CS1004: Intro to CS in Java, Spring 2005

Lecture #12: Java OO cont'd.

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Agenda

- Continue OO concepts
- We're going to hold off the GUI examples for Chapter 3 and 4 until next week; I'd like to finish the discussion on classes and objects first

The Random Class

- The `Random` class is part of the `java.util` package
- It provides methods that generate pseudorandom numbers
- A `Random` object performs complicated calculations based on a *seed value* to produce a stream of seemingly random values
- Let's try a quick example (more complex one on page 126)

The Math Class

- The `Math` class is part of `java.lang`
- The `Math` class contains methods that perform various mathematical functions, including absolute value, square root, exponentiation, and trigonometric functions
- The methods of the `Math` class are *static methods* (also called *class methods*)
- Static methods can be invoked through the class name itself – no object of the `Math` class is needed

```
value = Math.cos(90) + Math.sqrt(delta);
```

Formatting Output

- As HW#2 demonstrated, Java will use too many decimal places by default
- The Java standard class library contains classes that provide formatting capabilities to customize output
- The `NumberFormat` class allows you to format values as currency or percentages
- The `DecimalFormat` class allows you to format values based on a pattern
- Both are part of the `java.text` package

NumberFormat

- The `NumberFormat` class has static methods that return a formatter object

```
      getCurrencyInstance()
       getPercentInstance()
```

- Each formatter object has a method called `format` that returns a String with the specified information in the appropriate format

DecimalFormat

- The `DecimalFormat` class can be used to format a floating point value in various ways
- For example, you can specify that the number should be truncated to three decimal places
- The constructor of the `DecimalFormat` class takes a string that represents a pattern for the formatted number
- For HW#2, you could have used

```
DecimalFormat df = new
DecimalFormat("0.##")
```

Wrapper Classes

- Sometimes, we'll want to store the primitive objects inside a reference object
- We'll learn how to make our own objects, but Java provides *wrapper classes* for this purpose.
- These wrapper classes also have a number of useful utility methods and attributes that work with the corresponding primitive type
- Simple mnemonic: "capital form" of existing type

Primitive Type	Wrapper Class
`byte`	`Byte`
`short`	`Short`
`int`	`Integer`
`long`	`Long`
`float`	`Float`
`double`	`Double`
`char`	`Character`
`boolean`	`Boolean`
`void`	`Void`

Creating a wrapper class object

- The following declaration creates an `Integer` object which represents the integer 40 as an object

```
 Integer age = new Integer(40);
```

- An object of a wrapper class can be used in any situation where a primitive value will not suffice
- For example, some objects serve as containers of other objects
  - We'll see this later in the semester

Utility methods in wrapper classes

- Wrapper classes also contain static methods that help manage the associated type
- For example, the `Integer` class contains a method to convert an integer stored in a `String` to an `int` value:

```
    num = Integer.parseInt(str);
```

- The wrapper classes often contain useful constants as well
  - `MIN_VALUE` and `MAX_VALUE`, which hold the smallest and largest `int` values

Autoboxing

- Java 1.5 can auto-convert between a value of a primitive type and that of a reference type; this is called *autoboxing*

```
        Integer obj;
        int num = 42;
        obj = num;
```

- The reverse conversion (called *unboxing*) also occurs automatically as needed

Writing our own classes

- The programs we've written in previous examples have used classes defined in the Java standard class library
- Now we will begin to design programs that rely on classes that we write ourselves
- The class that we've written so far contain only one method – main – and that's just the starting point of a program
- True object-oriented programming is based on defining classes that represent objects with well-defined characteristics and functionality
  - Becoming an "expert" takes time

Book's example: Die

- Objects have *state* and *behavior*
- Consider a six-sided die (singular of dice)
  - State: what's the currently rolled value of the die?
  - Behavior: It can be (re-)rolled
- We can represent a die in software by designing a class called `Die` that models this state and behavior
  - The class serves as the blueprint for a die object
- We can then instantiate as many die objects as we need for any particular program

