

```

for (int count = 1; count <= 5; count++){
    g.setColor(ringColor);
    g.fillOval(x, y, width, height);

    //Adjust corner point for next oval
    x = x + thickness;
    y = y + thickness;

    //Adjust width and height for next oval
    width = width - thickness * 2;
    height = height - thickness * 2;

    //Change the color for the next oval
    if (ringColor == Color.red)
        ringColor = Color.white;
    else
        ringColor = Color.red;
}
}
}

```

As you can see, it would be easy to modify the appearance of the bull's-eye by changing the number of ovals drawn, their thickness, and the colors.

## EXERCISE 4.10

1. Write a code segment that uses an I/O dialog box to prompt the user for her name.
2. Write a code segment that displays your name and address in a message box. Your name and address should be formatted on separate lines by using the "\n" character.
3. Explain why we need to use the methods `Integer.parseInt` and `Double.parseDouble` when receiving numeric input from an I/O dialog box.
4. Give an example of a situation where you would want a panel to set its preferred size, rather than allow the size of the main window to determine that.

## Design, Testing, and Debugging Hints

- Most errors involving selection statements and loops are not syntax errors caught at compile time. Thus, you will detect these errors only after running the program, and perhaps then only with extensive testing.
- The presence or absence of the `{}` symbols can seriously affect the logic of a selection statement or loop. For example, the following selection statements have a similar look but a very different logic:

```

if (x > 0){
    y = x;
    z = 1 / x;
}

```

```

if (x > 0)
    y = x;
    z = 1 / x;

```

The first selection statement guards against division by 0; the second statement only guards against assigning *x* to *y*. The next pair of code segments shows a similar problem with a loop:

```

while (x > 0){
    y = x;
    x = x - 1;
}

```

```

while (x > 0)
    y = x;
    x = x - 1;

```

The first loop terminates because the value of *x* decreases within the body of the loop; the second loop is infinite because the value of *x* decreases below the body of the loop.

- When testing programs that use *if* or *if-else* statements, be sure to use test data that forces the program to exercise all of the logical branches.
- Use an *if-else* statement rather than two *if* statements when the alternative courses of action are mutually exclusive.
- When testing a loop, be sure to use limit values as well as typical values. For example, if a loop should terminate when the control variable equals 0, run it with the values 0, -1, and 1.
- Be sure to check entry conditions and exit conditions for each loop.
- For a loop with errors, use debugging output statements to verify the values of the control variable on each pass through the loop. Check this value before the loop is initially entered, after each update, and after the loop is exited.
- Text files are convenient to use when the data set is large, when the same data set must be used repeatedly with different programs, and when these data must be saved permanently.

## SUMMARY

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In this chapter, you learned:

- Java has some useful operators for extended assignment, such as *+=*, and for increment and decrement.
- The *Math* class provides several useful methods, such as *sqrt* and *abs*.
- The *Random* class allows you to generate random integers and floating-point numbers.
- *if* and *if-else* statements are used to make one-way and two-way decisions.
- The comparison operators, such as *==*, *<=*, and *>=*, return Boolean values that serve as conditions of control statements.
- The *while* loop allows the program to run a set of statements repeatedly until a condition becomes false.

- The for loop is a more concise version of the while loop.
- Other control statements, such as an if statement, can be nested within loops. A break statement can be used in conjunction with an if statement to terminate a loop early.
- There are many kinds of logic errors that can occur in loops. Examples are the off-by-one error and the infinite loop.

## VOCABULARY *Review*

Define the following terms:

Control statements

Counter

Count-controlled loop

Entry-controlled loop

Flowchart

Infinite loop

Iteration

Off-by-one error

Overloading

Sentinel

Task-controlled loop

## REVIEW *Questions*

### WRITTEN QUESTIONS

Write a brief answer to the following questions.

1. Assume that the variables  $x$  and  $y$  contain the values 19 and 2, respectively. Indicate if the Boolean expressions below are true, false, or syntactically incorrect.
  - A.  $x \leq y$
  - B.  $x * 2 > y$
  - C.  $x - 1 == y * 9$
  - D.  $x < y < 25$
  - E.  $x * 2 != y$
2. For each of the following items, write a valid Java statement.
  - A. Display "greater" if the value of variable  $x$  is greater than the value of variable  $y$ . Otherwise, display "less" if the value of variable  $x$  is less than the value of variable  $y$ . Otherwise, display "equal."
  - B. Add 10 to the value of  $x$  and display this value if the variable  $y$  is negative.
  - C. Display the string A if  $x$  is greater than 90, B if  $x$  is greater than 80 and less than or equal to 90, or C otherwise.



