More Inheritance, Abstract Classes, and Interfaces

CS211
Fall 2000

Recall: Overriding of Methods

```
class Animal {
    protected String name = "";
    protected String noise = "";

    public setName (String myName) {
            name = myName;
            }
    public void identifySelf ( ) {
            System.out.println(
              "My name is " + name);
            }
    public void perform ( ) {
            }
    }
```

- Method perform( ) in Dog overrides perform( ) in Animal

```
class Dog extends Animal {
    public Dog ( ) {
            noise = "woof";
            }
    public void perform ( ) {
            identifySelf( );
            System.out.println("I am a Dog");
            System.out.println(noise);
            }
    }
```

2

Variable Shadowing

- What happens if Dog also has a field called name?

```
class Dog extends Animal {
    protected String name = "xxx";
    public Dog ( ) {
            noise = "woof";
            }
    public void perform ( ) {
            identifySelf( );
            System.out.println("I am a Dog");
            System.out.println(noise);
            }
    }
```

- The name field in Animal is hidden or shadowed
- Within Dog, *super.name* can be used to access the field in Animal
- When a method is invoked, the *actual type* of the reference is used (i.e., dynamic binding)
- When a variable is accessed, the declared type of the reference is used (i.e., static binding)
- Try to avoid shadowing

3

Constructors

- Goal: Modify Animal so that the animalType is specified when the Animal is created
  - Need a new constructor in Animal
  - Need a modified identifySelf( ) in Animal
  - What changes are needed in Dog?

```
class Animal {
    protected String name = "";
    protected String noise = "";
    private String animalType = "";

    public Animal (String animalType)
            {this.animalType = animalType;}
    public setName (String myName)
            {name = myName;}

    public void identifySelf  {
System.out.println("My name is " + name);
System.out.println("I am a " + animalType);
            }
    public void perform ( )
            { }
    }
```

4

Old Dog vs. New Dog

```
class Dog extends Animal {
    public Dog ( ) {
            noise = "woof";
            }
    public void perform ( ) {
            identifySelf( );
            System.out.println("I am a Dog");
            System.out.println(noise);
            }
    }
```

- The old Dog constructor starts by calling super( )
- This is now an error since there is no such constructor in Animal

```
class Dog extends Animal {
    public Dog ( ) {
            super("Dog");
            noise = "woof";
            }
    public void perform ( ) {
            identifySelf( );
            System.out.println(noise);
            }
    }
```

- The construction "super(xxx)" calls the constructor in Animal

5

Constructor Chaining

- Within the same class
  - Use the construction *this(xxx)*
  - Arguments are allowed
  - Constructors can be overloaded
- Chaining to superclass
  - Use the construction *super(xxx)*
  - Arguments are allowed
  - Uses constructor in superclass with matching signature
- Without an explicit occurrence of *this( )* or *super( )*, an occurrence of *super( )* (with no arguments) is assumed
- Implication: any use of *this( )* or *super( )* must occur in first statement of constructor
- Note: if no constructor is specified then a no-argument constructor is assumed

6

Use of *this* and *super* in Java

this(xxx)	Calls different constructor in current class (must be 1st statement)
this.xxx	Accesses a current-class variable
this.method(xxx)	Calls a current-class method
super(xxx)	Calls a superclass constructor (must be 1st statement)
super.xxx	Accesses a superclass variable
super.method(xxx)	Calls a superclass method
super.super.xxx	Invalid

7

Abstract Classes

- How do we keep users from defining generic Animals?
  - Make the class abstract
- An abstract class is "incomplete" and thus cannot be instantiated
- A method can also be abstract (e.g., perform( ))
- A class that inherits (without overriding) or contains an abstract method is also abstract

```
abstract class Animal {
    protected String name = "";
    protected String noise = "";
    private String animalType = "";

    public Animal (String animalType)
            {this.animalType = animalType;}
    public setName (String myName)
            {name = myName;}

    public void identifySelf  {
System.out.println("My name is " + name);
System.out.println("I am a " + animalType);
            }
    abstract public void perform ( );
    }
```

