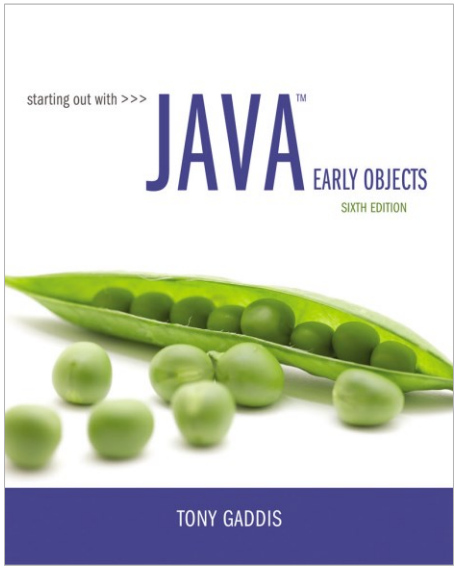
CHAPTER 2

Java Fundamentals



Topics

- The Parts of a Java Program
- The `System.out.print` and `System.out.println` Methods, and the Java API
- Variables and Literals
- Primitive Data Types
- Arithmetic Operators
- Combined Assignment Operators
- Conversion between Primitive Data Types
- Creating named constants with `final`
- The `String` class
- Scope
- Comments
- Programming style
- Reading keyboard input
- Dialog boxes
- The `System.out.printf` method

The Parts of a Java Program

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5     public static void main(String[] args)
6     {
7        System.out.println("Programming is great fun!");
8     }
9  }
```

The output of the program is as follows. This is what appears on the screen when the program runs.

Program Output

```
Programming is great fun!
```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The Parts of a Java Program (cont'd.)

- **To compile the example:**

```
javac Simple.java
```

  - **Notice the `.java` file extension is needed.**
  - **This will result in a file named *`Simple.class`* being created.**

- **To run the example:**

```
java Simple
```

  - **Notice there is no file extension here.**
  - **The *java* command assumes the extension is `.class`.**

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The Parts of a Java Program (cont'd.)

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5     public static void main(String[] args)
6     {
7        System.out.println("Programming is great fun!");
8     }
9  }
```

Comment

- The // in line 1 marks the beginning of a comment.
- The compiler ignores everything from the double slash to the end of the line.
- Comments are not required, but comments are very important because they help explain what is going on in the program.

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The Parts of a Java Program (cont'd.)

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5     public static void main(String[] args)
6     {
7        System.out.println("Programming is great fun!");
8     }
9  }
```

Blank Line

- Line 2 is blank.
- Blank lines are often inserted by the programmer because they can make the program easier to read.

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The Parts of a Java Program (cont'd.)

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5     public static void main(String[] args)
6     {
7        System.out.println("Programming is great fun!");
8     }
9  }
```

Class Header

- Line 3 is known as a *class header*, and it marks the beginning of a *class definition*.
- This line of code tells the compiler that a publicly accessible class named `Simple` is being defined.
- A Java program must have at least one class definition.

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The Parts of a Java Program (cont'd.)

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5
6
7
8
9  }
```

Opening Brace

Class Body

Closing Brace

- Line 4 contains an opening brace, and it is associated with the beginning of the class definition.
- The last line in the program, line 9, contains the closing brace.
- Everything between the two braces is the *body* of the class named `Simple`.

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The Parts of a Java Program (cont'd.)

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5     public static void main(String[] args)
6     {
7        System.out.println("Programming is great fun!");
8     }
9  }
```

Method Header

- Line 5 is known as a *method header*, and it marks the beginning of a *method*.
- The name of the method is `main`, and the rest of the words are required for the method to be properly defined.
  - Every Java application must have a method named `main`.
  - The `main` method is the starting point of the application.

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The Parts of a Java Program (cont'd.)

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5     public static void main(String[] args)
6     {
7
8     }
9  }
```

Opening Brace

Method Body

Closing Brace

- Line 6 contains an opening brace that belongs to the `main` method, and line 8 contains the closing brace.
- Everything between the two braces is the *body* of the `main` method.
- Make sure to have a closing brace for every opening brace in your program.

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The Parts of a Java Program (cont'd.)

Code Listing 2-1 (Simple.java)

```
1  // This is a simple Java program.
2
3  public class Simple
4  {
5     public static void main(String[] args)
6     {
7        System.out.println("Programming is great fun!");
8     }
9  }
```

Statement

- Line 7 contains a statement that displays a message on the screen.
  - The group of characters inside the quotation marks is called a *string literal*.
  - At the end of the line is a semicolon; it marks the end of a statement in Java.
    - Not every line of code ends with a semicolon, however.

The Parts of a Java Program (cont'd.)

- Java is a case-sensitive language.
- All Java programs must be stored in a file with a `.java` file extension.
- Comments are ignored by the compiler.
- A `.java` file may contain many classes but may only have one public class.
- If a `.java` file has a public class, the class must have the same name as the file.
- Java applications must have a `main` method.
- For every left brace, or opening brace, there must be a corresponding right brace, or closing brace.
- Statements are terminated with semicolons, but comments, class headers, method headers, and braces are not.

The Parts of a Java Program (cont'd.)

Table 2-1 Special characters

Characters	Name	Meaning
//	Double slash	Marks the beginning of a comment
( )	Opening and closing parentheses	Used in a method header
{ }	Opening and closing braces	Encloses a group of statements, such as the contents of a class or a method
" "	Quotation marks	Encloses a string of characters, such as a message that is to be printed on the screen
;	Semicolon	Marks the end of a complete programming statement

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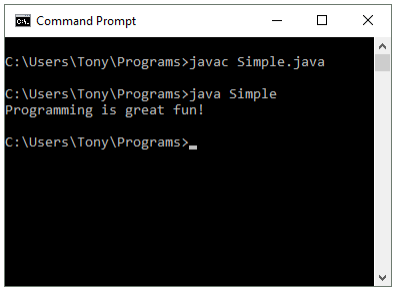
The `System.out.print` and `System.out.println` Methods, and the Java API

- **Many of the programs that you will write will run in a console window.**



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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- The console window that starts a Java application is typically known as the *standard output* device.
- The *standard input* device is typically the keyboard.
- Java sends information to the standard output device by using a Java class stored in the standard Java library.

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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- Java classes in the standard Java library are accessed using the Java Applications Programming Interface (API).
- The standard Java library is commonly referred to as the *Java API*.

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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- The previous example uses the line:

