstract classes
  - May or may not include abstract methods

```
// 1. abstract class containing abstract methods

abstract class Shape { // declaration of abstract class
   public Shape() { }
   public void paint() { draw(); }
   abstract public void draw(); // declaration of abstract method
}
```

No implementation for abstract methods

```
// 2. abstract class without abstract methods

abstract class MyComponent { // declaration of abstract class
   String name;
   public void load(String name) {
      this.name = name;
   }
}
```

# Abstract Class: Definition (cont'd)

- Inheritance of abstract classes
  - Abstract class inheriting another abstract class
    - Subclass cannot be instantiated

```
abstract class Shape { // abstract class
   public Shape() { }
   public void paint() { draw(); }
   abstract public void draw(); // abstract method
}
abstract class Line extends Shape { // abstract class, not implementing draw() method
   public String toString() { return "Line"; }
}
```

  - Concrete class inheriting an abstract class
    - All abstract methods MUST be implemented (overriding)
    - Concrete subclass can be instantiated

# Abstract Class: Usecases

- Example)
  - An array containing various payment methods
  - Process a series of payments using abstraction and polymorphism

```
public class MethodOverridingEx {
   static void purchase(Payment[] pay){
      for (Payment s: pay){
         s.pay(1000);
      }
   }

   public static void main(String[] args) {
      Payment[] myPayments = new Payment[3];
      myPayments[0] = new Cash();
      myPayments[1] = new Bitcoin();
      myPayments[2] = new Credit();

      purchase(myPayments);
   }
}
```

# Abstract Class: Usecases (cont'd)

- Example)
  - An array containing various payment methods
  - Process a series of payments using abstraction and polymorphism

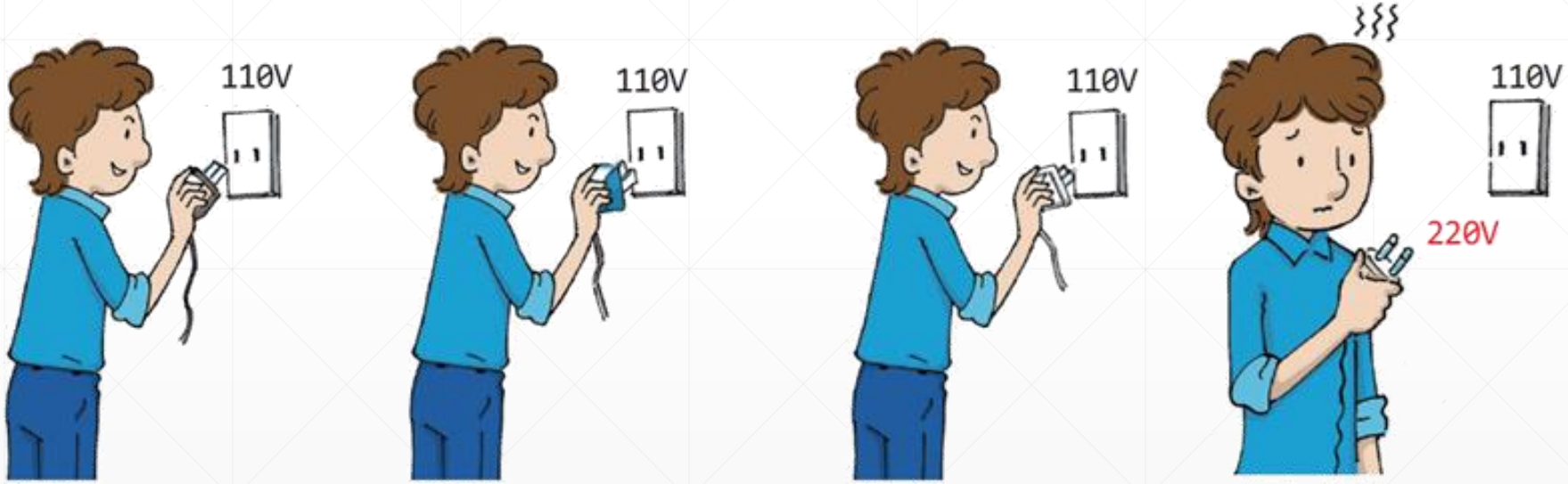
```
abstract class Payment {
  abstract void pay(int money);
}

class Cash extends Payment {
   void pay(int money) { System.out.println("Success!"+ money+" Won paid"); }
}

class Bitcoin extends Payment {
   void pay(int money) { System.out.println("Fail! Coin destroyed!"); }
}

class Credit extends Payment {
   void pay(int money) { System.out.println("Success! Payment made with your card!"); }
}
```

