

## CMSC 131: Chapter 26

### Interfaces II

#### Review of Overloading and Overriding

Before discussing interfaces, let's review some elements of method **overloading** and **overriding**.

When **overriding** a method the subclass method prototype must match **exactly** the prototype of the superclass (same name, same return type, same arguments).

You may change **access specifier** (public, private, protected), but derived classes **cannot decrease the visibility**.

#### Example: You be the Compiler

```
public class Base {  
    protected void someMethod( int x ) { ... }  
}
```

```
public class Derived extends Base {  
  
    public void someMethod( int x ) { ... }  
  
    public int someMethod( int x ) { ... }  
  
    public void someMethod( double d ) { ... }  
}
```

(the following appears in the same package)

```
Base b = new Base( );  
Base d = new Derived( );  
Derived e = new Derived( );  
b.someMethod( 5 );  
d.someMethod( 6 );  
d.someMethod( 7.0 );  
e.someMethod( 8.0 );
```

## Object is not Abstract

We discussed abstract classes and methods. Note that **Object is not an abstract class**. You can create instances of `Object`, you just can't do very much with them.

```
Object o = new Object( );
Object p = new Object( );
System.out.println( o.toString( ) + " " + p.toString( ) );
```

## Interfaces: Recap

We introduced the concept of interfaces earlier this semester (in the context of the `cm131PictureLib`). Recall:

### Interface:

- Is defined by the keyword **interface** (rather than **class**).
- It is **abstract**. That is, it defines **methods** (as many as you like), but does **not** give **method bodies** (the executable statements that make up the method).

```
public interface Y {
    public void someMethod( int z );
    public int anotherMethod( );
}
```

- These methods are usually **public**, since they are expected to be part of an object's **public interface**.
- An **interface is not a class**. Because an interface is abstract, you **cannot** create an instance of interface `Y` using "new `Y`".

## Interfaces: Recap

### Implementing an Interface:

- An interface is a convenient way for a class to say that it "**promises**" to implement certain methods.
- A class is said to **implement** an interface if it provides definitions for these methods.
- To inform Java that a class implements a particular interface `Y`, we add "**implements `Y`**" after the class name:

```
public class X implements Y {
    // ...(instance data and other methods)...
    public void someMethod( int z ) { ... code goes here ... }
    public int anotherMethod( ) { ... code goes here ... }
}
```

- An **interface is a type**: We may use a reference to an `X` any place that a reference to an object of type `Y` is expected.

# Interfaces and Inheritance

**Abstract methods and classes:** Recall that in any class we can leave a method undefined (abstract):

```
public abstract class Shape {
    // ... (details omitted)
    public abstract void drawMe( );
}

public class Circle extends Shape {
    // ... (details omitted)
    public void drawMe( ) { ... Circle drawing code goes here ... }
}
```

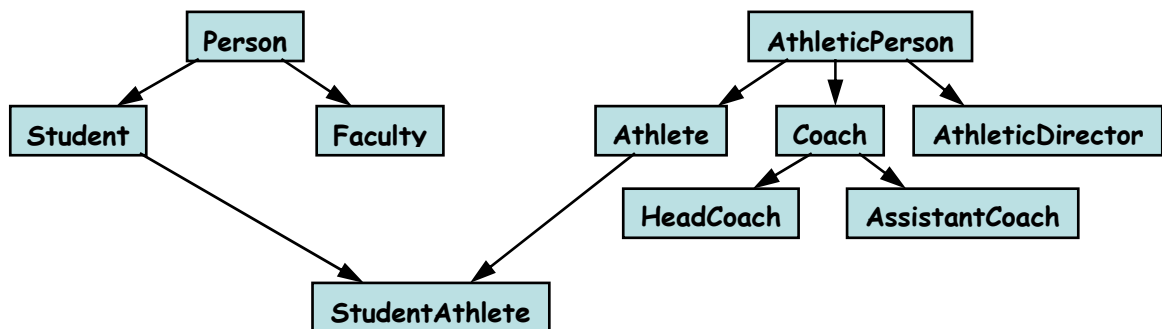
**Some questions :**

- What is the **difference** between abstract methods and interfaces?
- Why **do we need interfaces**? Can't we do everything using abstract methods and classes?
- Is it possible to have **interface hierarchies**, in the same way we can have class hierarchies?

## Multiple Inheritance

**Motivation:** There are many situations where a simple class hierarchy is **not adequate** to describe a class's structure.

**Example:** Suppose that we have our class hierarchy of **university people**, and we also develop a class hierarchy of **athletic people**:



**StudentAthlete:** Suppose we want to create an object that inherits all the elements of a **Student** (admission year, GPA) as well as all the elements of an **Athlete** (sport, amateur-status).