```
System.out.println("Programming is great fun!");
```

- This line uses the `System` class from the standard Java library.
- The `System` class contains methods and objects that perform system level tasks.
- The `out` object, a member of the `System` class, contains the methods `print` and `println`.

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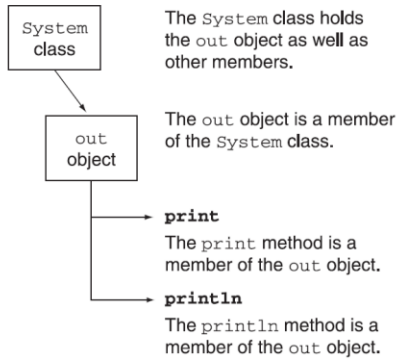
The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

Figure 2-3 Relationship among the `System` class, the `out` object, and the `print` and `println` methods



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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- **The `print` and `println` methods actually perform the task of sending characters to the output device.**
- **The line:**

```
System.out.println("Programming is great fun!");
```

is pronounced: "*system dot out dot print line*"

- **The value inside the parenthesis, called an *argument*, will be sent to the output device (in this case, a string).**

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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- **The `println` method places a newline character at the end of whatever is being printed out.**
  - The following lines:

```
System.out.println("This is being printed out");
System.out.println("on two separate lines.");
```

Would be printed out on separate lines since the first statement sends a newline command to the screen.

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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- **The `print` statement works very similarly to the `println` statement.**
- **However, the `print` statement does not put a newline character at the end of the output.**
- **The lines:**

```
System.out.print("These lines will be");
System.out.print("printed on");
System.out.println("the same line.");
```

  - Produce the following output:

```
These lines will beprinted onthe same line.
```

  - Notice the odd spacing?
  - Why do some words run together?

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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- **For all of the previous examples, we have been printing out strings of characters.**
- **Later, we will see that much more can be printed.**
- **There are some special characters that can be put into the output.**

```
System.out.print("This will have a newline.\n");
```

- **The `\n` in the string is an escape sequence that represents the newline character.**
- **Escape sequences allow the programmer to print characters that otherwise would be unprintable.**

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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

Table 2-2 Common escape sequences

Escape Sequence	Name	Description
`\n`	Newline	Advances the cursor to the next line for subsequent printing
`\t`	Horizontal tab	Causes the cursor to skip over to the next tab stop
`\b`	Backspace	Causes the cursor to back up, or move left, one position
`\r`	Return	Causes the cursor to go to the beginning of the current line, not the next line
`\\`	Backslash	Causes a backslash to be printed
`\'`	Single quote	Causes a single quotation mark to be printed
`\"`	Double quote	Causes a double quotation mark to be printed

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The `System.out.print` and `System.out.println` Methods, and the Java API (cont'd.)

- **Even though the escape sequences are comprised of two characters, they are treated by the compiler as a single character.**

```
System.out.print("These are our top sellers:\n");
System.out.print("\tComputer games\n\tCoffee\n ");
System.out.println("\tAspirin");
```

- **Would result in the following output:**

```
These are our top sellers:
        Computer games
        Coffee
        Asprin
```

Tabs.java, TabsIssue.java

- **With escape sequences, complex text output can be achieved.**

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Variables and Literals

- A *variable* is a named storage location in the computer's memory.
- A *literal* is a value that is written into the code of a program.
- Programmers determine the number and type of variables a program will need.

Variables and Literals (cont'd.)

Code Listing 2-7 (Variable.java)

```
1  // This program has a variable.
2
3  public class Variable
4  {
5     public static void main(String[] args)
6     {
7        int value;
8
9        value = 5;
10       System.out.print("The value is ");
11       System.out.println(value);
12    }
13 }
```

Literals.java,
Variable.java,
VariableBadExample.java

Variable Declaration

- Line 7 contains a variable declaration.
- Variables must be declared before they are used.
- A variable declaration tells the compiler the variable's name and the type of data it will hold.
- This variable's name is `value`, and the word `int` means that it will hold an integer value.

Notice that variable declarations end with a semicolon.

Variables and Literals (cont'd.)

Code Listing 2-7 (Variable.java)

```
1  // This program has a variable.
2
3  public class Variable
4  {
5     public static void main(String[] args)
6     {
7        int value;
8
9        value = 5;
10       System.out.print("The value is ");
11       System.out.println(value);
12    }
13 }
```

Assignment Statement

- **Line 9 contains an assignment statement.**
- **The equal sign is an operator that stores the value on its right (in this case 5) into the variable named on its left.**
- **After this line executes, the value variable will contain the value 5.**

Line 9 *doesn't print anything. It runs silently behind the scenes.*

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Variables and Literals (cont'd.)

Code Listing 2-7 (Variable.java)

```
1  // This program has a variable.
2
3  public class Variable
4  {
5     public static void main(String[] args)
6     {
7        int value;
8
9        value = 5;
10       System.out.print("The value is ");
11       System.out.println(value);
12    }
13 }
```

Display String Literal
Display Variable's Contents

- **Line 10 sends the string literal `"The value is "` to the `print` method.**
- **Line 11 send the name of the `value` variable to the `println` method.**
- **When you send a variable name to `print` or `println`, the variable's contents are displayed.**

Notice there are no quotation marks around the variable `value`.

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Variables and Literals (cont'd.)

Code Listing 2-7 (Variable.java)

```
1  // This program has a variable.
2
3  public class Variable
4  {
5     public static void main(String[] args)
6     {
7        int value;
8
9        value = 5;
10       System.out.print("The value is ");
11       System.out.println(value);
12    }
13 }
```

Program Output

```
The value is 5
```


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Displaying Multiple Items with the + Operator

- **The + operator can be used in two ways.** Variable2.java
  - as a concatenation operator
  - as an addition operator
- **If either side of the + operator is a string, the result will be a string.**

