

Chapter 3 Selections

Liang, Introduction to Java Programming,
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Motivations

If you assigned a negative value for radius in Listing 2.1, ComputeArea.java, the program would print an invalid result. If the radius is negative, you don't want the program to compute the area. How can you deal with this situation?

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The `boolean` Type and Operators

Often in a program you need to compare two values, such as whether `i` is greater than `j`. Java provides six comparison operators (also known as relational operators) that can be used to compare two values. The result of the comparison is a Boolean value: true or false.

```
boolean b = (1 > 2);
```

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Comparison Operators

<i>Operator</i>	<i>Name</i>
<	less than
<=	less than or equal to
>	greater than
>=	greater than or equal to
==	equal to
!=	not equal to

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Problem: A Simple Math Learning Tool

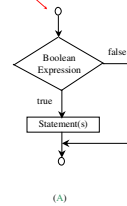
This example creates a program to let a first grader practice additions. The program randomly generates two single-digit integers number1 and number2 and displays a question such as "What is 7 + 9?" to the student. After the student types the answer, the program displays a message to indicate whether the answer is true or false.

[AdditionQuiz](#)
[Run](#)

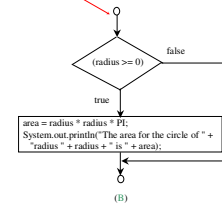
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One-way if Statements

```
if (boolean-expression) {
    statement(s);
}
```



```
if (radius >= 0) {
    area = radius * radius * PI;
    System.out.println("The area"
        + " for the circle of radius "
        + radius + " is " + area);
}
```



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Note

```
if i > 0 {
    System.out.println("i is positive");
}
```

(a) Wrong

```
if (i > 0) {
    System.out.println("i is positive");
}
```

(b) Correct

```
if (i > 0) {
    System.out.println("i is positive");
}
```

(a)

Equivalent

```
if (i > 0)
    System.out.println("i is positive");
```

(b)

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Simple if Demo

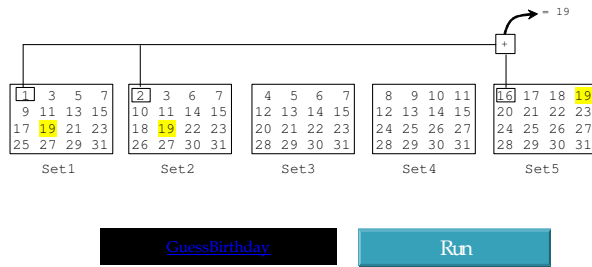
Write a program that prompts the user to enter an integer. If the number is a multiple of 5, print HiFive. If the number is divisible by 2, print HiEven.

[SimpleIfDemo](#)
[Run](#)

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Problem: Guessing Birthday

The program can guess your birth date. Run to see how it works.

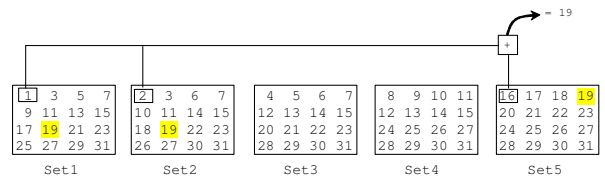


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Mathematics Basis for the Game

19 is 10011 in binary. 7 is 111 in binary. 23 is 11101 in binary

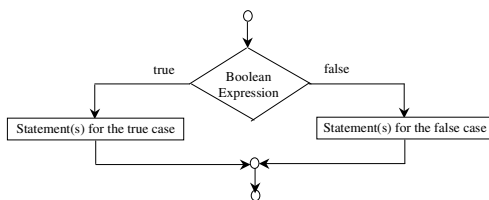
$$\begin{array}{r} 10000 \\ 10 \\ + 1 \\ \hline 10011 \\ 19 \end{array} \quad \begin{array}{r} 00110 \\ 10 \\ + 1 \\ \hline 00111 \\ 7 \end{array} \quad \begin{array}{r} 10000 \\ 1000 \\ 100 \\ + 1 \\ \hline 11101 \\ 23 \end{array}$$



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The Two-way if Statement

```
if (boolean-expression) {
    statement(s)-for-the-true-case;
}
else {
    statement(s)-for-the-false-case;
}
```