3. Indicate whether or not each of the following loop headings is syntactically correct. If incorrect, explain why.
- A. `while (x > 0)`
  - B. `while (y = 10)`
  - C. `while x != 0`
4. Write a valid Java statement for each of the following items.
- A. Output the positive numbers from `x` up to `y`.
  - B. Output the product of the squares of the numbers from `x` up to `y`.
  - C. Output the numbers from `y` down to 0.
5. Assume that the variables `x` and `y` contain integers. Write code to perform the following tasks.
- A. Output the largest value, using an `if` statement.
  - B. Output the largest value, using the method `Math.max`.

## PROJECTS

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### PROJECT 4-1

When you first learned to divide, you expressed answers using a quotient and a remainder rather than a fraction or decimal quotient. For example, if you divided 9 by 2, you gave the answer as 4r. 1. Write a program that takes two integers as inputs and displays their quotient and remainder as outputs. Do not assume that the integers are entered in any order, but be sure to divide the larger integer by the smaller integer.

### PROJECT 4-2

Write a program that takes the lengths of three sides of a triangle as inputs. The program should display whether or not the triangle is a right triangle.

### PROJECT 4-3

A 2-minute telephone call to Lexington, Virginia, costs \$1.15. Each additional minute costs \$0.50. Write a program that takes the total length of a call in minutes as input and calculates and displays the cost.

### PROJECT 4-4

Run the Factorial program of Section 4.5 with inputs of 5, 10, and 20. Notice that the number for the last output is large but negative. Place an output statement in the loop so that you can view the value of count and number on each pass. Can you explain what the problem is? Now change the type of product from int to long, recompile the program, and run it again with the same inputs. Explain what happens. How large does the input have to be before you encounter the same problem again?

### PROJECT 4-5

The German mathematician Gottfried Leibniz developed the following method to approximate the value of  $\pi$ :

$$\pi/4 = 1 - 1/3 + 1/5 - 1/7 + \dots$$

Write a program that allows the user to specify the number of iterations used in this approximation and displays the resulting value.

### PROJECT 4-6

A local biologist needs a program to predict population growth. The inputs would be the initial number of organisms, the rate of growth (a real number greater than 0), the number of hours it takes to achieve this rate, and a number of hours during which the population grows. For example, one might start with a population of 500 organisms, a growth rate of 2, and a growth period to achieve this rate of 6 hours. Assuming that none of the organisms die, this would imply that this population would double in size every 6 hours. Thus, after allowing 6 hours for growth, we would have 1000 organisms, and after 12 hours, we would have 2000 organisms. Write a program that takes these inputs and displays a prediction of the total population.

### PROJECT 4-7

Computers use the binary system, which is based on powers of 2. Write a program that displays the positive powers of 2. When the user enters the exponent at a prompt, the program displays 2 to that power. The program halts when the user enters -1.

### PROJECT 4-8

Modify the program of Project 4-7 so that the user can specify the base (2 or higher) as well. The first line of the output should display which base was entered.

### PROJECT 4-9

Modify the program of Project 4-8 so that it processes a file of inputs. Each line of the file contains a base and an exponent. The program should read the data from each line, compute the result, and display each set of inputs and their result on an output line in the terminal window.

**PROJECT 4-10**

Teachers in most school districts are paid on a schedule that provides a salary based on their number of years of teaching experience. For example, a beginning teacher in the Bellingham School District might be paid \$20,000 the first year. For each year of experience after this up to 10 years, a 2 percent increase over the preceding value is received. Write a program that displays a salary schedule for teachers in a school district. The inputs are the starting salary, the percentage increase, and the number of years in the schedule. Each row in the schedule should contain the year number and the salary for that year.

**PROJECT 4-11**

A checkerboard consists of an 8-by-8 grid of black and red squares in which no two squares of the same color are adjacent. Write a graphics program that displays a checkerboard.

**PROJECT 4-12**

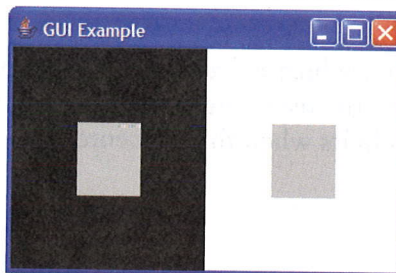
Modify the program of Project 4-11 so that it prompts the user for the number of rows and columns of the board before displaying them. Use I/O dialog boxes to accept the inputs.

**PROJECT 4-13**

An interesting optical illusion is caused by a phenomenon known as *induced contrast*. This illusion occurs when two images of the same shade are placed on backgrounds of sharply contrasting shades, as shown in Figure 4-7. One image appears darker than the other, even though they are exactly the same shade. Write a graphics program that generates such an illusion. (*Hint*: Use two panels that draw the same shape.)

**FIGURE 4-7**

The phenomenon of induced contrast



## CRITICAL *Thinking*

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Do the mathematical analysis needed to show that the Lucky Sevens game is not so lucky for the gambler. (*Hint*: The answer involves comparing the number of possible combinations of all totals and the number of possible combinations of 7.)