```
System.out.println("Hello " + "World");
System.out.println("The value is: " + 5);
System.out.println("The value is: " + value);
System.out.println("The value is: " + '/n' + 5);
```


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String Concatenation

- **Java commands that have string literals must be treated with care.**
- **A string literal value cannot span lines in a Java source code file.**

```
System.out.println("This line is too long and now it
has spanned more than one line, which will cause a
syntax error to be generated by the compiler. ");
```


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String Concatenation (cont'd.)

- **The String concatenation operator can be used to fix this problem.**

```
System.out.println("These lines are " +
                   "now ok and will not " +
                   "cause the error as before.");
```

- **String concatenation can join various data types.**

```
System.out.println("We can join a string to " +
                   "a number like this: " + 5);
```


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String Concatenation (cont'd.)

- **The Concatenation operator can be used to format complex String objects.**

```
System.out.println("The following will be printed " +
                   "in a tabbed format: " +
                   "\n\tFirst = " + 5 * 6 + ", " +
                   "\n\tSecond = " + (6 + 4) + "," +
                   "\n\tThird = " + 16.7 + ".");
```

- **Notice that if an addition operation is also needed, it must be put in parenthesis.**

StringCat.java

Identifiers

- **Identifiers are programmer-defined names for:**
  - classes
  - variables
  - methods
- **Identifiers may not be any of the Java reserved key words.**

Identifiers (cont'd.)

- **Identifiers must follow certain rules:**
  - An identifier may only contain:
    - letters **a**–**z** or **A**–**Z**,
    - the digits **0**–**9**,
    - underscores (**_**), or
    - the dollar sign (**$**)
  - The first character may not be a digit.
  - Identifiers are case sensitive.
    - **itemsOrdered** is not the same as **itemsordered**.
  - Identifiers cannot include spaces.

Variable and Class Names

- **Variable names should begin with a lower case letter and then capitalize the first letter of each word thereafter:**

  Ex: `int caTaxRate`
- **Class names should begin with a capital letter and each word thereafter should be capitalized.**

  Ex: `public class BigLittle`
- **This helps differentiate the names of variables from the names of classes.**

Primitive Data Types

- **Primitive data types are built into the Java language and are not derived from classes.**
- **There are 8 Java primitive data types.**
  - `byte`
  - `short`
  - `int`
  - `long`
  - `float`
  - `double`
  - `boolean`
  - `char`

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Numeric Data Types

Table 2-5 Primitive data types for numeric data

Data Type	Size	Range
`byte`	1 byte	Integers in the range of −128 to +127
`short`	2 bytes	Integers in the range of −32,768 to +32,767
`int`	4 bytes	Integers in the range of −2,147,483,648 to +2,147,483,647
`long`	8 bytes	Integers in the range of −9,223,372,036,854,775,808 to +9,223,372,036,854,775,807
`float`	4 bytes	Floating-point numbers in the range of $\pm 3.4 \times 10^{-38}$ to $\pm 3.4 \times 10^{38}$, with 7 digits of accuracy
`double`	8 bytes	Floating-point numbers in the range of $\pm 1.7 \times 10^{-308}$ to $\pm 1.7 \times 10^{308}$, with 15 digits of accuracy

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Variable Declarations

- **Variable Declarations take the following form:**
  - *DataType VariableName;*

```
byte inches;
short month;
int speed;
long timeStamp;
float salesCommission;
double distance;
```


Integer Data Types

IntegerVariables.java

- **`byte`, `short`, `int`, and `long` are all integer data types.**
- **They can hold whole numbers such as 5, 10, 23, 89, etc.**
- **Integer data types cannot hold numbers that have a decimal point in them.**
- **Integers embedded into Java source code are called *integer literals*.**

Floating-Point Data Types

- **Data types that allow fractional values are called *floating-point* numbers.**
  - 1.7 and -45.316 are floating-point numbers.
- **In Java there are two data types that can represent floating-point numbers.**
  - `float`- also called *single precision*
    - (7 decimal points)
  - `double` - also called *double precision*
    - (15 decimal points)

Floating-Point Literals

- **When floating-point numbers are embedded into Java source code they are called *floating-point literals*.**
- **The default data type for floating-point literals is `double`.**
  - 29.75, 1.76, and 31.51 are `double` data types.
- **Java is a *strongly-typed* language**

Floating-Point Literals (cont'd.)

- **Literals cannot contain embedded currency symbols or commas.**

```
grossPay = $1,257.00; // ERROR!
grossPay = 1257.00;   // Correct.
```

- **Floating-point literals can be represented in *scientific notation*.**
  - 47,281.97 == 4.728197 x 10^4.
- **Java uses *E notation* to represent values in scientific notation.**
  - 4.728197X10^4 == 4.728197E4.

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Scientific and E Notation

SunFacts.java

Table 2-6 Floating-point representations

Decimal Notation	Scientific Notation	E Notation
247.91	2.4791×10^2	2.4791E2
0.00072	7.2×10^{-4}	7.2E-4
2,900,000	2.9×10^6	2.9E6

NOTE: The E can be uppercase or lowercase.

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The `boolean` Data Type

- **The Java `boolean` data type can have two possible values.**
  - `true`
  - `false`
- **The value of a `boolean` variable may only be copied into a `boolean` variable.**

TrueFalse.java, TrueFalseRevisited.java

The `char` Data Type

Letters.java

- **The Java `char` data type provides access to single characters.**
- **`char` literals are enclosed in single quote marks.**
  - `'a', 'Z', '\n', '1'`
- **Don't confuse `char` literals with string literals.**
  - `char` literals are enclosed in single quotes.
  - String literals are enclosed in double quotes.

Unicode

- Internally, characters are stored as numbers.
- Character data in Java is stored as Unicode characters.
- The Unicode character set can consist of 65536 (2^{16}) individual characters.
- This means that each character takes up 2 bytes in memory.
- The first 256 characters in the Unicode character set are compatible with the ASCII* character set.

*American Standard Code for Information Interchange

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Unicode (cont'd.)

Figure 2-4 Characters and how they are stored in memory

Letters2.java

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Variable Assignment and Initialization

- **In order to store a value in a variable, an *assignment statement* must be used.**
- **The *assignment operator* is the equal (=) sign.**
- **The operand on the left side of the assignment operator must be a variable name.**
- **The operand on the right side must be either a literal or expression that evaluates to a type that is compatible with the type of the variable.**

UnInitialized.java

Code Listing 2-16 (Initialize.java)

Initialize.java,
Initialize2.java,
InitializeRevisited.java