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if...else Example

```
if (radius >= 0) {
    area = radius * radius * 3.14159;

    System.out.println("The area for the "
        + "circle of radius " + radius +
        " is " + area);
}
else {
    System.out.println("Negative input");
}
```

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Multiple Alternative if Statements

```
if (score >= 90.0)
    grade = 'A';
else
    if (score >= 80.0)
        grade = 'B';
    else
        if (score >= 70.0)
            grade = 'C';
        else
            if (score >= 60.0)
                grade = 'D';
            else
                grade = 'F';
```

Equivalent

```
if (score >= 90.0)
    grade = 'A';
else if (score >= 80.0)
    grade = 'B';
else if (score >= 70.0)
    grade = 'C';
else if (score >= 60.0)
    grade = 'D';
else
    grade = 'F';
```

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animation

Trace if-else statement

Suppose score is 70.0

The condition is false

```
if (score >= 90.0)
    grade = 'A';
else if (score >= 80.0)
    grade = 'B';
else if (score >= 70.0)
    grade = 'C';
else if (score >= 60.0)
    grade = 'D';
else
    grade = 'F';
```

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animation

Trace if-else statement

Suppose score is 70.0

The condition is false

```
if (score >= 90.0)
    grade = 'A';
else if (score >= 80.0)
    grade = 'B';
else if (score >= 70.0)
    grade = 'C';
else if (score >= 60.0)
    grade = 'D';
else
    grade = 'F';
```

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animation

Trace if-else statement

Suppose score is 70.0

The condition is true

```
if (score >= 90.0)
    grade = 'A';
else if (score >= 80.0)
    grade = 'B';
else if (score >= 70.0)
    grade = 'C';
else if (score >= 60.0)
    grade = 'D';
else
    grade = 'F';
```

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animation

Trace if-else statement

Suppose score is 70.0

grade is C

```

if (score >= 90.0)
    grade = 'A';
else if (score >= 80.0)
    grade = 'B';
else if (score >= 70.0)
    grade = 'C';
else if (score >= 60.0)
    grade = 'D';
else
    grade = 'F';

```

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animation

Trace if-else statement

Suppose score is 70.0

Exit the if statement

```

if (score >= 90.0)
    grade = 'A';
else if (score >= 80.0)
    grade = 'B';
else if (score >= 70.0)
    grade = 'C';
else if (score >= 60.0)
    grade = 'D';
else
    grade = 'F';

```

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Note

The else clause matches the most recent if clause in the same block.

```

int i = 1;
int j = 2;
int k = 3;

if (i > j)
    if (i > k)
        System.out.println("A");
else
    System.out.println("B");

```

(a)

Equivalent

=====

```

int i = 1;
int j = 2;
int k = 3;

if (i > j)
    if (i > k)
        System.out.println("A");
    else
        System.out.println("B");

```

(b)

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Note, cont.

Nothing is printed from the preceding statement. To force the else clause to match the first if clause, you must add a pair of braces:

```

int i = 1;
int j = 2;
int k = 3;
if (i > j) {
    if (i > k)
        System.out.println("A");
}
else
    System.out.println("B");

```

This statement prints B.

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Common Errors

Adding a semicolon at the end of an if clause is a common mistake.

```
if (radius >= 0); Wrong
{
    area = radius*radius*Pi;
    System.out.println(
        "The area for the circle of radius " +
        radius + " is " + area);
}
```

This mistake is hard to find, because it is not a compilation error or a runtime error, it is a logic error.

This error often occurs when you use the next-line block style.

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TIP

```
if (number % 2 == 0)
    even = true;
else
    even = false;
```

(a)

Equivalent

```
boolean even
    = number % 2 == 0;
```

(b)

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CAUTION

```
if (even == true)
    System.out.println(
        "It is even.");
```

(a)

Equivalent

```
if (even)
    System.out.println(
        "It is even.");
```

(b)

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Problem: An Improved Math Learning Tool

This example creates a program to teach a first grade child how to learn subtractions. The program randomly generates two single-digit integers number1 and number2 with number1 > number2 and displays a question such as "What is 9 – 2?" to the student. After the student types the answer in the input dialog box, the program displays a message dialog box to indicate whether the answer is correct.

