CS1004: Intro to CS in Java, Spring 2005

Lecture #24: OO Design, cont'd.

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Administrivia

- 4 classes left (including today)… yikes!
- HW#5 due now
  - We'll start putting up HW#4 and HW#5 solutions by the end of the week
- HW#6 already out
  - Not more implementation work, but more design and thinking than HW#5
- Final scheduling
  - If you can't make the time due to a scheduling conflict, find me ASAP

Scoping, revisited

- Before I remotivate **`this`** again, let's be clear on Java's *scoping rules*
- A *code block* is *usually* delineated with { and }
  - Includes a class definition, a method definition, an if/else/do/for/while/switch clause
    - If you don't use { and } in if/else/do/for/while, there is a implicit code block, but it's exactly one statement long; switch requires {,}
    - Variables declared in a for clause exist only within the for statement and corresponding code block
  - Can *also* have an arbitrary code block inside a method
  - In general, an entity is *directly* visible within a code block and any nested code blocks, but not in other blocks outside of the block

Scoping and variables

- There are three kinds of variables: static (class) variables, instance variables, and local variables
- Variables exist as long as their code block does
- Instance/static variables
  - A variable *v* can be declared exactly once at the class level
  - You *cannot* have both a static variable and an instance variable with the same name
  - Instance variables garbage collected when the object is garbage collected (and if there are no other references to it)
  - Static variables are *never* garbage collected

Scoping and local variables

- Local variables
  - Defined inside a method
  - *Can* have the same name as a static/instance variable; *shadows* (hides) that static/instance variable by default
  - Cannot be redefined within the same or nested code block, but *can* be redefined in another code block
  - Formal parameters are in the appropriate method code block
  - Garbage collected as soon as the method ends (and if there are no other references to it)

The this Reference

- The **`this`** reference allows a line of code to refer to the object that it's in
  - That is, the **`this`** reference, used inside a method, refers to the object through which the method is being executed
  - *Only* applicable in a "non-static context"
- Useful for two applications:
  - Disambiguating local and instance variables of the same name
  - Handing a reference to an object to another entity within the object itself
- We'll see the second case later

Disambiguation with this

- The **`this`** reference can be used to distinguish the instance variables of a class from corresponding method parameters with the same names

```
public Account (String name, long acctNumber,
                double balance) {
   this.name = name;
   this.acctNumber = acctNumber;
   this.balance = balance;
}
```

Interfaces

- A Java *interface* is a collection of abstract methods and constants
- An *abstract method* is a method header without a method body
- An abstract method can be declared using the modifier `abstract`, but because all methods in an interface are abstract, usually it is left off
- An interface is used to establish a set of methods that a class will implement

Interfaces

interface is a reserved word

None of the methods in an interface are given a definition (body)

```
public interface Doable
{
   public void doThis();
   public int doThat();
   public void doThis2(float value, char ch);
   public boolean doTheOther(int num);
}
```

A semicolon immediately follows each method header

Why interfaces?

- Interfaces are commonly called a *contract* that a class agrees to by implementing the interface
- You'd do this for one of several reasons:
  - You want your buddy to implement part of the assignment, and want to tell him what to name his methods, variables, return types, etc. *(Useful in design, but not for this class!)*
  - You want to write an algorithm/program that can easily work with many different objects that all need to have some common functionality
    - For our Blackjack design yesterday, we might make a *Player interface* with two *implementations:* a user player and a computer player

Interfaces

- An interface cannot be instantiated
- Methods in an interface have public visibility by default
- A class formally implements an interface by:
  - stating so in the class header
  - providing implementations for each abstract method in the interface
- If a class asserts that it implements an interface, it must define all methods in the interface

Interfaces

```
public class CanDo implements Doable
{
   public void doThis ()
   {
      // whatever
   }

   public void doThat ()
   {
      // whatever
   }

   // etc.
}
```

implements is a reserved word

Each method listed in Doable is given a definition

Interfaces

- A class that implements an interface can implement other methods as well
- In addition to (or instead of) abstract methods, an interface can contain constants
  - (Remember that constants are declared via `public static int` or something similar)
- When a class implements an interface, it gains access to all its constants
- A class can also implement multiple interfaces; separate them with a comma

Interfaces

- The Java standard class library contains many helpful interfaces
- The `Comparable` interface contains one abstract method called `compareTo`, which is used to compare two objects
  - We discussed the `compareTo` method of the `String` class; since it's there, `String` can *implement* `Comparable`
- What's the use of implementing `Comparable`?

