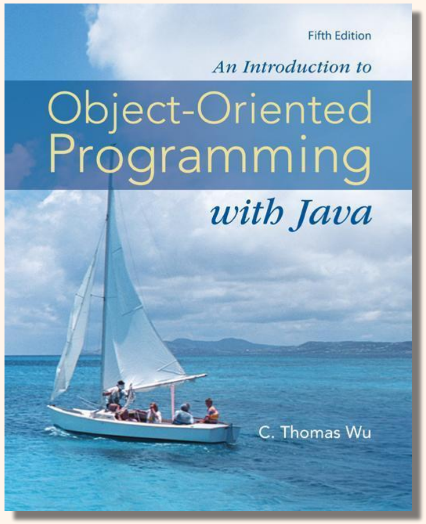


Chapter 7

Defining Your Own Classes

Part 2

Objectives

- After you have read and studied this chapter, you should be able to
  - Describe how objects are returned from methods
  - Describe how the reserved word this is used
  - Define overloaded methods and constructors
  - Define class methods and variables
  - Describe how the arguments are passed to the parameters using the pass-by-value scheme
  - Document classes with javadoc comments
  - Organize classes into a package

Returning an Object from a Method

- As we can return a primitive data value from a method, we can return an object from a method also.
- We return an object from a method, we are actually returning a reference (or an address) of an object.
  - This means we are not returning a copy of an object, but only the reference of this object

Sample Object-Returning Method

- Here's a sample method that returns an object:

```
public Fraction simplify( ) {
    Fraction simp;

    int num   = getNumberator();
    int denom = getDenominator();
    int gcd   = gcd(num, denom);

    simp = new Fraction(num/gcd, denom/gcd);

    return simp;
}
```

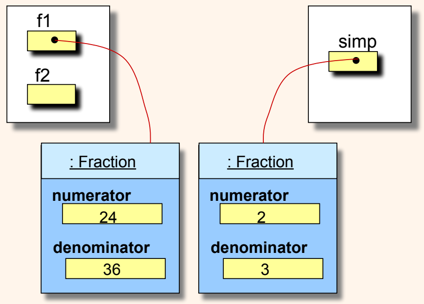
Return type indicates the class of an object we're returning from the method.

Return an instance of the Fraction class

A Sample Call to simplify

```
f1 = new Fraction(24, 26);

f2 = f1.simplify();
```

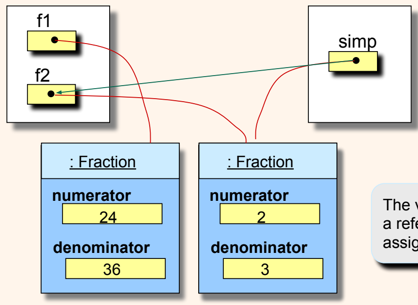
```
public Fraction simplify( ) {
   int num    = getNumerator();
   int denom  = getDenominator();
   int gcd    = gcd(num, denom);
   Fraction simp = new
         Fraction(num/gcd, denom/gcd);
   return simp;
}
```



A Sample Call to simplify (cont'd)

```
f1 = new Fraction(24, 26);

f2 = f1.simplify();
```

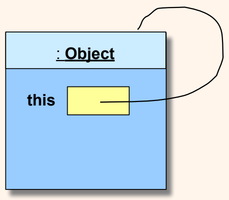
```
public Fraction simplify( ) {
   int num    = getNumerator();
   int denom  = getDenominator();
   int gcd    = gcd(num, denom);
   Fraction simp = new
         Fraction(num/gcd, denom/gcd);
   return simp;
}
```



The value of simp, which is a reference, is returned and assigned to f2.

Reserved Word this

- The reserved word this is called a *self-referencing pointer* because it refers to an object from the object's method.