```
1  // This program shows variable initialization.
2
3  public class Initialize
4  {
5     public static void main(String[] args)
6     {
7        int month = 2, days = 28;
8
9        System.out.println("Month " + month + " has " +
10                          days + " days.");
11    }
12 }
```

Program Output

```
Month 2 has 28 days.
```

Variable Assignment and Initialization (cont'd.)

- Variables can only hold one value at a time.
- Local variables do not receive a default value.
- Local variables must have a valid type in order to be used.

Arithmetic Operators

Contribution.java, Discount.java, Sale.java, Wages.java

Table 2-7 Arithmetic operators

Operator	Meaning	Type	Example
+	Addition	Binary	`total = cost + tax;`
-	Subtraction	Binary	`cost = total - tax;`
*	Multiplication	Binary	`tax = cost * rate;`
/	Division	Binary	`salePrice = original / 2;`
%	Modulus	Binary	`remainder = value % 3;`

Arithmetic Operators (cont'd.)

- The operators are called binary operators because they must have two operands.
- Each operator must have a left and right operand.
- The arithmetic operators work as one would expect.
- It is an error to try to divide any number by zero.
- When working with two integer operands, the division operator requires special attention.

Integer Division

- Division can be tricky.

  In a Java program, what is the value of 1/2?
- You might think the answer is 0.5…
- But, that's wrong.
- The answer is simply 0.
- Integer division will truncate any decimal remainder.

BooksPerMonthBad.java, BooksPerMonthFixed.java, IntDivisionCast.java, IntDivisionIssue.java

Operator Precedence

- **Mathematical expressions can be very complex.**
- **There is a set order in which arithmetic operations will be carried out.**

	Operator	Associativity	Example	Result
Higher Priority	– (unary negation)	right to left	`x = -4 + 3;`	-1
	`* / %`	left to right	`x = -4 + 4 % 3 * 13 + 2;`	11
Lower Priority	`+ -`	left to right	`x = 6 + 3 - 4 + 6 * 3;`	23

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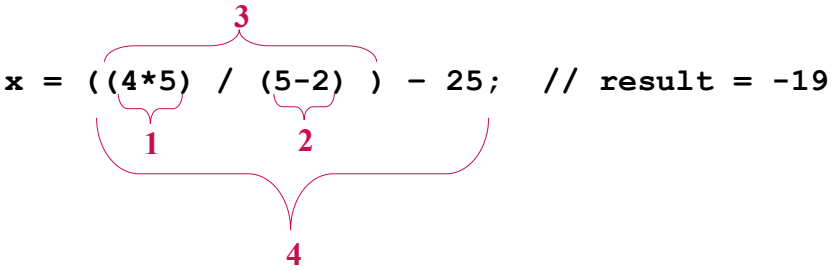
Grouping with Parenthesis

- **When parenthesis are used in an expression, the inner most parenthesis are processed first.**
- **If two sets of parenthesis are at the same level, they are processed left to right.**



IntegerVariablesRevisited.java, SplitCheck.java, SplitCheckBad.java

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The `Math` Class

DemoNoFinal.java

- **The Java API provides a class named `Math`, which contains several methods that are useful for performing complex mathematical operations.**
  - In Java, raising a number to a power requires the `Math.pow` method

```
double result = math.pow(4.0, 2.0);
```

  - The `Math.sqrt` method accepts a `double` value as its argument and returns the square root of the value

```
double result = math.sqrt(9.0);
```


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Combined Assignment Operators

- **Java has some combined assignment operators.**
- **These operators allow the programmer to perform an arithmetic operation and assignment with a single operator.**
- **Although not required, these operators are popular since they shorten simple equations.**

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Combined Assignment Operators (cont'd.)

Table 2-13 Combined assignment operators

Operator	Example Usage	Equivalent to
+=	`x += 5;`	`x = x + 5;`
-=	`y -= 2;`	`y = y - 2;`
*=	`z *= 10;`	`z = z * 10;`
/=	`a /= b;`	`a = a / b;`
%=	`c %= 3;`	`c = c % 3;`

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Conversion between Primitive Data Types

- **Java is a *strongly typed language.***
  - Before a value is assigned to a variable, Java checks the data types of the variable and the value being assigned to it to determine if they are compatible.
  - When you try to assign an incompatible value to a variable, an error occurs at compile-time.

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Conversion between Primitive Data Types (cont'd.)

- **For example, look at the following statements:**

```
int x;
double y = 2.5;
x = y;
```

This statement will cause a compiler error because it is trying to assign a `double` value (2.5) in an `int` variable.

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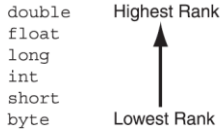
Conversion between Primitive Data Types (cont'd.)

- **The Java primitive data types are ranked, as shown here:**

Figure 2-6 Primitive data type ranking



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Conversion between Primitive Data Types (cont'd.)

- **Widening conversions are allowed.**
  - This is when a value of a lower-ranked data type is assigned to a variable of a higher-ranked data type.
- **Example:**

```
double x;
int y = 10;
x = y;
```

Widening Conversion

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Conversion between Primitive Data Types (cont'd.)

- **Narrowing conversions are *not* allowed.**
  - This is when a value of a higher-ranked data type is assigned to a variable of a lower-ranked data type.
- **Example:**

```
int x;
double y = 2.5;
x = y;
```

Narrowing Conversion

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Conversion between Primitive Data Types (cont'd.)

- **Cast Operators**
  - Let you manually convert a value, even if it means that a narrowing conversion will take place.
- **Example:**