Classes

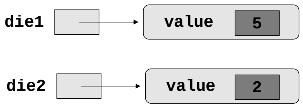
- A class can contain data declarations (state) and method declarations (functionality)
- So far, we haven't used *any* data declarations, and only one method declaration: main
- For our `Die` class, we can declare an int that represents the current value showing on the face
- One of the methods would "roll" the die by setting that value to a random number between one and six

Instance Variables

- We can not only create a variable inside a method, but *outside* it; these are called *instance variables*
- Each object based on a class can have different values in these instance variables
- Goal: for every Die that we create, we want an individual value for the die
- The objects of a class share the method definitions, but each object has its *own* data space

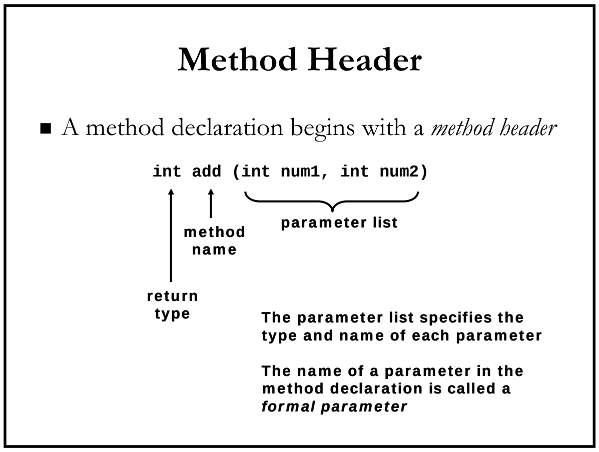
Instance Data

- If we have two `Die` objects in a `DieRoller` class, it might look like the following:



Method Declarations

- A method begins with a *declaration*, followed by code that will be executed when the method is *invoked* (*called*)
- When a method is invoked, the flow of control jumps to the method and executes its code
- When complete, the flow returns to the place where the method was called and continues
- The invocation may or may not *return* a value, depending on how the method is defined
- Think of methods as (complex) mathematical functions



Method Header

- A method declaration begins with a *method header*

```
int add (int num1, int num2)
```

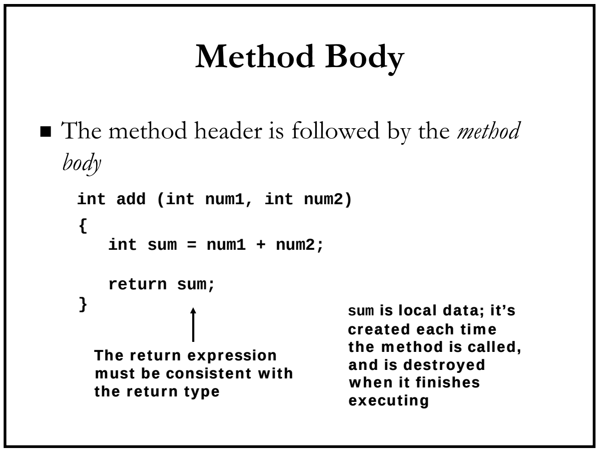
return type

method name

parameter list

The parameter list specifies the type and name of each parameter

The name of a parameter in the method declaration is called a ***formal parameter***



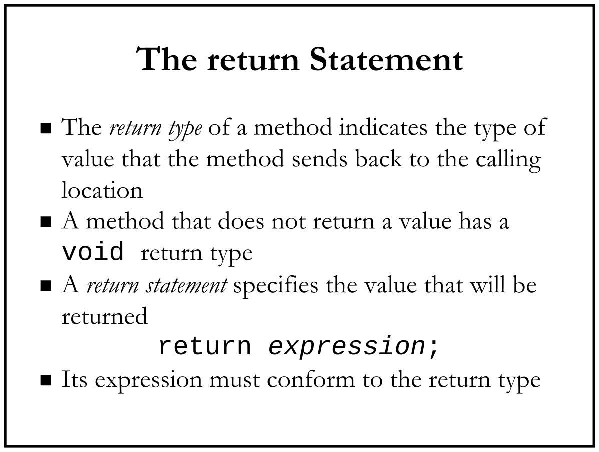
Method Body

- The method header is followed by the *method body*

```
int add (int num1, int num2)
{
   int sum = num1 + num2;

   return sum;
}
```