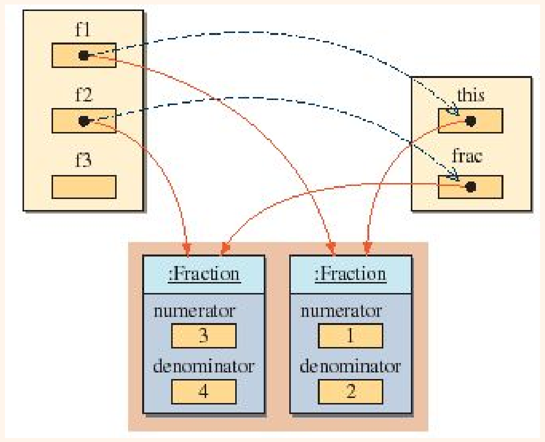


- The reserved word this can be used in three different ways. We will see all three uses in this chapter.

The Use of this in the add Method

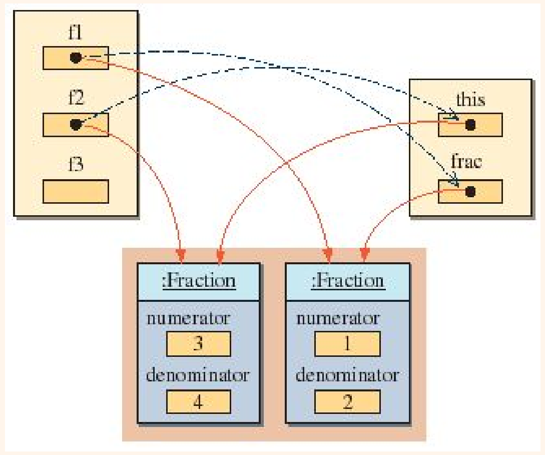
```
public Fraction add(Fraction frac) {

    int       a, b, c, d;
    Fraction sum;

    a = this.getNumerator();    //get the receiving
    b = this.getDenominator(); //object's num and denom

    c = frac.getNumerator();    //get frac's num
    d = frac.getDenominator(); //and denom

    sum = new Fraction(a*d + b*c, b*d);

    return sum;
}
```

f3 = f1.add(f2)



Because f1 is the receiving object (we're calling f1's method), so the reserved word this is referring to f1.

f3 = f2.add(f1)



This time, we're calling f2's method, so the reserved word this is referring to f2.

Using this to Refer to Data Members

- In the previous example, we showed the use of this to call a method of a receiving object.
- It can be used to refer to a data member as well.

```
class Person {

    int  age;

     public void setAge(int val) {
         this.age = val;
    }
    . . .
}
```

Overloaded Methods

- Methods can share the same name as long as
  - they have a different number of parameters (Rule 1) or
  - their parameters are of different data types when the number of parameters is the same (Rule 2)

```
public void myMethod(int x, int y) { ... }
public void myMethod(int x) { ... }
```

✓ Rule 1

```
public void myMethod(double x) { ... }
public void myMethod(int x) { ... }
```

✓ Rule 2

Overloaded Constructor

- The same rules apply for overloaded constructors
  - this is how we can define more than one constructor to a class

```
public Person( ) { ... }
public Person(int age) { ... }
```

✓ Rule 1

```
public Pet(int age) { ... }
public Pet(String name) { ... }
```

✓ Rule 2

Constructors and this

- To call a constructor from another constructor of the same class, we use the reserved word this.

```
public Fraction( ) {
   //creates 0/1
   this(0. 1);
}

public Fraction(int number) {
   //creates number/1
   this(number, 1);
}

public Fraction(Fraction frac) {
   //copy constructor
   this(frac.getNumerator(),
        frac.getDenominator());
}

public Fraction(int num, int denom) {
   setNumerator(num);
   setDenominator(denom);
}
```

Class Methods

- We use the reserved word static to define a class method.

```
public static int gcd(int m, int n) {

   //the code implementing the Euclidean algorithm
}

public static Fraction min(Fraction f1, Fraction f2) {

   //convert to decimals and then compare

}
```

Call-by-Value Parameter Passing

- When a method is called,
  - the value of the argument is passed to the matching parameter, and
  - separate memory space is allocated to store this value.
- This way of passing the value of arguments is called a *pass-by-value* or *call-by-value scheme*.
- Since separate memory space is allocated for each parameter during the execution of the method,
  - the parameter is local to the method, and therefore
  - changes made to the parameter will not affect the value of the corresponding argument.