```
int x;
double y = 2.5;
x = (int)y;
```

Cast Operator

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Conversion between Primitive Data Types (cont'd.)

Table 2-14 Example uses of cast operators

Statement	Description
`littleNum = (short)bigNum;`	The cast operator returns the value in `bigNum`, converted to a `short`. The converted value is assigned to the variable `littleNum`.
`x = (long)3.7;`	The cast operator is applied to the expression 3.7. The operator returns the value 3, which is assigned to the variable `x`.
`number = (int)72.567;`	The cast operator is applied to the expression 72.567. The operator returns 72, which is used to initialize the variable `number`.
`value = (float)x;`	The cast operator returns the value in `x`, converted to a `float`. The converted value is assigned to the variable `value`.
`value = (byte)number;`	The cast operator returns the value in `number`, converted to a `byte`. The converted value is assigned to the variable `value`.

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Conversion between Primitive Data Types (cont'd.)

- **Mixed Integer Operations**
  - When values of the `byte` or `short` data types are used in arithmetic expressions, they are temporarily converted to `int` values.
  - The result of an arithmetic operation using only a mixture of `byte`, `short`, or `int` values will always be an `int`.

Conversion between Primitive Data Types (cont'd.)

- **Mixed Integer Operations**
  - For example:

```
short a;
short b = 3;
short c = 7;
a = b + c;
```

This statement will cause an error because the result of `b + c` is an `int`. It cannot be assigned to a `short` variable.

```
a = (short)(b + c);
```

To fix the statement, rewrite the expression using a cast operator.

Conversion between Primitive Data Types (cont'd.)

- **Other Mixed Mathematical Expressions**
  - If one of an operator's operands is a `double`, the value of the other operand will be converted to a `double`.
  - The result of the expression will be a `double`.
  - If one of an operator's operands is a `float`, the value of the other operand will be converted to a `float`.
  - The result of the expression will be a `float`.
  - If one of an operator's operands is a `long`, the value of the other operand will be converted to a `long`.
  - The result of the expression will be a `long`.

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Creating Named Constants with `final`

- **Many programs have data that does not need to be changed.**
- **Littering programs with literal values can make the program hard do read and maintain.**
- **Replacing literal values with constants remedies this problem.**
- **Constants allow the programmer to use a name rather than a value throughout the program.**
- **Constants also give a singular point for changing those values when needed.**

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Creating Named Constants with `final` (cont'd.)

- Constants keep the program organized and easier to maintain.
- Constants are identifiers that can hold only a single value.
- Constants are declared using the keyword `final`.
- Constants need not be initialized when declared; however, they must be initialized before they are used or a compiler error will be generated.

Creating Named Constants with `final` (cont'd.)

- Once initialized with a value, constants cannot be changed programmatically.
- By convention, constants are all upper case and words are separated by the underscore character.
- For example:

```
final double CAL_SALES_TAX = 0.0725;
```

DemoFinal.java

The `String` Class

- Java has no primitive data type that holds a series of characters.
- The `String` class from the Java standard library is used for this purpose.
- In order to be useful, the a variable must be created to reference a `String` object.

```
String number;
```

- Notice the `S` in `String` is upper case.
- By convention, class names should always begin with an upper case character.

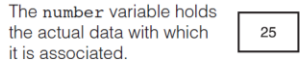
Primitive-Type Variables and Class-Type Variables

- Primitive variables actually contain the value that they have been assigned.

```
number = 25;
```

- The value 25 will be stored in the memory location associated with the variable `number`.

Figure 2-7 A primitive-type variable holds the data with which it is associated



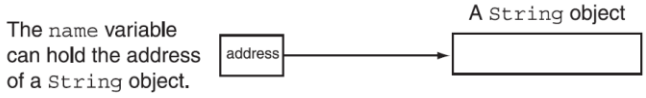
- Objects are not stored in variables, however. Objects are *referenced* by variables.

Primitive-Type Variables and Class-Type Variables (cont'd.)

- When a variable references an object, it contains the memory address of the object's location.
- Then it is said that the variable *references* the object.

```
String name = "Joe Mahoney";
```

Figure 2-8 A `String` class variable can hold the address of a `String` object



StringDemo.java

Creating a `String` Object

- A variable can be assigned a string literal.

```
String value = "Hello";
```

- `String` objects are the only objects that can be created in this way.
- A variable can be created using the ***new*** keyword.

```
String value = new String("Hello");
```

- This is the method that all other objects must use when they are created.

Creating a `String` Object (cont'd.)

- Since `String` is a class, objects that are instances of it have methods.
- One of those methods is the `length` method.

```
stringSize = value.length();
```

- This statement calls the `length` method on the object pointed to by the `value` variable

StringLength.java, StringMethods.java

Creating a `String` Object (cont'd.)

- The `String` class contains many methods that help with the manipulation of `String` objects.
- `String` objects are *immutable*, meaning that they cannot be changed.
- Many of the methods of a `String` object can create new versions of the object.

Scope

Scope.java

- ***Scope*** **refers to the part of a program that has access to a variable's contents.**
- **Variables declared inside a method (like the `main` method) are called *local variables*.**
- **The scope of a local variable begins at the declaration of the variable and ends at the end of the method in which it was declared.**

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Comments

- **Comments are:**
  - notes of explanation that document lines or sections of a program.
  - part of the program, but the compiler ignores them.
  - intended for people who may be reading the source code.
- **In Java, there are three types of comments:**
  - Single-line comments
  - Multiline comments
  - Documentation comments

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Single-Line Comments

Code Listing 2-24 (Comment1.java)

Comment3.java

```
1  // PROGRAM: Comment1.java
2  // Written by Herbert Dorfmann
3  // This program calculates company payroll
4
5  public class Comment1
6  {
7     public static void main(String[] args)
8     {
9        double payRate;       // Holds the hourly pay rate
10       double hours;         // Holds the hours worked
11       int employeeNumber;   // Holds the employee number
12
13       // The remainder of this program is omitted.
14    }
15 }
```

- **Place two forward slashes (//) where you want the comment to begin.**
  - The compiler ignores everything from that point to the end of the line.

Multiline Comments

Code Listing 2-25 (Comment2.java)

