

8.15 Using BigDecimal for Precise Monetary Calculations

In earlier chapters, we demonstrated monetary calculations using values of type `double`. In [Chapter 5](#), we discussed the fact that some `double` values are represented *approximately*. Any application that requires precise floating-point calculations—such as those in financial applications—should instead use class `BigDecimal` (from package `java.math`).¹

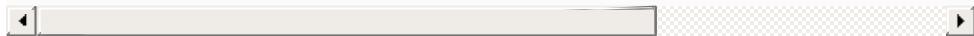
¹. Dealing with currencies, monetary amounts, conversions, rounding and formatting is complex. The new JavaMoney API (<http://javamoney.github.io>) was developed to meet these challenges. At this time, JavaMoney is not part of Java SE or Java EE. [Exercise 8.22](#) asks you to investigate Java-Money and use it to build a currency converter app.

Interest Calculations Using BigDecimal

[Figure 8.16](#) reimplements the interest-calculation example of [Fig. 5.6](#) using objects of class `BigDecimal` to perform the calculations. We also introduce class `NumberFormat` (package `java.text`) for formatting numeric values as *locale-specific Strings*—for example, in the U.S. locale, the value 1234.56, would be formatted as “1,234.56”, whereas

in many European locales it would be formatted as
“1.234, 56”.

```
1 // Fig. 8.16: Interest.java
2 // Compound-interest calculations with BigDecimal
3 import java.math.BigDecimal;
4 import java.text.NumberFormat;
5
6 public class Interest {
7     public static void main(String args[]) {
8         // initial principal amount before interest
9         BigDecimal principal = BigDecimal.valueOf(
10             BigDecimal rate = BigDecimal.valueOf(0.05)
11
12         // display headers
13         System.out.printf("%s%20s%n", "Year", "Amount")
14
15         // calculate amount on deposit for each of
16         for (int year = 1; year <= 10; year++) {
17             // calculate new amount for specified year
18             BigDecimal amount =
19                 principal.multiply(rate.add(BigDecimal
20
21             // display the year and the amount
22             System.out.printf("%4d%20s%n", year,
23                 NumberFormat.getInstance().format(
24                     amount
25                 }
26             }
```



Year	Amount on deposit
1	\$1,050.00
2	\$1,102.50
3	\$1,157.62
4	\$1,215.51
5	\$1,276.28

6	\$1,340.10
7	\$1,407.10
8	\$1,477.46
9	\$1,551.33
10	\$1,628.89

Fig. 8.16

Compound-interest calculations with `BigDecimal`.

Creating `BigDecimal` Objects

Lines 9–10 declare and initialize `BigDecimal` variables `principal` and `rate` using the `Big-Decimal static` method `valueOf` that receives a `double` argument and returns a `BigDecimal` object that represents the *exact* value specified.

Performing the Interest Calculations with `BigDecimal`

Lines 18–19 perform the interest calculation using

`BigDecimal` methods `multiply`, `add` and `pow`. The expression in line 19 evaluates as follows:

1. First, the expression `rate.add(BigDecimal.ONE)` adds 1 to the `rate` to produce a `BigDecimal` containing 1.05—this is equivalent to `1.0 + rate` in line 15 of Fig. 5.6. The `BigDecimal` constant `ONE` represents the value 1. Class `BigDecimal` also provides the commonly used constants `ZERO (0)` and `TEN (10)`.
2. Next, `BigDecimal` method `pow` is called on the preceding result to raise `1.05` to the power `year`—this is equivalent to passing `1.0 + rate` and `year` to method `Math.pow` in line 15 of Fig. 5.6.
3. Finally, we call `BigDecimal` method `multiply` on the `principal` object, passing the preceding result as the argument. This returns a `BigDecimal` representing the amount on deposit at the end of the specified `year`.

Since the expression `rate.add(BigDecimal.ONE)` produces the same value in each iteration of the loop, we could have simply initialized `rate` to `1.05` in line 10 of Fig. 8.16; however, we chose to mimic the precise calculations we used in line 15 of Fig. 5.6.

Formatting Currency Values with NumberFormat

During each iteration of the loop, line 23 of Fig. 8.16

```
NumberFormat.getCurrencyInstance().format(amount)
```



evaluates as follows:

1. First, the expression uses `NumberFormat`'s `static` method `getCurrencyInstance` to get a `NumberFormat` that's preconfigured to format numeric values as locale-specific currency `Strings`—for example, in the U.S. locale, the numeric value 1628.89 is formatted as \$1,628.89. Locale-specific formatting is an important part of **internationalization**—the process of customizing your applications for users' various locales and spoken languages.
2. Next, the expression invokes method `NumberFormat` method `format` (on the object returned by `getCurrencyInstance`) to perform the formatting of the `amount` value. Method `format` then returns the locale-specific `String` representation. For the U.S. locale, the result is rounded to two digits to the right of the decimal point.

Rounding BigDecimal Values

In addition to precise calculations, `BigDecimal` gives you control over rounding—by default all calculations are exact and *no* rounding occurs. If you do not specify how to round `BigDecimal` values and a given value cannot be represented exactly—such as the result of 1 divided by 3, which is 0.333333...—an `ArithmeticException` occurs.

Though we do not do so in this example, you can specify the *rounding mode* for `Big-Decimal` by supplying a `MathContext` object (package `java.math`) to class `BigDecimal`'s constructor when you create a `BigDecimal`. You may also provide a `MathContext` to various `BigDecimal` methods that perform calculations.

Class **MathContext** contains several preconfigured **MathContext** objects that you can learn about at

<http://docs.oracle.com/javase/8/docs/api/java/math/MathContext.html>

By default, each preconfigured **MathContext** uses so-called “banker’s rounding” as explained for the **RoundingMode** constant **HALF_EVEN** at:

<http://docs.oracle.com/javase/8/docs/api/java/math/RoundingMode.html>

Scaling BigDecimal Values

A **BigDecimal**’s scale is the number of digits to the right of its decimal point. If you need a **BigDecimal** rounded to a specific digit, you can call **BigDecimal** method **setScale**. For example, the following expression returns a **BigDecimal** with two digits to the right of the decimal point and using banker’s rounding:

`amount.setScale(2, RoundingMode.HALF_EVEN)`