Call-by-Value Example

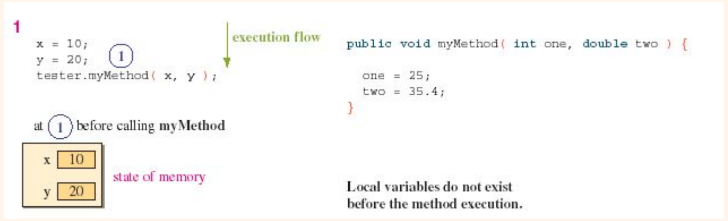
```
class Tester {
    public void myMethod(int one, double two ) {
        one = 25;
        two = 35.4;
    }
}
```

```
Tester tester;
int x, y;
tester = new Tester();
x = 10;
y = 20;
tester.myMethod(x, y);
System.out.println(x + " " + y);
```

produces

```
10 20
```

Memory Allocation for Parameters

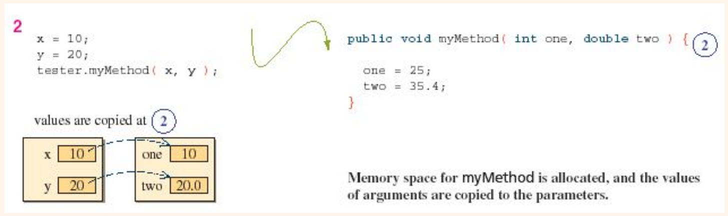


1

```
x = 10;
y = 20;
tester.myMethod( x, y );
```

```
public void myMethod( int one, double two ) {

  one = 25;
  two = 35.4;
}
```

Local variables do not exist before the method execution.



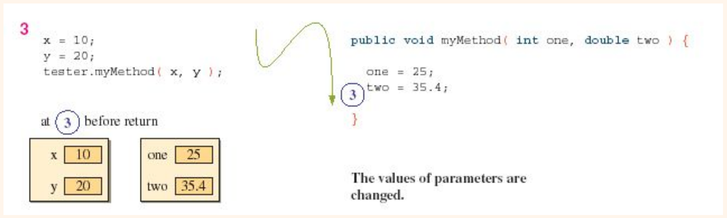
2

```
x = 10;
y = 20;
tester.myMethod( x, y );
```

```
public void myMethod( int one, double two ) {

  one = 25;
  two = 35.4;
}
```

Memory space for myMethod is allocated, and the values of arguments are copied to the parameters.

Memory Allocation for Parameters (cont'd)

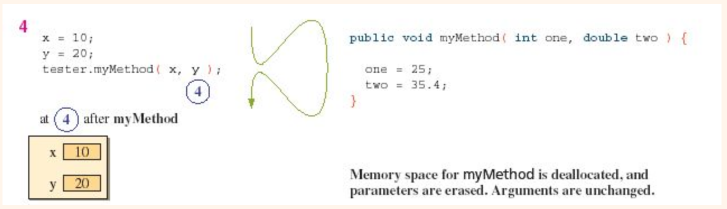


3

```
x = 10;
y = 20;
tester.myMethod( x, y );
```

```
public void myMethod( int one, double two ) {

  one = 25;
  two = 35.4;
}
```

The values of parameters are changed.



4

```
x = 10;
y = 20;
tester.myMethod( x, y );
```

```
public void myMethod( int one, double two ) {

  one = 25;
  two = 35.4;
}
```

Memory space for myMethod is deallocated, and parameters are erased. Arguments are unchanged.