Easy way to sort an array in Java

- There's a static method in the `Arrays` class (in java.util) called `sort`
  - It can sort primitives: ints, doubles, floats, etc.
- For objects, it can sort them if they implement Comparable
  - In other words, it can *sort any object as long as it implements the Comparable interface*
  - Fundamental idea: Java's sort code doesn't care what your object is, as long as it knows it can compare two of them at a time
- Let's do a quick example, but note, you **can't** use this for HW5

The Iterator Interface

- Recall that an iterator is an object that provides a means of processing a collection of objects one at a time
- An iterator is created formally by implementing the `Iterator` interface, which contains three methods: hasNext, next, and remove
- By having a class implement the Iterator interface, you can use the "compact" version of the for loop
- We'll discuss this further when we talk about ArrayLists in a few weeks

Enumerated Types

- Earlier, we introduced *enumerated types*, which define a new data type and list all possible values of that type
- enums actually define a special class with those values as constants
  - You can set up special constructors and methods
- We could have used enums for Rock-Paper-Scissors

Enumerated Types

- Every enumerated type contains a static method called `values` that returns a list of all possible values for that type
- The list returned from `values` is an iterator, so a `for` loop can be used to process them easily
- A carefully designed enumerated type provides a versatile and type-safe mechanism for managing data

Method Design

- L/L chapter 6 talks about algorithm design/decomposition
- Mostly overlap with what we've gone over, but there are some Java-specific aspects
- Pig Latin example: "read-only"

Method Decomposition

- A method should be relatively small, so that it can be understood as a single entity
- A potentially large method should be decomposed into several smaller methods as needed for clarity
- A public *service method* of an object may call one or more private *support methods* to help it accomplish its goal
- Support methods might call other support methods if appropriate

Parameter Passing

- Another important issue related to method design involves parameter passing
- Parameters in a Java method are *passed by value*
- A *copy* of the actual parameter (the value passed in) is stored into the formal parameter (in the method header)
- Therefore passing parameters is similar to an assignment statement
- A quick example…

Passing Objects to Methods

- When an object is passed to a method, the actual parameter and the formal parameter become aliases of each other, because a copy of the *reference* is made
- What a method does with a parameter may or may not have a permanent effect (outside the method)
- Note the difference between changing the internal state of an object versus changing which object a reference points to

Method Overloading

- *Method overloading* is the process of giving a single method name multiple definitions
- If a method is overloaded, the method name is not sufficient to determine which method is being called
- The *signature* of each overloaded method must be unique
- The signature includes the number, type, and order of the parameters

Method Overloading

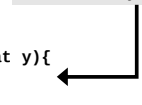
- The compiler determines which method is being invoked by analyzing the parameters

```
float tryMe(int x){
   return x + .375;
}

float tryMe(int x, float y){
   return x*y;
}
```

Invocation

```
result = tryMe(25, 4.32)
```



Method Overloading

- The `println` method is overloaded:

```
println (String s)
println (int i)
println (double d)
```

  and so on...
- The following lines invoke different versions of the `println` method:

```
System.out.println ("The total is:");
System.out.println (total);
```

Overloading Methods

- The return type of the method is not part of the signature
- That is, overloaded methods cannot differ only by their return type
- Constructors can *also* be overloaded
- Overloaded constructors provide multiple ways to initialize a new object

The ArrayList Class

- Arrays not the only way to store data
- The `ArrayList` class is part of the `java.util` package
- Nifty feature: it's auto-resizing
- Like an array, it can store a list of values and reference each one using a numeric index
- However, you cannot use the bracket syntax with an `ArrayList`: it's an *object*
- Furthermore, an `ArrayList` object grows and shrinks as needed, adjusting its capacity as necessary

The ArrayList Class

- Elements can be inserted or removed with a single method invocation
- When an element is inserted, the other elements "move aside" to make room
- Likewise, when an element is removed, the list "collapses" to close the gap
- The indexes of the elements adjust accordingly
- By default, an `ArrayList` stores references to the `Object` class, which allows it to store any kind of object, but is a pain to use

ArrayLists of one type

- We can define an `ArrayList` object to accept only a particular type of object, like an Array
- The following declaration creates an `ArrayList` object that only stores `Family` objects

```
ArrayList<Family> reunion = new ArrayList<Family>();
```

- Example of *generics*; general discussion out of the scope of this class
- If you want to store `int`s, create an `ArrayList` of `Integer`s; as we saw earlier, Java 1.5 is smart enough to auto-convert the two

ArrayList Efficiency

- The `ArrayList` class is implemented using an underlying array
- The array is manipulated so that *indexes remain continuous* as elements are added or removed
- The `size()` method returns the number of actual objects in the ArrayList, and the code *prevents you* from accessing empty cells
- If elements are added to and removed from the end of the list, this processing is fairly efficient
- If elements are inserted and removed from the front or middle of the list, the remaining elements are shifted

Next time

- Finish Java!
- Finish some theory topics