8

final Methods, Classes, and Variables

- What if we don't want any subclasses of Animal to mess with identifySelf( )?
  - Make identifySelf( ) a *final* method
- A final method cannot be overridden
- A final class cannot be extended (e.g., Integer, String in Java)
- A final variable cannot be changed (i.e., it's constant)

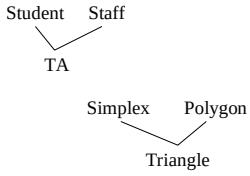
- Why use final methods and final classes?
  - A method's behavior may be important to class correctness
  - Can lead to more efficient code (i.e., can use static binding instead of dynamic binding)

```
final public void identifySelf  {
System.out.println("My name is " + name);
System.out.println("I am a " + animalType);
}
```

9

Multiple Inheritance

- *Multiple inheritance* allows the creation of classes that inherit from more than one superclass



- *Not allowed* in Java
- But other object-oriented languages allow it (e.g., C++, Lisp(CLOS))
- Java allows only single inheritance (or *linear inheritance*)
  - Simpler to implement
  - More efficient
  - Less confusing

10

Interfaces

- In Java, an *interface* is a special kind of "class" that has only abstract methods (and constants)
  - The method signatures are known, but no implementations are given
- In Java, a class *extends* a superclass, but it *implements* an interface

Example:
java.lang.Comparable

```
public interface Comparable {
    public int compareTo (object o);
    }
```

- A class that implements Comparable *must* provide a method compareTo (with matching signature)

11

A Kind of Multiple Inheritance

- A class can extend just one superclass
  - Multiple inheritance can cause conflicts
  - Example: Which of 2 inherited methods to use when both have identical signatures?
- But it can implement multiple interfaces
  - Multiple interfaces don't conflict because there are no implementations

12

Interfaces Define New Types

- An interface cannot be instantiated (e.g., `Comparable c = new Comparable( );` is illegal)
- But you can declare a variable using the interface type (e.g., `Comparable c = new String("hello");` is legal because the class String implements Comparable)

```
interface Pet {
    void perform ( );
    }
class Dog extends Animal
                implements Pet {
    public Dog ( ) {
        super("Dog");
        noise = "woof";}
    public void perform ( ) {
        identifySelf( );
        System.out.println(noise);}
    }
Dog d = new Dog( );
System.out.println(d instanceof Pet);  // true
Pet p = d;              // OK
p.perform( );           // OK
p.identifySelf( );      // Compile-time errror
```

13

More on Interfaces

- Interface methods
  - Interface methods are implicitly public and abstract
  - No static methods are allowed in interfaces
- Interface constants
  - Interface constants are public, static, and final
  - Can inherit multiple versions of constants
    - ▲Compiler detects this
    - ▲When this occurs, fully qualified names are required

14

Why Interfaces *and* Abstract Classes?

Why have both?

- Because an abstract class can include method implementations
  - We used this in Animal
    - ▲ identifySelf( )
    - ▲ constructor for Animal
  - Useful in Shape class in text

```
abstract class Animal {
    protected String name = "";
    protected String noise = "";
    private String animalType = "";

    public Animal (String animalType)
        {this.animalType = animalType;}
    public setName (String myName)
        {name = myName;}

    public void identifySelf  {
System.out.println("My name is " + name);
System.out.println("I am a " + animalType);
        }
    abstract public void perform ( );
    }
```

15

Aggregation

- Two major mechanisms for code reuse in Object Oriented Programming
  - Inheritance
  - Aggregation
- Aggregation is based on the "has-a" relationship
  - a Car *has an* Engine
  - an Order *has a* Customer
  - a Customer *has a* CreditRecord
- The idea of aggregation is to use objects as parts of other objects
- Example: The programmer who writes the Order class does not need to know implementation details about the Customer class even though the Order class uses a Customer field

16