```
1  /*
2     PROGRAM: Comment2.java
3     Written by Herbert Dorfmann
4     This program calculates company payroll
5  */
6
7  public class Comment2
8  {
9     public static void main(String[] args)
10    {
11       double payRate;      // Holds the hourly pay rate
12       double hours;        // Holds the hours worked
13       int employeeNumber;  // Holds the employee number
14
15       // The remainder of this program is omitted.
16    }
17 }
```

- **Start with /* (a forward slash followed by an asterisk) and end with */ (an asterisk followed by a forward slash).**
  - **Everything between these markers is ignored.**
  - **Can span multiple lines**

Block Comments

Table 2-16 Block comments

```
/**                                    //**********************************
 *   This program demonstrates the      //    This program demonstrates the *
 *   way to write comments.             //    way to write comments.        *
 */                                     //**********************************

//////////////////////////////////////   //----------------------------------
//    This program demonstrates the     //    This program demonstrates the
//    way to write comments.            //    way to write comments.
//////////////////////////////////////   //----------------------------------
```

- Many programmers use asterisks or other characters to draw borders or boxes around their comments.
- This helps to visually separate the comments from surrounding code.

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Documentation Comments

- Any comment that starts with `/**` and ends with `*/` is considered a documentation comment.
- You write a documentation comment just before:
  - a class header, giving a brief description of the class.
  - each method header, giving a brief description of the method.
- *Documentation comments* can be read and processed by a program named javadoc, which comes with the Sun JDK.

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Documentation Comments (cont'd.)

Code Listing 2-26 (Comment3.java)

```
1  /**
2     This class creates a program that calculates company payroll.
3  */
4
5  public class Comment3
6  {
7     /**
8        The main method is the program's starting point.
9     */
10
11    public static void main(String[] args)
12    {
13       double payRate;        // Holds the hourly pay rate
14       double hours;          // Holds the hours worked
15       int employeeNumber;    // Holds the employee number
16
17       // The Remainder of This Program is Omitted.
18    }
19 }
```


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Documentation Comments (cont'd.)

- The purpose of the javadoc program is to read Java source code files and generate attractively formatted HTML files that document the source code.
- To create the documentation, run the `javadoc` program with the source file as an argument.
  - For example:

```
javadoc Comment3.java
```

- The `javadoc` program will create `index.html` and several other documentation files in the same directory as the input file

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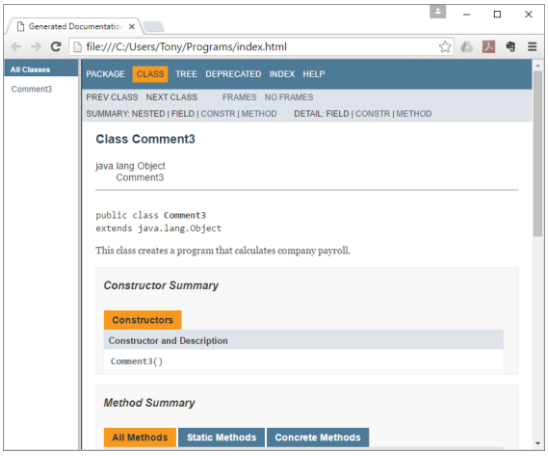
Documentation Comments (cont'd.)



Programming Style

- **Programming style refers to the way a programmer visually arranges a program's source code.**
- When the compiler reads a program it:
  - Processes it as one long stream of characters.
  - Doesn't care that each statement is on a separate line, or that spaces separate operators from operands.
  - Humans, on the other hand, find it difficult to read programs that aren't written in a visually pleasing manner.

Programming Style (cont'd.)

Code Listing 2-27 (Compact.java)

```
1  public class Compact {public static void main(String [] args){int
2  shares=220; double averagePrice=14.67; System.out.println(
3  "There were "+shares+" shares sold at $"+averagePrice+
4  " per share.");}}
```

Program Output

```
There were 220 shares sold at $14.67 per share.
```

Compact.java, Readable.java

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Programming Style (cont'd.)

Code Listing 2-28 (Readable.java)

```
1 // This example is much more readable than Compact.java.
2
3 public class Readable
4 {
5    public static void main(String[] args)
6    {
7       int shares = 220;
8       double averagePrice = 14.67;
9
10      System.out.println("There were " + shares
11                         + " shares sold at $"
12                         + averagePrice + " per share.");
13   }
14 }
```

Program Output

```
There were 220 shares sold at $14.67 per share.
```


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Reading Keyboard Input

- To read input from the keyboard we can use the `Scanner` class.
- The `Scanner` class is defined in `java.util`, so we will use the following statement at the top of our programs:

Payroll.java, TripCalculator.java

```
import java.util.Scanner;
```


Reading Keyboard Input (cont'd.)

- Scanner objects work with `System.in`
- To create a `Scanner` object and connect it to the `System.in` object:

```
Scanner keyboard = new Scanner (System.in);
```

Figure 2-12 The parts of the statement

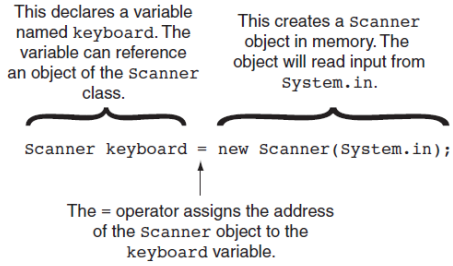
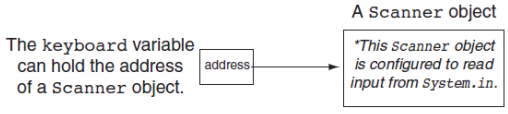


Figure 2-13 The keyboard variable references a Scanner object



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Reading Keyboard Input (cont'd.)

- The Scanner class has methods for reading:
  - strings using the `nextLine` method
  - `byte`s using the `nextByte` method
  - integers using the `nextInt` method
  - long integers using the `nextLong` method
  - short integers using the `nextShort` method
  - `float`s using the `nextFloat` method
  - `double`s using the `nextDouble` method

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Reading a Character

- The `Scanner` class does not have a method for reading a single character.
  - Use the `Scanner` class's `nextLine` method to read a string from the keyboard.
  - Then use the `String` class's `charAt` method to extract the first character of the string.

Reading a Character (cont'd.)