Parameter Passing: Key Points

1. *Arguments are passed to a method by using the pass-by-value scheme.*
2. *Arguments are matched to the parameters from left to right.The data type of an argument must be assignment-compatible with the data type of the matching parameter.*
3. *The number of arguments in the method call must match the number of parameters in the method definition.*
4. *Parameters and arguments do not have to have the same name.*
5. *Local copies, which are distinct from arguments,are created even if the parameters and arguments share the same name.*
6. *Parameters are input to a method, and they are local to the method.Changes made to the parameters will not affect the value of corresponding arguments.*

Organizing Classes into a Package

- For a class A to use class B, their bytecode files must be located in the same directory.
  - This is not practical if we want to reuse programmer-defined classes in many different programs
- The correct way to reuse programmer-defined classes from many different programs is to place reusable classes in a package.
- A *package* is a Java class library.

Creating a Package

- The following steps illustrate the process of creating a package name myutil that includes the Fraction class.

1. Include the statement

```
package myutil;
```

as the first statement of the source file for the Fraction class.

2. The class declaration must include the visibility modifier public as

```
public class Fraction {
    ...
}
```

3. Create a folder named myutil, the same name as the package name. In Java, the package must have a one-to-one correspondence with the folder.

4. Place the modified Fraction class into the myutil folder and compile it.

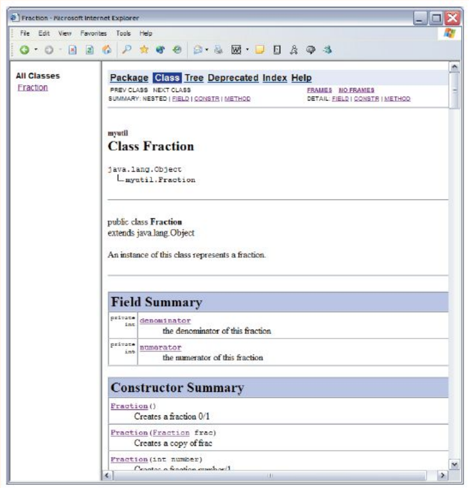
5. Modify the CLASSPATH environment variable to include the folder that contains the myutil folder.

Using Javadoc Comments

- Many of the programmer-defined classes we design are intended to be used by other programmers.
  - It is, therefore, very important to provide meaningful documentation to the client programmers so they can understand how to use our classes correctly.
- By adding javadoc comments to the classes we design, we can provide a consistent style of documenting the classes.
- Once the javadoc comments are added to a class, we can generate HTML files for documentation by using the javadoc command.

javadoc for Fraction

- This is a portion of the HTML documentation for the Fraction class shown in a browser.
- This HTML file is produced by processing the javadoc comments in the source file of the Fraction class.


Fraction - Microsoft Internet Explorer
File Edit View Favorites Tools Help
All Classes
Fraction
Package Class Tree Deprecated Index Help
PREV CLASS NEXT CLASS
SUMMARY: NESTED | FIELD | CONSTR | METHOD
FRAMES NO FRAMES
DETAIL: FIELD | CONSTR | METHOD

myutil
Class Fraction

```
java.lang.Object
  └myutil.Fraction
```

public class **Fraction**
extends java.lang.Object

An instance of this class represents a fraction.

Field Summary

private int	denominator the denominator of this fraction
private int	numerator the numerator of this fraction

Constructor Summary

Fraction() Creates a fraction 0/1
Fraction(Fraction frac) Creates a copy of frac
Fraction(int number)

javadoc Tags

- The javadoc comments begins with /** and ends with */
- Special information such as the authors, parameters, return values, and others are indicated by the @ marker