## Multiple Inheritance

Can we define a **StudentAthlete** by inheriting all the elements from both **Student** and **Athlete**?

```
public class StudentAthlete extends Student, extends Athlete
{ ... }
```

Alas, no. At least not in Java.

### Multiple Inheritance:

- Building a class by extending multiple base classes is called **multiple inheritance**.
- It is a very powerful programming construct, but it has many **subtleties** and **pitfalls**. (E.g., Athlete and Student both have a **name** instance variable and a **toString( )** method. Which one do we inherit?)
- **Java does not support this**. (Although C++ does.)
  - In Java a class can be **extended** from **only one** base class.
  - However, a class can **implement any number** of **interfaces**.

## "Faking" Multiple Inheritance with Interfaces

Since Java lacks multiple inheritance, is there an alternative? What public methods do we require of an Athlete object?

- String **getSport( )**: Return the athlete's sport
- boolean **isAmateur( )**: Does this athlete have amateur status?

We can define an interface Athlete that contains these methods:

```
public interface Athlete {
    String getSport( );
    boolean isAmateur( );
}
```

Now, we can define a StudentAthlete that **extends** Student and **implements** Athlete.

## "Faking" Multiple Inheritance with Interfaces

`StudentAthlete` **extends** `Student` and **implements** `Athlete`:

```
public class StudentAthlete extends Student implements Athlete {
    String mySport;
    boolean amateur;
    // ... other things omitted
    String getSport( ) { return mySport; }
    boolean isAmateur( ) { return amateur; }
}
```

`StudentAthlete` can be used:

- anywhere that a **Student** object is **expected** (because it is **derived** from `Student`)
- anywhere that an **Athlete** object is **expected** (because it **implements** the public interface of `Athlete`).

So, we have effectively achieved some of the goals of **multiple inheritance**, by using Java's single inheritance mechanism.

## Common Uses of Interfaces

Interfaces are flexible things and can be used for many purposes in Java:

- A work-around for Java's lack of **multiple inheritance**.  
(We have just seen this.)
- Specifying **minimal functional requirements** for classes.  
(This is its **principal** purpose.)
- For defining groups of related **symbolic constants**.  
(This is a somewhat **unexpected** use, but is not uncommon.)

## Using Interfaces for Symbolic Constants

In addition to containing method declarations, interfaces can contain **constants**, that is, variables that are **public final static**. Sometimes interfaces are used for just for this purpose:

```
public interface Months {
    public final static int    JANUARY = 1;
    public final static int    FEBRUARY = 2;
    public final static int    MARCH = 3;
    /* ... blah blah blah ... */
    public final static int    DECEMBER = 12;
}

public class MonthDemo implements Months {

    public static void main( String[ ] args ) {
        System.out.println( "March is month number " + MARCH );
    }
}
```

## Using Interfaces to Specify Requirements

Specifying **minimal functional requirements** for classes:

- **Picture** (in our cmsc131PictureLib): defines methods **getHeight()**, **getWidth()**, and **getColor( int i, int j )**

Standard interfaces from the **Java class library**:

- **Comparable** (java.lang): defines a method **compareTo()**. It is used in situations where a class defines objects that can be ordered.
- **Iterator** (java.util): defines methods **hasNext()**, **next()**, **remove()**. It is used for enumerating all the elements of an object consisting of a collection of items, such as ArrayList.

## Interface Hierarchies

Inheritance applies to interfaces, just as it does to classes. When an interface is **extended**, it inherits all the previous methods.

**Example:** As we saw before, an **Iterator** is an object that allows you to step through a collection of items. Here is its definition:

```
public interface Iterator {
    boolean hasNext( );           // any more items?
    Object next( );              // return the next item
    void remove( );             // remove the current item
}
```

Suppose that we want a **bi-directional iterator**, which can move both forwards and backwards. We could implement it as follows:

```
public interface BidirectionalIterator extends Iterator {
    boolean hasPrevious( );      // any prior items?
    Object previous( );         // return the previous item
}
```

## Polymorphism Through Interfaces

Interfaces allow us to write methods that are **polymorphic**, in the sense that they can be applied to a wide variety of objects.

**Example:** Suppose that we want to write a function, which is given an array of references to some class type, and **sorts** the elements in **increasing order**.

**Polymorphic Design:** Any sorting function must be able to compare two objects. Suppose we use **compareTo( )** to do this. This allows us to apply the sorting algorithm to **any array** containing objects that implement the **Comparable interface**. (More on this later.)