```
String input;   // To hold a line of input
char answer;    // To hold a single character

// Create a Scanner object for keyboard input.
Scanner keyboard = new Scanner(System.in);

// Ask the user a question.
System.out.print("Are you having fun? (Y=yes, N=no) ");
```

Mixing Calls to `nextLine` with Calls to Other `Scanner` Methods

- Keystrokes are stored in an area of memory that is sometimes called the *keyboard buffer*.
- Pressing the Enter key causes a newline character to be stored in the keyboard buffer.
- The `Scanner` methods that are designed to read primitive values, such as `nextInt` and `nextDouble`, will ignore the newline and return only the numeric value.
- The `Scanner` class's `nextLine` method will read the newline that is left over in the keyboard buffer, return it, and terminate without reading the intended input.

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Mixing Calls to `nextLine` with Calls to Other `Scanner` Methods (cont'd.)

- **Remove the newline from the keyboard buffer by calling the `Scanner` class's `nextLine` method, ignoring the return value.**

```
// Get the user's income
System.out.print("What is your annual income? ");
income = keyboard.nextDouble();
```

Read Primitive

```
[redacted]
```

Remove Newline

```
// Get the user's name.
System.out.print("What is your name? ");
name = keyboard.nextLine();
```

Read String

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Dialog Boxes

PayrollDialog.java, TripCalculatorDialog.java

- **A *dialog box* is a small graphical window that displays a message to the user or requests input.**
- **A variety of dialog boxes can be displayed using the `JOptionPane` class.**
- **Two of the dialog boxes are:**
  - Message Dialog - a dialog box that displays a message.
  - Input Dialog - a dialog box that prompts the user for input.

Dialog Boxes (cont'd.)

- **The `JOptionPane` class is not automatically available to your Java programs.**
- **The following statement must appear before the program's class header:**

```
import javax.swing.JOptionPane;
```

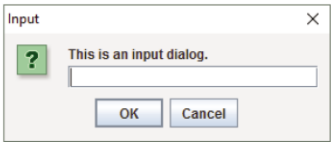
- **This statement tells the compiler where to find the `JOptionPane` class.**

Dialog Boxes (cont'd.)

The `JOptionPane` class provides methods to display each type of dialog box.

Message dialog

Input dialog



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Displaying Message Dialogs

- **`JOptionPane.showMessageDialog` method is used to display a message dialog.**

```
JOptionPane.showMessageDialog(null, "Hello World");
```

  - Use `null` as the first argument.
  - The second argument is the message that is to be displayed.

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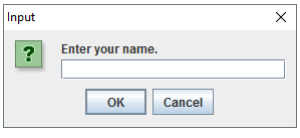
Displaying Input Dialogs

- An input dialog is a quick and simple way to ask the user to enter data.
- The dialog displays a text field, an OK button and a Cancel button.
- If OK is pressed, the dialog returns the user's input.
- If Cancel is pressed, the dialog returns `null`.

Displaying Input Dialogs (cont'd.)

```
String name;
name = JOptionPane.showInputDialog("Enter your name.");
```

- The argument passed to the method is the message to display.
- If the user clicks on the OK button, `name` references the string entered by the user.
- If the user clicks on the Cancel button, `name` references `null`.



Dialog Boxes (cont'd.)

- A program that uses `JOptionPane` does not automatically stop executing when the end of the `main` method is reached.
- Java generates a *thread*, which is a process running in the computer, when a `JOptionPane` is created.
- If the `System.exit` method is not called, this thread continues to execute.

Dialog Boxes (cont'd.)

- The `System.exit` method requires an integer argument.

```
System.exit(0);
```

- This argument is an *exit code* that is passed back to the operating system.
- This code is usually ignored, however, it can be used outside the program:
  - to indicate whether the program ended successfully or as the result of a failure.
  - The value `0` traditionally indicates that the program ended successfully.

Converting a String to a Number

- **The `JOptionPane`'s `showInputDialog` method always returns the user's input as a `String`**
- **A `String` containing a number, such as `"127.89"`, can be converted to a numeric data type.**

Converting a String to a Number (cont'd.)

- **Each of the numeric wrapper classes, (covered in Chapter 8) has a method that converts a string to a number.**
  - The `Integer` class has a method that converts a string to an `int`.
  - The `Double` class has a method that converts a string to a `double`.
  - etc.
- **These methods are known as *parse methods* because their names begin with the word "parse."**

Converting a String to a Number (cont'd.)

Table 2-18 Methods for converting strings to numbers

Method	Use This Method to . . .	Example Code
`Byte.parseByte`	Convert a string to a byte.	`byte num;` `num = Byte.parseByte(str);`
`Double.parseDouble`	Convert a string to a double.	`double num;` `num = Double.parseDouble(str);`
`Float.parseFloat`	Convert a string to a float.	`float num;` `num = Float.parseFloat(str);`
`Integer.parseInt`	Convert a string to an int.	`int num;` `num = Integer.parseInt(str);`
`Long.parseLong`	Convert a string to a long.	`long num;` `num = Long.parseLong(str);`
`Short.parseShort`	Convert a string to a short.	`short num;` `num = Short.parseShort(str);`

Converting a String to a Number (cont'd.)

- **Example conversion from string to `int`:**

```
int number;
String str;
str = JOptionPane.showInputDialog("Enter a number.");
number = Integer.parseInt(str);
```

- **Example conversion from string to `double`:**

```
double price;
String str;
str = JOptionPane.showInputDialog("Enter the retail price.");
price = Double.parseDouble(str);
```

The `System.out.printf` Method

- **You can perform formatted console output with the `System.out.printf` method.**
- **The method's general format is:**

```
System.out.printf(FormatString, ArgumentList)
```

  - *`FormatString`* is a string that contains text and/or special formatting specifiers
  - *`ArgumentList`* is a list of zero or more additional arguments, formatted according to the format specifiers listed in the *`FormatString`*.

Simple Output

- **The simplest way you can use the `printf` method is with only a format string and no additional arguments.**

```
System.out.printf("I love Java programming.\n");
```

- **This method call simply prints the string**

```
I love Java programming.
```

- **Using the method without any format specifiers is like using the `System.out.print` method.**

Single Format Specifier and Argument

- Let's look at an example that uses a format specifier and an additional argument:

```
int hours = 40;
System.out.printf("I worked %d hours this week.\n",hours);
```

- When this string is printed, the value of the `hours` argument will be printed in place of the `%d` format specifier.

