Interfaces

November 6, 2006

ComS 207: Programming I (in Java)
Iowa State University, FALL 2006
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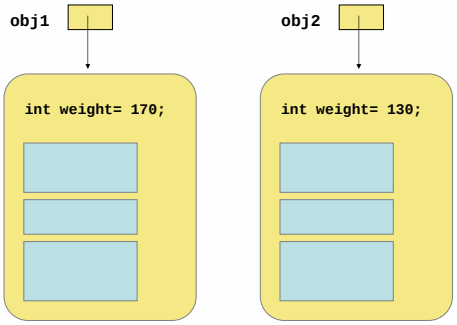
Quick Review of Last Lecture

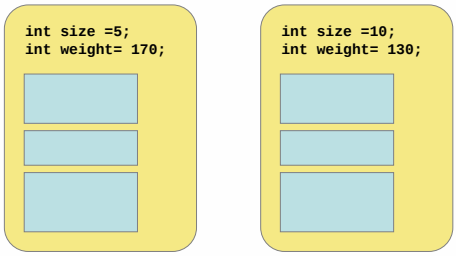
Objects – instances of a class with a static variable 'size'



static int size;

Objects – instances of classes

- Note that the variables can have different values in the two objects



Static Class Members

- The order of the modifiers can be interchanged, but by convention visibility modifiers come first
- Recall that the `main` method is static – it is invoked by the Java interpreter without creating an object
- Static methods cannot reference instance variables because instance variables don't exist until an object exists
- However, a static method can reference static variables or local variables

Static Class Members

- Recall that a static method is one that can be invoked through its class name
- For example, the methods of the `Math` class are static:

```
result = Math.sqrt(25);
```

- Variables can be static as well
- Determining if a method or variable should be static is an important design decision

Static Methods

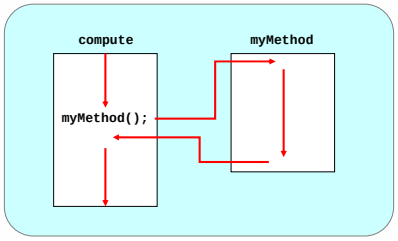
```
class Helper
{
   public static int cube (int num)
   {
      return num * num * num;
   }
}
```

Because it is declared as static, the method can be invoked as

```
value = Helper.cube(5);
```

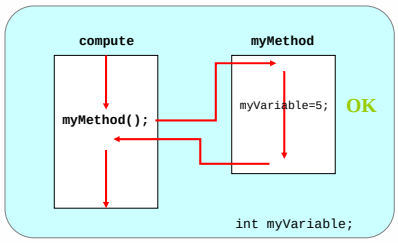

Method Control Flow

- If the called method is in the same class, only the method name is needed



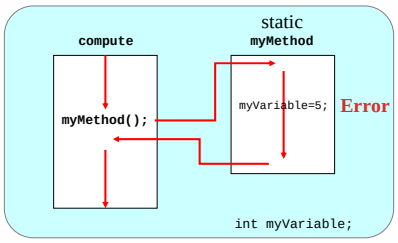
Accessing Variables

- If the called method is in the same class, only the method name is needed



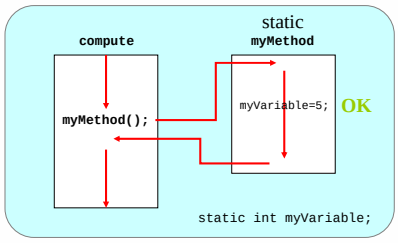
Accessing Variables

- Static methods cannot use non static class variables.



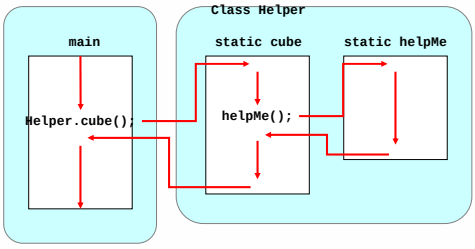
Accessing Variables

- Static methods can use static class varables



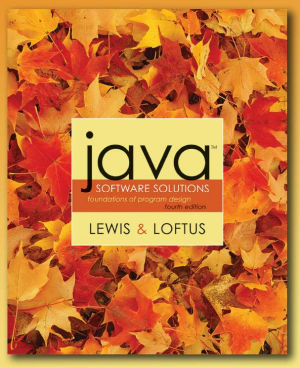
Method Control Flow

- Static methods can only call other static methods within the same classs



Chapter 6

Section 6.4



Class Relationships

- Classes in a software system can have various types of relationships to each other
- Three of the most common relationships:
  - Dependency: A *uses* B
  - Aggregation: A *has-a* B
  - Inheritance: A *is-a* B