[SubtractionQuiz](#)

Run

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Problem: Body Mass Index

Body Mass Index (BMI) is a measure of health on weight. It can be calculated by taking your weight in kilograms and dividing by the square of your height in meters. The interpretation of BMI for people 16 years or older is as follows:

BMI	Interpretation
below 16	serious underweight
16-18	underweight
18-24	normal weight
24-29	overweight
29-35	seriously overweight
above 35	gravely overweight

[ComputeBMI](#)


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Logical Operators

Operator	Name
!	not
&&	and
	or
^	exclusive or

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Truth Table for Operator !

p	!p	Example (assume age = 24, gender = 'M')
true	false	!(age > 18) is false, because (age > 18) is true.
false	true	!(gender != 'F') is true, because (gender != 'F') is false.

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Truth Table for Operator &&

p1	p2	p1 && p2	Example (assume age = 24, gender = 'F')
false	false	false	(age > 18) && (gender == 'F') is true, because (age > 18) and (gender == 'F') are both true.
false	true	false	
true	false	false	(age > 18) && (gender != 'F') is false, because (gender != 'F') is false.
true	true	true	

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Truth Table for Operator ||

p1	p2	p1 p2	Example (assume age = 24, gender = 'F')
false	false	false	<code>(age > 34) (gender == 'F')</code> is true, because <code>(gender == 'F')</code> is true.
false	true	true	
true	false	true	<code>(age > 34) (gender == 'M')</code> is false, because <code>(age > 34)</code> and <code>(gender == 'M')</code> are both false.
true	true	true	

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Examples

Here is a program that checks whether a number is divisible by 2 and 3, whether a number is divisible by 2 or 3, and whether a number is divisible by 2 or 3 but not both:

[TestBooleanOperators](#)

Run

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Truth Table for Operator !

p	!p	Example
true	false	<code>!(1 > 2)</code> is true, because <code>(1 > 2)</code> is false.
false	true	<code>!(1 > 0)</code> is false, because <code>(1 > 0)</code> is true.

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Truth Table for Operator &&

p1	p2	p1 && p2	Example
false	false	false	<code>(3 > 2) && (5 >= 5)</code> is true, because <code>(3 > 2)</code> and <code>(5 >= 5)</code> are both true.
false	true	false	
true	false	false	<code>(3 > 2) && (5 > 5)</code> is false, because <code>(5 > 5)</code> is false.
true	true	true	

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Truth Table for Operator ||

p1	p2	p1 p2	Example
false	false	false	(2 > 3) (5 > 5) is false, because (2 > 3) and (5 > 5) are both false.
false	true	true	
true	false	true	(3 > 2) (5 > 5) is true, because (3 > 2) is true.
true	true	true	

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Truth Table for Operator ^

p1	p2	p1 ^ p2	Example (assume age = 24, gender = 'F')
false	false	false	(age > 34) ^ (gender == 'F') is true, because (age > 34) is false but (gender == 'F') is true.
false	true	true	
true	false	true	(age > 34) ^ (gender == 'M') is false, because (age > 34) and (gender == 'M') are both false.
true	true	false	

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Examples

```
System.out.println("Is " + number + " divisible by 2 and 3? " +
    ((number % 2 == 0) && (number % 3 == 0)));
```

```
System.out.println("Is " + number + " divisible by 2 or 3? " +
    ((number % 2 == 0) || (number % 3 == 0)));
```

```
System.out.println("Is " + number +
    " divisible by 2 or 3, but not both? " +
    ((number % 2 == 0) ^ (number % 3 == 0)));
```

[TestBooleanOperators](#)

Run

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[Companion Website](#)

The & and | Operators

Supplement III.B, "The & and | Operators"

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Companion
Website

The & and | Operators

If x is 1, what is x after this expression?

```
(x > 1) & (x++ < 10)
```

If x is 1, what is x after this expression?

```
(1 > x) && (1 > x++)
```

How about `(1 == x) | (10 > x++)?`

```
(1 == x) || (10 > x++)?
```

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Problem: Determining Leap Year?

This program first prompts the user to enter a year as an int value and checks if it is a leap year.

A year is a leap year if it is **divisible by 4** but **not by 100**, or it is **divisible by 400**.

```
(year % 4 == 0 && year % 100 != 0) || (year % 400 == 0)
```

LeapYear

Run

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