The return expression must be consistent with the return type

`sum` is local data; it's created each time the method is called, and is destroyed when it finishes executing



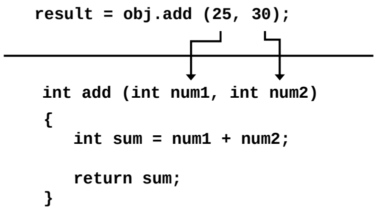
The return Statement

- The *return type* of a method indicates the type of value that the method sends back to the calling location
- A method that does not return a value has a `void` return type
- A *return statement* specifies the value that will be returned

  `return` *`expression`*`;`
- Its expression must conform to the return type

Parameters

- When a method is called, the *actual parameters* in the invocation are copied into the *formal parameters* in the method header



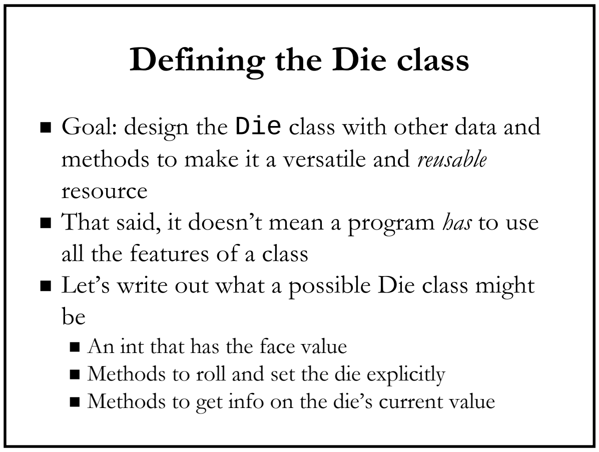
```
result = obj.add (25, 30);

int add (int num1, int num2)
{
   int sum = num1 + num2;

   return sum;
}
```

Local Data

- As we've seen, local variables can be declared inside a method
- The formal parameters of a method create *automatic local variables* when the method is invoked
- When the method finishes, all local variables are destroyed (including the formal parameters)
- Keep in mind that instance variables, declared at the class level, exists as long as the object exists

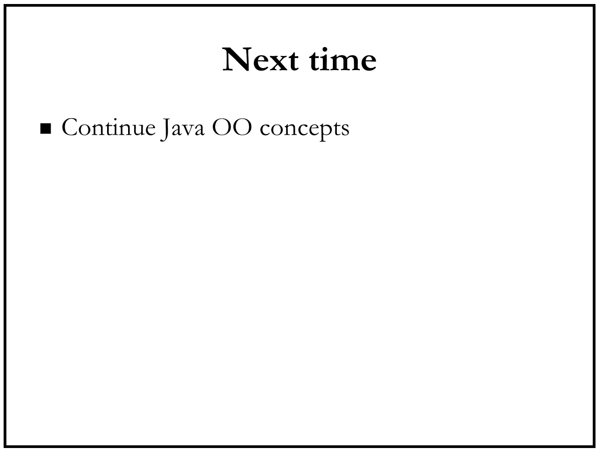
Constructors

- As mentioned previously, a *constructor* is a special method that is used to set up an object when it is initially created from a class
- A constructor has the same name as the class, and **no return type**
  - Major bug alert!
- You can have a constructor set a *default value* or have it take an *initial value* for an object



Defining the Die class

- Goal: design the `Die` class with other data and methods to make it a versatile and *reusable* resource
- That said, it doesn't mean a program *has* to use all the features of a class
- Let's write out what a possible Die class might be
  - An int that has the face value
  - Methods to roll and set the die explicitly
  - Methods to get info on the die's current value



Next time

- Continue Java OO concepts