Dependency

- A *dependency* exists when one class relies on another in some way, usually by invoking the methods of the other
- We've seen dependencies in many previous examples
- We don't want numerous or complex dependencies among classes
- Nor do we want complex classes that don't depend on others
- A good design strikes the right balance

Dependency Example: Client-Server

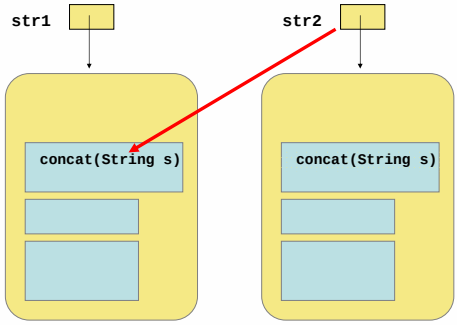
Dependency

- Some dependencies occur between objects of the same class
- A method of the class may accept an object of the same class as a parameter
- For example, the `concat` method of the `String` class takes as a parameter another `String` object

```
str3 = str1.concat(str2);
```

- This drives home the idea that the service is being requested from a particular object

Concatenation Example



Dependency

- The following example defines a class called `Rational` to represent a rational number
- A rational number is a value that can be represented as the ratio of two integers
- Some methods of the `Rational` class accept another `Rational` object as a parameter
- See RationalTester.java (page 297)
- See Rational.java (page 299)

Representing Rational Numbers

- public class RationalNumber
  {
  private int numerator, denominator;
  // …
- }

Adding Two rational numbers

```
public RationalNumber add (RationalNumber op2)
{
  int commonDenominator = denominator *op2.getDenominator();

  int numerator1 = numerator * op2.getDenominator();

  int numerator2 = op2.getNumerator() * denominator;

  int sum = numerator1 + numerator2;

  return new RationalNumber (sum, commonDenominator);
}
```


Aggregation

- An *aggregate* is an object that is made up of other objects
- Therefore aggregation is a *has-a* relationship
  - A car *has a* chassis
  - A student has an address

Aggregation

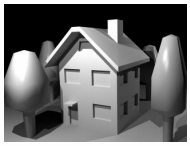
- In software, an aggregate object contains references to other objects as instance data
- The aggregate object is defined in part by the objects that make it up
- This is a special kind of dependency – the aggregate usually relies on the objects that compose it

Aggregation Example: Copmonents of a Student

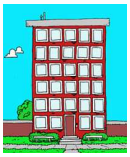
Student

First Name

Last Name



Home Address



School Address

john

John

Smith

21 Jump Street

800 Lancaster Ave.

marsha

Marsha

Jones

123 Main Street

800 Lancaster Ave.

Aggregation

- **In the following example, a `Student` object is composed, in part, of `Address` objects**
- **A student has an address (in fact each student has two addresses)**
- **See StudentBody.java (page 304)**
- **See Student.java (page 306)**
- **See Address.java (page 307)**
- **An aggregation association is shown in a UML class diagram using an open diamond at the aggregate end**

Other Stuff from Section 6.4

A More Complicated Student Example

Name

University

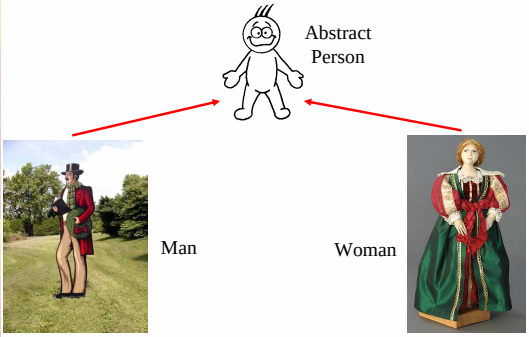
Degree Program

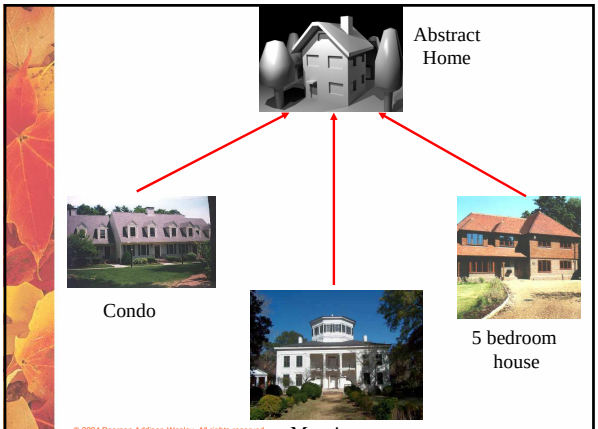
Home Address

School Address

How would you write the code for the more complicated student example?