Abstract Class

# Interface

# Interface: Goal

- Interface in real life
  - Define a standard for interaction between devices



# Interface: Goal (cont'd)

- Interface in Java world
  - Define a standard (contract) for interaction between class/objects

POS

giveMoney(…)

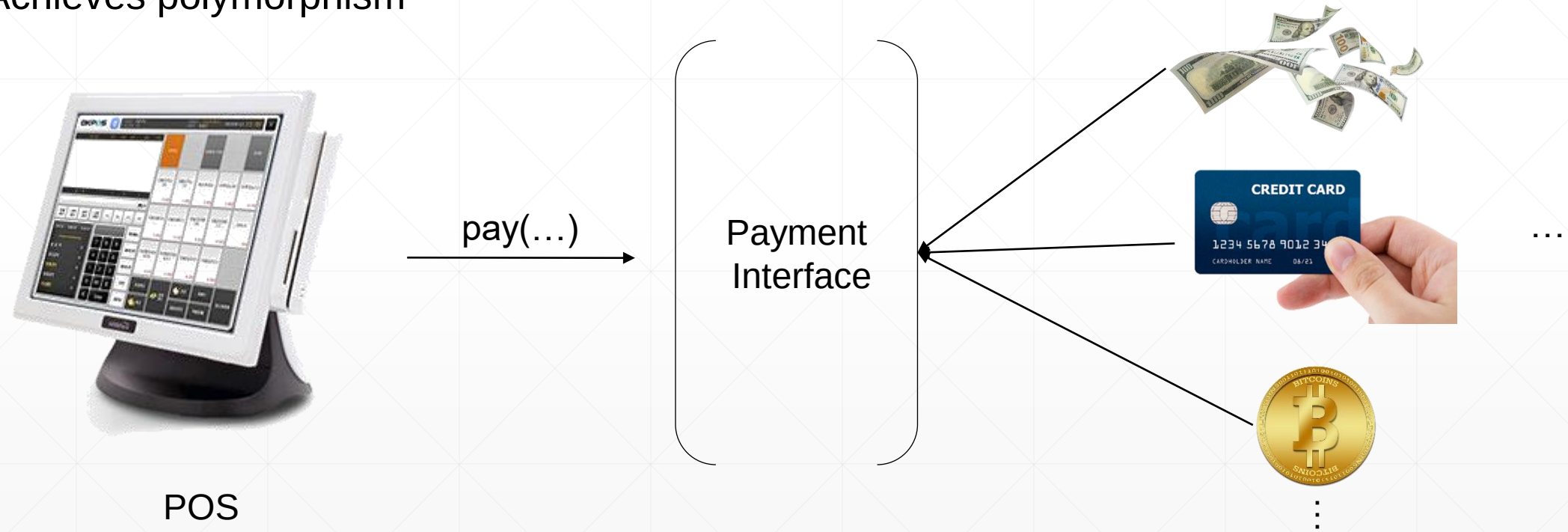
payCard(…)


pushCoin(…)


Need to know all the details of each counterpart!

# Interface: Goal (cont'd)

- Interface in Java world
  - Define a standard (contract) for interaction between class/objects
  - Achieves polymorphism




Only interact with Payment interface using pay() method!

# Interface: Definition

- Declaration of interface
  - Use *interface* keyword!

