1.00 Lecture 14

Inheritance, part 2

Reading for next time: Big Java: sections 9.1-9.4

Exercise: Plants

- Create a base class `Plant`: (File->New->Class)
  - Private `Strings genus, species, boolean isAnnual`
  - Write the constructor
    `public Plant( …) { … }`
- Create a derived class `Tree`: (File->New->Class)
  - Class declaration `extends _____`
  - Private data `Strings barkColor, leafType`
  - Write the constructor
    `public Tree( …) { … }`
    - Use `super( … )` to call its superclass constructor
    - All trees are perennials

Plant Exercise, p.2

- Create a derived class `Flower`: (File->New->Class)
  - Class declaration `extends _____`
  - Private data `String petalColor`
  - Write constructor
- Create a derived class `Rose`: (File->New->Class)
  - Class declaration `extends _____`
  - Private data `boolean isHybrid`
  - Write constructor
  - All roses are perennials

Exercise, p.3

- Write a class `PlantTest`
  - It has just a `main()` method, which:
    - Creates a `Plant, Tree, Flower, Rose`
    - Genus and species examples:
      - Rosa villosa (rose)
      - Quercus alba (white oak)
      - Narcissus jonquilla (daffodil)
      - Nabalus boottii (Boott's rattlesnake root)
    - The other data is:
      - Bark color= brown, leaf type= rounded for oak
      - Petal color= red for rose, yellow for daffodil
      - Rosa villosa is not hybrid
      - Nabalus is perennial, Narcissus is annual
  - Step through the debugger to see how the constructors are called (Run->Debug as)

Abstract classes

- Classes can be very general at the top of a class hierarchy.
  - For example, MIT could have a class `Person`, from which `Employees`, `Students`, `Visitors`, `Faculty` inherit
  - `Person` is too abstract a class for MIT to ever use in a computer system but it can hold `name`, `address`, `birthdate`, etc. that is in common to all the subclasses
  - We can make `Person` an abstract class: `Person` objects cannot be created, but subclass objects, such as `Student`, can be
- Example:

```
public abstract class Person {
   private String name;
   protected String address;
   public Person(String n, String a) {
         name= n; address= a; }
   // And additional methods}
```

Abstract classes, p.2

- Another example (leading to graphics in the next lectures)
  - `Shape` class in a graphics system
  - `Shapes` are too general to draw; we only know how to draw specific shapes like circles or rectangles
  - `Shape` abstract class can define a common set of methods that all shapes must implement (e.g., draw()), so the graphics system can count on certain things being available in every concrete class
  - `Shape` abstract class can implement some methods that every subclass must use, for consistency: e.g., `getObjectID()`, `getForegroundColor()`

Shape class

```
public abstract class Shape {
   public abstract void draw();
   // Drawing function must be implemented in each concrete
   // derived class but no default is possible: abstract

   public void setVisible(boolean v) { … }
   // setVisible function must be implemented in each derived
   // class and a default is available: non-abstract method

   public final int objectID() { … }
   // Object ID function: each derived class must have one
   // and must use this implementation: final method

   …};

public class Square extends Shape {…};
public class Circle extends Shape {…};
```

Abstract class, method

- Shape is an abstract class (keyword)
  - No objects of type Shape can be created
- Shape has an abstract method draw()
  - draw() must be redeclared by any concrete (non-abstract) class that inherits it
  - There is no definition of draw() in Shape
  - This says that all Shapes must be drawable, but the Shape class has no idea of how to draw specific shapes

Non-abstract method

- Shape has a non-abstract method `setVisible()`
  - Each derived class may define its own setVisible method using this signature, overriding the superclass method
  - Or it may use the super class implementation as a default
- If it overrides the superclass method, it must have exactly the same signature as the superclass method
  - If you write a method with same name but different arguments, it's considered a new method in the subclass
- Be careful. If new derived classes are added and you fail to review and, if needed, redefine non-abstract methods, the default will be invoked but may do the wrong thing
  - E.g., kangaroos

Final method

- Shape has a final method `objectID`
  - Final method is invariant across derived classes
  - Behavior is not supposed to change, no matter how specialized the derived class becomes
- Super classes should have a mix of methods
  - Don't make all abstract super class methods abstract
  - If you can make methods final, do so

An aside: final classes

- To prevent someone from inheriting from your class, declare it final:

```
public final class Grad extends Student { …
```

  - This would not allow SpecGrad to be built
  - Class can have `abstract`, `final` or no keyword

