Inheritance and Polymorphism

Implementation

Game plan

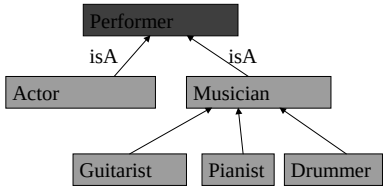
- Inheritance, Subclassing, Polymorphism
  - Yesterday: Basic concepts
  - Today: How it's done in Java

But first…

- Questions from last time?

Inheritance and Java

- Class hierarchy for theatre app



Inheritance and Java

- To define a class as a subclass, in Java we say that the subclass `extends` the superclass

Inheritance and Java

```
public class Performer {
…
}
public class Musician extends Performer {
…
}

public class Guitarist extends Musician {
…
}
```

Inheritance, Java, and Constructors

- When in a subclass, to call the constructor of your superclass use the `super()` function.
- `super()` must be called if all of the constructors for a superclass have arguments.
- `super()`, if used, must be the first statement in the constructor of the subclass.

Inheritance, Java, and Constructors

```
public class Performer {
   private String myName;

   // constructor
   public Performer (String name){…}
}

public class Musician extends Performer {
   private Instrument myInstrument;
   public Musician (String name, Instrument I)
   {
      super(name);
      myInstrument = I;
   }
}
```

Inheritance, Java, and Constructors

```
public class Musician extends Performer {
   private Instrument myInstrument;
   public Musician (String name, Instrument I)
   {
      super(name);
      myInstrument = I;
   }
}

public class Guitarist extends Musician {
   public Guitarist(String name)
   {
       super (name, new Guitar());
   }
}
```

The Java `Object` class

- All classes in Java, whether explicitly stated or not, are subclasses of the java `Object` class (defined in package `java.lang`)
- `String Object.toString()` method

toString() example

```
public class Musician extends Performer{
…
    public String toString()
   {
      return “I am a musician”;
   }
}


public class Drummer extends Musician {
…
    public String toString()
    {
       return “I am a drummer”;
    }
}
```

toString example

```
Object P = new Performer (“foo”);
Object M = new Musician (“fred”, new Guitar());
Object D = new Drummer (“keith”);
Object G = new Guitarist (“barney”);

System.out.println (M.toString());
System.out.println (D.toString());
System.out.println (G.toString());
System.out.println (P.toString());
```

Output:

```
I am a musician
I am a drummer
I am a musician
Performer@77d163
```

Accessing superclass methods using super

- You can access any public or protected member of your superclass explicitly using `super`

```
public class Drummer extends Musician {
…
    public String toString()
    {
      return super.toString() + " that plays the drums";
    }
}
```

Accessing superclass methods using super

- You can only specify one level up the hierarchy.

```
public class Drummer extends Musician {
…
    public String toString()
    {
      // This will cause a compiler error
      return Performer.toString() +
       " that plays the drums";
    }
}
```

Just a side note

- You cannot override/redeclare methods/variables declared as `final` in the superclass.

Declaring abstract classes

- To declare a class as abstract, use the `abstract` keyword when defining the class:

```
public abstract class Performer {
…
}
```

Declaring abstract methods

- To declare a method to be abstract, add the `abstract` keyword to the method.
- The abstract method in the superclass will have no body defined for it.

```
public abstract class Performer {
…
   public abstract double calculatePay();
}
```

Declaring abstract methods

- If a class has an abstract class, it must be declared as abstract

```
public class Performer {
…
   public abstract double calculatePay();
}
```

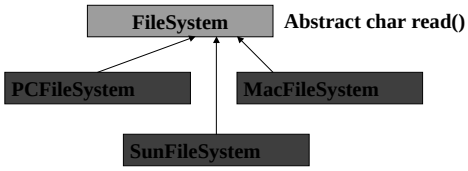
- Will fail at compile time

Why use abstract classes

- Abstract classes
  - provide a set of methods that a subclass must implement
  - Subclass Implementations may be vastly different but set of methods are the same

Abstract classes

- FileSystem Object



Declaring abstract methods

- Abstract classes
  - A class that has abstract method must be declared as abstract
  - However, you can declare an class that does not have abstract methods to be abstract.

Abstract classes

```
public abstract class Instrument {
private double rentalCost;

protected Instrument (double cost)
{
   rentalCost = cost;
}

public double getWeeklyRental ()
{
   return rentalCost;
}
}
```

Abstract classes

- Why would one do this?
  - Design purposes – If, in your logical design of your app, a class is so general that it doesn't make sense to instantiate an object of the class directly
  - Reserve the right to add abstract methods later.

More on Polymorphism

- When you declare a variable with type of a superclass, it can hold an object of type superclass or any class inherited from superclass.
- When sending messages to that object via a method call, you must use the method set available by the superclass

More on Polymorphism

```
public abstract class Performer {
…

   public abstract double calculatePay();
}

public class Musician extends Performer {
…
   public double calculatePay() { …}

   public Instrument getInstrument() { … }
}

Performer P = new Musician("fred");
double pay = P.calculatePay();  // this call is okay
Instrument I = P.getInstrument(); // this call is bad
```

More on Polymorphism

- Polymorphism works on method arguments as well.

```
public class Payroll {
…
    public void addPerformer(Performer P) { ... }

    public static void main (String args[]) {

      Payroll P = new Payroll();
      Guitarist G = new Guitarist ("fred");
      P.addPerformer (G);
      ...
    }
}
```

Multiple Inheritance

- In some languages (like C++), it is possible for class to inherit from more than one class (I.e. have more than one superclass).
- This is called multiple inheritance.
- Java does not support multiple inheritance.
- Instead, Java provides a different mechanism: interfaces.

Interfaces

- An interface defines a set of methods that need to be implemented by a class.
- It's "somewhat" like an abstract class that contain only constants and method definitions where all of the methods are abstract.
- A class does not `extend` an interface, instead, it `implements` an interface.

Interfaces

- To define an interface:

```
public interface InterfaceName {

   // constants defined by the interface
   public static int constant1 = 12;
   public static int constant2 = 20;

   // set of methods that need to be defined by
   // classes implementing this interface
   public void method1();
   public float method2 (int arg1);

}
```

Interfaces

- When a class has definitions for all methods of an interface, we declare that class to implement the interface:

```
public class Foo implements InterfaceName {
…
}
```

- A class can have only one superclass, however, it can implement as many interfaces as it likes.

```
public class Foo2 extends Foobar implements
InterfaceName2, IntefaceName3 {
…
}
```

Interface

- Example: `java.lang.Comparable`
  - Interface for objects that can compare itself with other objects
  - Used by sorting methods in the `java.util` package.

```
public interface Comparable {

   public int compareTo(Object O);
}
```

Interface

- Let's make our Performer implement Comparable

```
public class Performer implements Comparable {
   private String myName; …

   public int compareTo(Object O)
   {
       // Objects must be of same class if not
       // exception is thrown
       Performer P = (Performer)O;

       // compare by name
       return myName.compareTo (P.myName)
}
```

Summary

- `extends`
- `super()`
- `abstract`
- `super` again
- `interface` / `implements`

- Questions?