- Declaration of interface members
  - Constants
  - Abstract methods
  - Default, private, static methods
  - Variables are NOT allowed

# Interface: Definition (cont'd)

- Declaration of interface
  - Use *interface* keyword!

```
interface PhoneInterface { // interface
    public static final int TIMEOUT = 10000; // constant
    public abstract void sendCall(); //
    public abstract void receiveCall();
    public default void printLogo() { //
        System.out.println("** Phone **");
    };
}
```

abstract methods

default method

- Declaration of interface members
  - Constants
  - Abstract methods
  - Default, private, static methods
  - Variables are NOT allowed

# Interface: Definition (cont'd)

- Declaration of interface members
  - Constants
    - All fields defined in an interface are automatically declared as public static final
    - Naming convention: USE CAPITAL LETTERS

```
interface PhoneInterface { //
    public static final int TIMEOUT = 10000; //
    public abstract void sendCall(); //
    public abstract void receiveCall();
    public default void printLogo() { //
        System.out.println("** Phone **");
    };
}
```

  - Abstract methods
    - All methods defined in the interface are basically abstract without implementation
    - 'public abstract' keywords can be omitted

# Interface: Definition (cont'd)

- Declaration of interface members
  - Default methods
    - Methods with implementations
    - MUST be declared as "default"
    - Can be overridden by subclasses or interface realizations
    - Access modifier: public
  - Private methods
    - Methods with implementations
    - Access modifier: private
    - Only accessible by the methods inside the same interface
  - Static methods
    - Can be either public or private (default: public)

```
interface PhoneInterface { //
    public static final int TIMEOUT = 10000; //
    public abstract void sendCall(); //
    public abstract void receiveCall();
    public default void printLogo() { //
        System.out.println("** Phone **");
    };
}
```

# Interface: Characteristics

- Instantiation
  - Interfaces cannot be instantiated, like abstract classes
  - Cannot use new() keyword for object instantiation

```
new PhoneInterface();
```

- Reference
  - Reference variable of a certain interface type can be declared

```
PhoneInterface galaxy;
```

OK!

- Inheritance
  - Can extend another interface
  - Can extend multiple interfaces

# Interface: Characteristics (cont'd)

- Example of interface definition and inheritance

```
interface PhoneInterface {
    final int TIMEOUT = 10000;
    void sendCall();
    void receiveCall();
}

interface MP3Interface {
    void play();
    void stop();
}
```

```
interface MobilePhoneInterface extends PhoneInterface {
    void sendSMS();          // additional abstract methods
    void receiveSMS();       // additional abstract methods
}
```

Interface can extend another interface!

```
interface MusicPhoneInterface extends MobilePhoneInterface, MP3Interface {
    void playMP3RingTone(); // additional abstract methods
}
```

Interface can extend multiple interfaces!

# Interface: Realization

- Use ‘implements’ keyword to realize a certain interface
  - Multiple realization is also allowed
  - All abstract methods defined in the interface MUST be implemented

- Example of interface realization

```
class SamsungPhone implements PhoneInterface {

    public void sendCall() { System.out.println("RRRRiiinnnngg~~"); }
    public void receiveCall() { System.out.println("Incoming call!!"); }

    public void flash() { System.out.println("Mmmmmyyy Flash----!!"); }
}
```

SamsungPhone’s additional method

```
interface PhoneInterface {

    final int TIMEOUT = 10000;

    void sendCall();
    void receiveCall();

}
```

# Interface: Realization (cont'd)

- Example of interface realization (cont'd)

```
class LGPhone implements PhoneInterface {

    public void sendCall() { System.out.println("Yap, my call!!"); }
    public void receiveCall() { System.out.println("Give me a call!!"); }

    public void knock() { System.out.println("knock, knock!"); }
}

public class InterfaceEx{
    public static void main(String[] args) {
        SamsungPhone myPhone = new SamsungPhone();
        LGPhone yourPhone = new LGPhone();

        myPhone.sendCall();
        myPhone.receiveCall();
        myPhone.flash();

        yourPhone.sendCall();
        yourPhone.receiveCall();
        yourPhone.knock();

    }
}
```