    @param
    @author
    @return
    etc

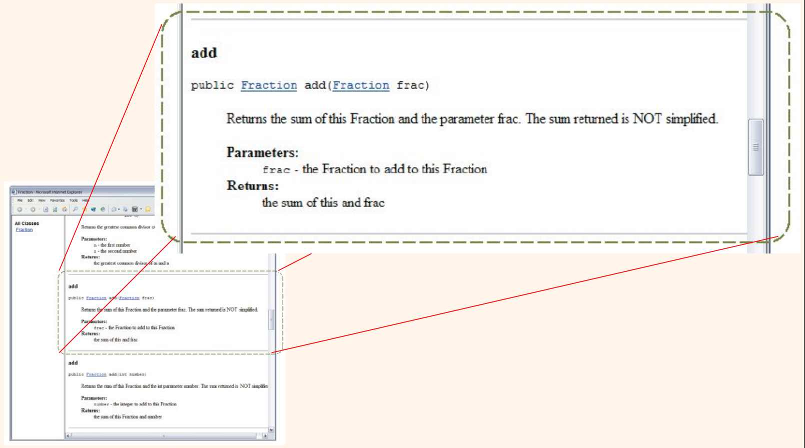
Example: javadoc Source

```
. . .

/**
 * Returns the sum of this Fraction
 * and the parameter frac. The sum
 * returned is NOT simplified.
 *
 * @param frac the Fraction to add to this
 *             Fraction
 *
 * @return the sum of this and frac
 */
public Fraction add(Fraction frac) {
    ...
}
. . .
```

this javadoc

will produce

Example: javadoc Output



add

`public Fraction add(Fraction frac)`

Returns the sum of this Fraction and the parameter frac. The sum returned is NOT simplified.

Parameters:
`frac` - the Fraction to add to this Fraction
Returns:
the sum of this and frac

Fraction - Microsoft Internet Explorer
File Edit View Favorites Tools Help
All Classes
Fraction

Returns the greatest common divisor o

Parameters:
`m` - the first number
`n` - the second number
Returns:
the greatest common divisor of m and n

add

`public Fraction add(Fraction frac)`

Returns the sum of this Fraction and the parameter frac. The sum returned is NOT simplified.

Parameters:
`frac` - the Fraction to add to this Fraction
Returns:
the sum of this and frac

add

`public Fraction add(int number)`

Returns the sum of this Fraction and the int parameter number. The sum returned is NOT simplifie

Parameters:
`number` - the integer to add to this Fraction
Returns:
the sum of this Fraction and number

javadoc Resources

- General information on javadoc is located at

    http://www.oracle.com/technetwork/java/javase/documentation/javadoc-137458.html

- Detailed reference on how to use javadoc on Windows is located at

    http://java.sun.com/j2se/1.5/docs/tooldocs/windows/javadoc.html

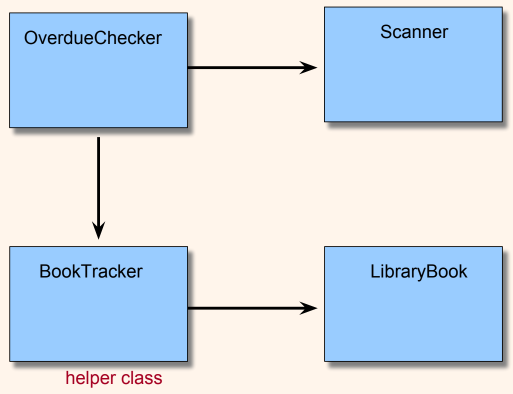
Problem Statement

Write an application that computes the total charges for the overdue library books. For each library book, the user enters the due date and (optionally) the overdue charge per day, the maximum charge, and the title. If the optional values are not entered, then the preset default values are used. A complete list of book information is displayed when the user finishes entering the input data. The user can enter different return dates to compare the overdue charges.

Overall Plan

- Tasks:
  1. Get the information for all books
  2. Display the entered book information
  3. Ask for the return date and display the total charge. Repeat this step until the user quits.

Required Classes



Development Steps

- We will develop this program in five steps:
  1. Define the basic LibraryBook class.
  2. Explore the given BookTracker class and integrate it with the LibraryBook class.
  3. Define the top-level OverdueChecker class. Implement the complete input routines.
  4. Complete the LibraryBook class by fully implementing the overdue charge computation.
  5. Finalize the program by tying up loose ends.