Inheritance is discussed in Chapter 8





The this Reference

- The `this` reference allows an object to refer to itself
- That is, the `this` reference, used inside a method, refers to the object through which the method is being executed
- Suppose the `this` reference is used in a method called `tryMe`, which is invoked as follows:

```
obj1.tryMe();
obj2.tryMe();
```

- In the first invocation, the `this` reference refers to `obj1`; in the second it refers to `obj2`

The this reference

- The `this` reference can be used to distinguish the instance variables of a class from corresponding method parameters with the same names
- The constructor of the `Account` class (from Chapter 4) could have been written as follows:

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

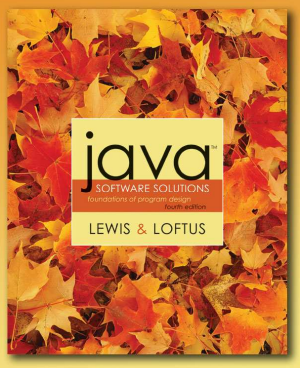

The this reference

```
public Account (Sring owner, long account,
                double initial)
{
   name = owner;
   acctNumber = account;
   balance = initial;
}

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

Chapter 6

Section 6.5 – 6.6



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

A semicolon immediately follows each method header

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
- See Complexity.java (page 310)
- See Question.java (page 311)
- See MiniQuiz.java (page 313)
- In addition to (or instead of) abstract methods, an interface can contain constants
- When a class implements an interface, it gains access to all its constants

Interfaces

- A class can implement multiple interfaces
- The interfaces are listed in the `implements` clause
- The class must implement all methods in all interfaces listed in the header

```
class ManyThings implements interface1, interface2
{
   // all methods of both interfaces
}
```


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 in Chapter 5
- The `String` class implements `Comparable`, giving us the ability to put strings in lexicographic order

Where ca you find the standard Java interfaces

- C:\Program Files\Java\jdk1.5.0\src.zip

The Comparable Interface

- Any class can implement `Comparable` to provide a mechanism for comparing objects of that type

```
if (obj1.compareTo(obj2) < 0)
   System.out.println ("obj1 is less than obj2");
```

- The value returned from `compareTo` should be negative is `obj1` is less that `obj2`, 0 if they are equal, and positive if `obj1` is greater than `obj2`
- When a programmer designs a class that implements the `Comparable` interface, it should follow this intent

The Comparable Interface

- It's up to the programmer to determine what makes one object less than another
- For example, you may define the `compareTo` method of an `Employee` class to order employees by name (alphabetically) or by employee number
- The implementation of the method can be as straightforward or as complex as needed for the situation

The Iterator Interface

- As we discussed in Chapter 5, 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
- The `hasNext` method returns a boolean result – true if there are items left to process
- The `next` method returns the next object in the iteration
- The `remove` method removes the object most recently returned by the `next` method

The Iterator Interface

- By implementing the `Iterator` interface, a class formally establishes that objects of that type are iterators
- The programmer must decide how best to implement the iterator functions
- Once established, the for-each version of the `for` loop can be used to process the items in the iterator

Interfaces

- You could write a class that implements certain methods (such as `compareTo`) without formally implementing the interface (`Comparable`)
- However, formally establishing the relationship between a class and an interface allows Java to deal with an object in certain ways
- Interfaces are a key aspect of object-oriented design in Java
- We discuss this idea further in Chapter 9

Interface Example:

Sortable.java
SortableIntArray.java
SortableStrigArray.java
SortingTest.java

Enumerated Types (read on your own)

Enumerated Types

- In Chapter 3 we introduced enumerated types, which define a new data type and list all possible values of that type

```
enum Season {winter, spring, summer, fall}
```

- Once established, the new type can be used to declare variables

```
Season time;
```

- The only values this variable can be assigned are the ones established in the `enum` definition

Enumerated Types

- An enumerated type definition is a special kind of class
- The values of the enumerated type are objects of that type
- For example, `fall` is an object of type `Season`
- That's why the following assignment is valid

```
time = Season.fall;
```

Enumerated Types

- An enumerated type definition can be more interesting than a simple list of values
- Because they are like classes, we can add additional instance data and methods
- We can define an `enum` constructor as well
- Each value listed for the enumerated type calls the constructor
- See Season.java (page 318)
- See SeasonTester.java (page 319)

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
- An enumerated type cannot be instantiated outside of its own definition
- A carefully designed enumerated type provides a versatile and type-safe mechanism for managing data

THE END