LGPhone's additional method

# Interface: Realization (cont'd)

- Example) default and private methods
  - New requirement: Every phone should be able to print Phone logo!
    - 1) adding abstract printLogo() method? → existing interface broken
    - 2) adding default printLogo() method! → method with implementation in the interface

```java
interface PhoneInterface {
    final int TIMEOUT = 10000;

    void sendCall();

    void receiveCall();

    default void printLogo() {
        System.out.println("** Phone **");
    }
}
```

```java
class IPhone implements PhoneInterface {

    public void sendCall() { System.out.println("Yap, my call!!"); }
    public void receiveCall() { System.out.println("Give me a call!!"); }

    public void printLogo(){
        System.out.println("IIIII PPPPHONE!");
    }

    public void watch() { System.out.println("Apple watch activated!"); }
}
```

Overriding the default method

# Interface: Realization (cont'd)

- Example) default and private methods (cont'd)
  - New requirement: Every phone should be able to print Phone logo!
    - 1) adding abstract printLogo() method? → existing interface broken
    - 2) adding default printLogo() method! → method with implementation in the interface

```
public class InterfaceEx{
    public static void main(String[] args) {
        SamsungPhone myPhone = new SamsungPhone();
        LGPhone yourPhone = new LGPhone();
        IPhone hisPhone = new IPhone();

        myPhone.printLogo();
        yourPhone.printLogo();      work!
        hisPhone.printLogo();

    }
}
```

# Interface: Realization (cont'd)

- Example) default and private methods (cont'd)
  - New requirement: Every phone should be able to print Phone logo!
    - 1) adding abstract printLogo() method? → existing interface broken
    - 2) adding default printLogo() method! → method with implementation in the interface
      - Even we can define and invoke a private method in the interface!

```
interface PhoneInterface {
    final int TIMEOUT = 10000;

    void sendCall();

    void receiveCall();

    default void printLogo() {
        System.out.println("** Phone **"+getPhoneID());
    }

    private int getPhoneID(){
        return (int)(Math.random()*10);
    }
}
```

# Interface: Realization (cont'd)

- Example) static methods
  - Utility method of an interface
    - Static methods of an interface can be only accessed via Interface name

```
interface PhoneInterface {
    final int TIMEOUT = 10000;

    void sendCall();

    void receiveCall();

    default void printLogo() {
        System.out.println("** Phone **"+getPhoneID());
    }

    private int getPhoneID(){
        return (int)(Math.random()*10);
    }

    static int getTimeout(){
        return TIMEOUT;
    }
}
```

```
public class InterfaceEx{
    public static void main(String[] args) {
        SamsungPhone myPhone = new SamsungPhone();
        LGPhone yourPhone = new LGPhone();

        System.out.println(PhoneInterface.getTimeout());
        System.out.println(myPhone.getTimeout());
    }
}
```

# Interface: Realization (cont'd)

```
interface MobilePhoneInterface extends PhoneInterface {
    void sendSMS();
    void receiveSMS();
}
```

- Realization of multiple interfaces
  - A class can implement multiple interfaces

```
interface AIInterface {
    void recognizeSpeech();
    void synthesizeSpeech();
}

class AIPhone implements MobilePhoneInterface, AIInterface { // realization of multiple interfaces
    // realize MobilePhoneInterface
    public void sendCall() { ... }
    public void receiveCall() { ... }
    public void sendSMS() { ... }
    public void receiveSMS() { ... }

    // realize AIInterface
    public void recognizeSpeech() { ... }
    public void synthesizeSpeech() { ... }

    // can add class-specific methdos
    public int touch() { ... }
}
```