Step 1 Design

- Develop the basic LibraryBook class.
- The key design task is to **identify the data members** for storing **relevant** information.
- We will include **multiple constructors** for ease of creating LibraryBook objects.
  – Make sure that an instance will be initiated correctly no matter which constructor is used.

Step 1 Code

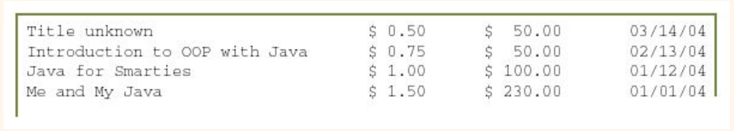
Program source file is too big to list here. From now on, we ask you to view the source files using your Java IDE.

Directory: Chapter7/Step1

Source Files: LibraryBook.java
Step1Main.java (test program)

Step 1 Test

- In the testing phase, we run the test main program Step1Main and confirm that we get the expected output:



```
Title unknown                    $ 0.50      $  50.00      03/14/04
Introduction to OOP with Java    $ 0.75      $  50.00      02/13/04
Java for Smarties                $ 1.00      $ 100.00      01/12/04
Me and My Java                   $ 1.50      $ 230.00      01/01/04
```

Step 2 Design

- Explore the helper BookTracker class and incorporate it into the program.
- Adjust the LibraryBook class to make it compatible with the BookTracker class.

Step 2 Code

Directory: Chapter7/Step2

Source Files: LibraryBook.java
Step2Main.java (test program)

Step 2 Test

- In the testing phase, we run the test main program Step2Main and confirm that we get the expected output.
- We run the program multiple times trying different variations each time.

Step 3 Design

- We implement the top-level control class OverdueChecker.
- The top-level controller manages a single BookTracker object and multiple LibraryBook objects.
- The top-level controller manages the input and output routines
  - If the input and output routines are complex, then we would consider designing separate classes to delegate the I/O tasks.

Step 3 Pseudocode

```
GregorianCalendar returnDate;
String reply, table;
double totalCharge;

inputBooks(); //read in all book information

table = bookTracker.getList();
System.out.println(table);

//try different return dates
do {
    returnDate = read return date ;
    totalCharge = bookTracker.getCharge(returnDate);
    displayTotalCharge(totalCharge);
    reply = prompt the user to continue or not;
} while ( reply is yes );
```

Step 3 Code

Directory: Chapter7/Step3

Source Files: OverdueChecker.java
LibraryBook.java

Step 3 Test

- Now we run the program multiple times, trying different input types and values.
- We confirm that all control loops are implemented and working correctly.
  - At this point, the code to compute the overdue charge is still a stub, so we will always get the same overdue charge for the same number of books.
- After we verify that everything is working as expected,we proceed to the next step.

Step 4: Compute the Charge

- To compute the overdue charge, we need two dates: the due date and the date the books are or to be returned.
- The getTimeInMillis method returns the time elasped since the epoch to the date in milliseconds.
- By subtracting this since-the-epoch milliseconds value of the due date from the same of the return date, we can find the difference between the two.
  - If the difference is negative, then it's not past due, so there's no charge.
  - If the difference is positive, then we convert the milliseconds to the equivalent number of days and multiply it by the per-day charge to compute the total charge.

Step 4 Code

Directory: Chapter7/Step3

Source Files: OverdueChecker.java
LibraryBook.java

Step 4 Test

- We run the program mutiple times again, possibly using the same set of input data.
- We enter different input variations to try out all possible cases for the computeCharge method.
  - Try cases such as the return date and due date are the same, the return date occurs before the due date, the charge is beyond the maximum, and so forth.
- After we verify the program,we move on to the next step.

Step 5: Finalize / Extend

- Program Review
  - Are all the possible cases handled?
  - Are the input routines easy to use?
  - Will it be better if we allow different formats for entering the date information?
- Possible Extensions
  - Warn the user, say, by popping a warning window or ringing an alarm, when the due date is approaching.
  - Provide a special form window to enter data

    (Note: To implement these extensions, we need techniques not covered yet.)