```
I worked 40 hours this week.
```

- The `%d` format specifier was used because the `hours` variable is an `int`.
- An error will occur if you use `%d` with a non-integer value.

Multiple Format Specifiers and Arguments

- Here's another example:

CatsAndDogs.java

```
int dogs = 2;
int cats = 4;
System.out.printf("We have %d dogs and %d cats.\n",dogs, cats);
```

- First, notice that this example uses two `%d` format specifiers in the format string.
- Also notice that two arguments appear after the format string.
  - The value of the first integer argument, `dogs`, is printed in place of the first `%d`.
  - The value of the second integer argument, `cats`, is printed in place of the second `%d`.

```
We have 2 dogs and 4 cats.
```

Multiple Format Specifiers and Arguments

- The following code shows another example:

```
int value1 = 3;
int value2 = 6;
int value3 = 9;
System.out.printf("%d %d %d\n", value1, value2, value3);
```

- In the `printf` method call, there are three format specifiers and three additional arguments after the format string.
- This code will produce the following output:

```
3 6 9
```

- These examples show the one-to-one correspondence between the format specifiers and the arguments that appear after the format string.

Setting the Field Width

- A format specifier may also include a field width. Here is an example:

```
int number = 9;
System.out.printf("The value is %6d\n", number);
```

- The format specifier `%6d` indicates that the argument number should be printed in a field that is 6 places wide. If the value in number is shorter than 6 places, it will be right justified. Here is the output of the code.

```
The value is     9
             123456
```

- If the value of the argument is wider than the specified field width, the field width will be expanded to accommodate the value.

Using Field Widths to Print Columns

- Field widths can help when you need to print values aligned in columns. For example, look at the following code:

```
int num1 = 97654, num2 = 598;
int num3 = 86,    num4 = 56012;
int num5 = 246,   num6 = 2;
System.out.printf("%7d %7d\n", num1, num2);
System.out.printf("%7d %7d\n", num3, num4);
System.out.printf("%7d %7d\n", num5, num6);
```

- This code displays the values of the variables in a table with three rows and two columns. Each column has a width of seven spaces. Here is the output for the code:

TabsIssueResolved.java

```
  97654     598
     86   56012
    246       2
1234567 1234567
```


Printing Formatted Floating-Point Values

- If you wish to print a floating-point value, use the `%f` format specifier. Here is an example:

```
double number = 1278.92;
System.out.printf("The number is %f\n", number);
```

- This code produces the following output:

```
The number is 1278.920000
```

- You can also use a field width when printing floating-point values. For example the following code prints the value of number in a field that is 18 spaces wide:

```
System.out.printf("The number is %18f\n", number);
```

Printing Formatted Floating-Point Values

- In addition to the field width, you can also specify the number of digits that appear after the decimal point. Here is an example:

```
double grossPay = 874.12;
System.out.printf("Your pay is %.2f\n", grossPay);
```

- In this code, the `%.2f` specifier indicates that the value should appear with two digits after the decimal point. The output of the code is:

```
Your pay is 874.12
```

BooksPerMonthFixedRevisited.java,
DiscountRevisited.java,
PayrollFormatted.java,
SunFactsFormatted.java,
SunFactsRevisited.java,
WagesRevisited.java

Printing Formatted Floating-Point Values

- When you specify the number of digits to appear after the decimal point, the number will be rounded. For example, look at the following code:

```
double number = 1278.92714;
System.out.printf("The number is %.2f\n", number);
```

- This code will produce the following output:

```
The number is 1278.93
```

Printing Formatted Floating-Point Values

- You can specify both the field width and the number of decimal places together, as shown here:

```
double grossPay = 874.12;
System.out.printf("Your pay is %8.2f\n", grossPay);
```

- The output of the code is:

```
Your pay is   874.12
             12345678
                   12
```


Printing Formatted Floating-Point Values

- You can also use commas to group digits in a number. To do this, place a comma after the `%` symbol in the format specifier. Here is an example:

```
double grossPay = 1253874.12;
System.out.printf("Your pay is %,.2f\n", grossPay);
```

- This code will produce the following output:

```
Your pay is 1,253,874.12
```

Printing Formatted `String` Values

- If you wish to print a string argument, use the `%s` format specifier. Here is an example:

```
String name = "Ringo";
System.out.printf("Your name is %s\n", name);
```

- This code produces the following output:

```
Your name is Ringo
```


Printing Formatted `String` Values

- You can also use a field width when printing strings. For example, look at the following code:

```
String name1 = "George",  name2 = "Franklin";
String name3 = "Jay",     name4 = "Ozzy";
String name5 = "Carmine", name6 = "Dee";
System.out.printf("%10s %10s\n", name1, name2);
System.out.printf("%10s %10s\n", name3, name4);
System.out.printf("%10s %10s\n", name5, name6);
```

- This code displays the values of the variables in a table with three rows and two columns. Each column has a width of ten spaces. Here is the output of the code:

```
    George   Franklin
       Jay       Ozzy
   Carmine        Dee
```

The `String.format` Method

- The `String.format` method works exactly like the `System.out.printf` method, except that it does not display the formatted string on the screen.
- Instead, it returns a reference to the formatted string.
- You can assign the reference to a variable, and then use it later.

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The `String.format` Method

- The general format of the method is:

```
String.format(FormatString,ArgumentList);
```

`FormatString` **is a string that contains text and/or special formatting specifiers.**

`ArgumentList` **is optional. It is a list of additional arguments that will be formatted according to the format specifiers listed in the format string.**

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The `String.format` Method

- **See examples:**
  - CurrencyFormat2.java
  - CurrencyFormat3.java