# Interface: Realization (cont'd)

- Example) Extending abstract class + implementing multiple interfaces

```java
interface PhoneInterface {
    final int TIMEOUT = 10000;
    void sendCall();
    void receiveCall();
    default void printLogo() {
        System.out.println("** Phone **");
    }
}
```

```java
interface MobilePhoneInterface extends
PhoneInterface {
    void sendSMS();
    void receiveSMS();
}
```

```java
interface AIInterface {
    void recognizeSpeech();
    void synthesizeSpeech();
}
```

```java
abstract class PDA {
     public int calculate(int x, int y) {
        return x + y;
    }
}
```

```java
class AIPhone extends PDA implements MobilePhoneInterface, AIInterface { // realization of multiple interfaces

    public void sendCall() {
        System.out.println("AI Sends call!");
    }
    public void receiveCall() {
        System.out.println("AI receives call!");
    }
    public void sendSMS() {
        System.out.println("AI sends sms!");}
    public void receiveSMS() {
        System.out.println("AI receives sms!");
    }

    public void recognizeSpeech() {
        System.out.println("AI recognized your speech!");
    }
    public void synthesizeSpeech() {
        System.out.println("AI synthesized your speech!");
    }

    // can add class-specific methdos
    public void touch() {
        System.out.println("Don't touch me!");
    }
}
```

*realize MobilePhoneInterface*

*realize AIInterface*

# Interface: Realization (cont'd)

- Example) Extending abstract class + implementing multiple interfaces (cont'd)

```
public class InterfaceEx{
    public static void main(String[] args) {
        AIPhone myPhone = new AIPhone();
        myPhone.touch();
        myPhone.sendCall();
        myPhone.receiveSMS();
        myPhone.synthesizeSpeech();
        System.out.println("My Phone can calculate: 10 + 10 = "+myPhone.calculate(10,10));
    }
}
```

# Interface: Usecases

- Example)
  - An array containing various payment methods
  - Process a series of payments using abstraction and polymorphism

```
interface Payment {
  public void pay(int money);
}

class Cash implements Payment {
 public void pay(int money) { System.out.println("Success!"+ money+" Won paid"); }
}

class Bitcoin implements Payment {
 public void pay(int money) { System.out.println("Fail! Coin destroyed!"); }
}

class Credit implements Payment {
 public void pay(int money) { System.out.println("Success! Payment made with your card!"); }
}
```

# Interface: Usecases (cont'd)

- Example)
  - An array containing various payment methods
  - Process a series of payments using abstraction and polymorphism

```
public class MethodOverridingEx {
   static void purchase(Payment[] pay){
      for (Payment s: pay){
         s.pay(1000);
      }
   }

   public static void main(String[] args) {
      Payment[] myPayments = new Payment[3];
      myPayments[0] = new Cash();
      myPayments[1] = new Bitcoin();
      myPayments[2] = new Credit();

      purchase(myPayments);
   }
}
```

# Abstract Class vs Interface

| Abstract class | Interface |
|---|---|
| Abstract class **does not support multiple inheritance** | Interface **supports multiple inheritance** |
| Abstract class **can have final, non-final, static and non-static variables** | Interface has **only static and final variables (constants)** |
| ***abstract* keyword** is used to declare abstract class | ***interface* keyword** is used to declare interface |
| Abstract class can **extend another class** and **implement multiple interfaces** | Interface can **extend another interface only** |
| Abstract class can be **extended** using keyword "**extends**" | Interface can be **implemented** using keyword "**implements**" |
| Abstract class can have class members like **private, protected, etc**. | Members of a Java interface are **public** by default |
| **Example:**<br>public abstract class Shape{<br>public abstract void draw();<br>} | **Example:**<br>public interface Drawable{<br>void draw();<br>} |

# Abstract Class vs Interface (cont'd)

- Which should you use, abstract classes or interfaces?
  - Consider using abstract classes if any of these statements apply to your situation:
    - You want to share code among several closely related classes
    - You expect that classes that extend your abstract class have many common methods or fields, or require access modifiers other than public (such as protected and private)
    - You want to declare non-static or non-final fields
  - Consider using interfaces if any of these statements apply to your situation:
    - You expect that unrelated classes would implement your interface
    - You want to specify the behavior of a particular data type, but not concerned about who implements its behavior
    - You want to take advantage of multiple inheritance of type

# Q&A

- Next week
  - Exception handling
  - Java basic packages