Exercise: Vehicle

```
public abstract class Vehicle {       // In your download
   private int ID;
   protected double mass;
   protected double maxSpeed;
   protected String name;
   private static int nextID= 1;

   public Vehicle(double mass, double maxSpeed, String name) {
        ID++;
        this.mass = mass;
        this.maxSpeed = maxSpeed;
        this.name = name;
}
```

- Write abstract getSafetyRating() method
- Write non-abstract getMaxEnergy() method
  - Returns 0.5*mass*maxSpeed^2; used to design brakes
- Write final method getID() that returns ID

Exercise, p.2

- **Write a concrete Jeep class**
  - Extends Vehicle
  - Has additional private variable: double maxGrade (0-1.0)
  - Write constructor
  - Write getSafetyRating() method
    - Returns max((100- 100*maxGrade – 0.5*maxSpeed), 0)
    - Must have same signature as base class (omit `abstract`)
    - What happens if you don't write one?
  - Write getMaxEnergy() method
    - Return 0.5*mass*maxSpeed^2 + 9.8*mass*maxGrade*100
      - This reflects jeep use on steep grades
    - You are overriding the superclass method that Jeep inherits from Vehicle
    - You may call super.getMaxEnergy() but it is not mandatory
    - What happens if you don't write one?
  - Try to write a getID() method
    - What happens?

Exercise, p.3

- Write a class VehicleTest with main() that:
  - Tries to create a Vehicle object
    - What happens? Comment it out if it doesn't work.
  - Creates a Jeep object
    - Mass 2000 kg, maxSpeed 30 m/sec, max grade 0.2, "jeep"
  - Prints its safety rating
  - Prints its max energy
  - Prints its ID

Fun with animals

```
public class Bird {
  public void fly();          // Birds can fly
   // Method body omitted
  };
```

Fun with animals

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public class Ostrich extends Bird {  // Ostriches are birds
   // Class body omitted
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Fun with animals

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public class Bird {
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public class Ostrich extends Bird {  // Ostriches are birds
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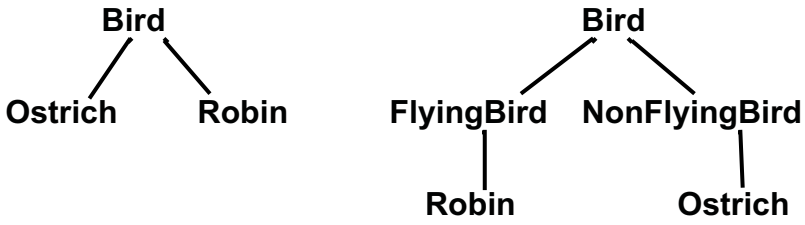
//  Problems:
//  If superclass method fly() is final, Ostriches must fly

//  If superclass method fly() is abstract or non-abstract,
//  Ostrich's fly() can print an error, etc. It's clumsy

//  With inheritance, every subclass has every method and
//  data field in the superclass. You can never drop
//  anything. This is a design challenge in real systems.
```

Possible solutions

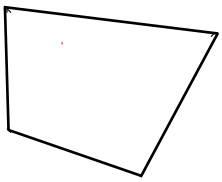


Decision depends on use of system:

If you're studying feet, difference between flying and not flying may not matter

More issues

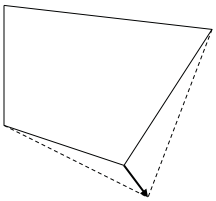
Quadrilateral



Rectangle

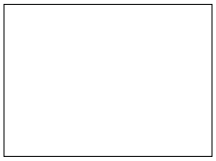
More issues

Quadrilateral



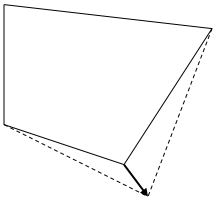
moveCorner()

Rectangle



More issues

Quadrilateral



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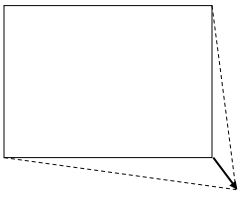

moveCorner()

More issues

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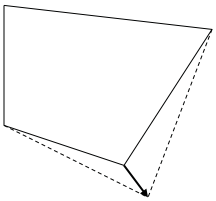

moveCorner()

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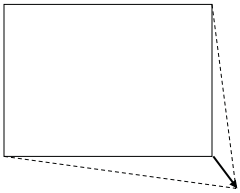

moveCorner()

Must override the moveCorner() method in subclasses to move multiple corners to preserve the correct shape

1.00 / 1.001 / 1.002 Introduction to Computers and Engineering Problem Solving
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