# GETTING STARTED WITH JAVA

## REVIEW *Questions*

### TRUE/FALSE

Circle T if the statement is true or F if it is false.

- T F 1. The first generation of programming language is assembly language.
- T F 2. Java is an example of a high-level language.
- T F 3. Mistakes found early in the coding process are much more expensive to fix than mistakes found later in the process.
- T F 4. Byte code is a program that behaves like a computer.
- T F 5. An arithmetic expression consists of operands and binary operators combined, as in algebra.
- T F 6. Programs manipulate objects by sending them methods.
- T F 7. An integer is a positive or negative whole number.
- T F 8. Strings are objects, not primitive data types.
- T F 9. A relational operator is used to compare data items.
- T F 10. Most, but not all, information in a computer is represented in binary form.

### FILL IN THE BLANK

Complete the following sentences by writing the correct word or words in the blanks provided.

- 1. OOP stands for \_\_\_\_\_.
- 2. The software responsible for translating a program in a high-level language to machine code is called a(n) \_\_\_\_\_.
- 3. JVM stands for \_\_\_\_\_.
- 4. When an object receives a message, the object responds by running a block of code called a(n) \_\_\_\_\_.
- 5. Numbers with a fractional part are called \_\_\_\_\_.
- 6. When evaluating an expression, Java performs operations of higher \_\_\_\_\_ first unless overridden by \_\_\_\_\_.

7. Use the \_\_\_\_\_ operator to create a new string out of existing strings.
8. The `while` statement implements a(n) \_\_\_\_\_.
9. A(n) \_\_\_\_\_ error occurs when a loop goes around one too many or one too few times.
10. A(n) \_\_\_\_\_ error occurs when a loop never stops.

### WRITTEN QUESTIONS

Write a brief answer to each of the following questions or problems.

1. What is the purpose of a variable in a program?
2. What are the three types of programming errors? Give a brief example of each.
3. Describe the differences between the data types `double` and `int`.
4. Assume that the variables `x` and `y` contain the values 8 and 4, respectively. What are the values of the expressions listed below?
  - A. `x + y * 2`
  - B. `(x + y) / 3`
  - C. `x - y * 3`
  - D. `x + y * 1.5`
5. Write a valid Java statement that adds 5 to the value of variable `x` if the value of variable `y` is greater than 10.



6. A program has the following loop heading: `while (3 < x < 10)`. Is the heading syntactically correct? If incorrect, explain why.
7. Write a loop that outputs the first 10 positive powers of 2.

## PROJECTS

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### PROJECT 1

The surface area of a cube is the sum of the areas of its faces. Write a program that expects the length of a cube's edge as input and displays its surface area.

### PROJECT 2

Write a program that expects the length and width of a rectangle as inputs. The program should calculate and display the rectangle's area and perimeter.

### PROJECT 3

Top-pick videos rent for \$3.00 per night, whereas oldies rent for \$2.00. Write a program that prompts the user for the number of each type of video to rent and outputs the total cost for that night.

### PROJECT 4

The local bookstore has a markup of 10 percent on each book sold. Write a program that takes the sales price of a book as input and displays the following outputs:

- The markup amount of the book just sold
- The wholesale amount (to go to the publisher) of the book just sold
- The total sales prices of all of the books sold thus far
- The total markup amount of all of the books sold thus far

## CRITICAL *Thinking*

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Modify the program of Project 4 so that it continues to prompt the user for the price of books. The prompts should end when the user enters a negative number for the price. The program should then display the total sales price and total markup of the books sold.



6. A program has the following loop header: `for (i = 1; i <= 10; i++)`. If the loop body contains a `break` statement, explain why the loop will not execute.

7. Write a loop that outputs the first 10 positive powers of 2.

## PROJECTS

### PROJECT 1

The surface area of a cube is the sum of the areas of its faces. Write a program that outputs the length of a cube's edge as input and displays its surface area.

### PROJECT 2

Write a program that accepts the length and width of a rectangle as input. The program should calculate and display the rectangle's area and perimeter.

### PROJECT 3

Top pick videos rent for \$3.00 per night, whereas other videos rent for \$2.00. Write a program that prompts the user for the number of each type of video to rent and outputs the total cost for that night.

### PROJECT 4

The local bookstore has a markup of 10 percent on each book sold. Write a program that takes the sales price of a book as input and displays the following outputs:

- The markup amount of the book just sold.
- The wholesale amount (to give the publisher of the book just sold).
- The total sales price of all of the books sold (to date).
- The total markup amount of all of the books sold (to date).

## CRITICAL THINKING

Modify the program of Project 4 so that it continues to prompt the user for the price of books. The program should end when the user enters a negative number for the price. The program should then display the total sales price and total markup of the books sold.