Chapter 1
Getting Started

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Contents

- Origins of the Java language
- OOP, Objects, Methods
- 2 types of java programs
- Compiling & running java programs
- Identifier, variables, constants, primitive-types
- The class String

Origins of the Java Language

Origins of the Java Language

- Created by Sun Microsystems team led by James Gosling (1991)
- Originally designed for programming home appliances
  - Difficult task because appliances are controlled by a wide variety of computer processors
  - Team developed a two-step translation process to simplify the task of compiler writing for each class of appliances

Origins of the Java Language

- Significance of Java translation process
  - Writing a compiler (translation program) for each type of appliance processor would have been very costly
  - Instead, developed intermediate language that is the same for all types of processors : Java *byte-code*
  - Therefore, only a small, easy to write program was needed to translate byte-code into the machine code for each processor

Origins of the Java Language

- Patrick Naughton and Jonathan Payne at Sun Microsystems developed a Web browser that could run programs over the Internet (1994)
  - Beginning of Java's connection to the Internet
  - Original browser evolves into *HotJava*
- Netscape Incorporated made its Web browser capable of running Java programs (1995)
  - Other companies follow suit

OOP, Objects, Methods

OOP, Objects and Methods

- Java is an *object-oriented programming (OOP)* language
  - Programming methodology that views a program as consisting of *objects* that interact with one another by means of actions (called *methods*)
  - Objects of the same kind are said to have the same *type* or be in the same *class*

Terminology Comparisons

- Other high-level languages have constructs called procedures, methods, functions, and/or subprograms
  - These types of constructs are called *methods* in Java
  - All programming constructs in Java, including *methods*, are part of a *class*

2 types of java programs

Java Application Programs

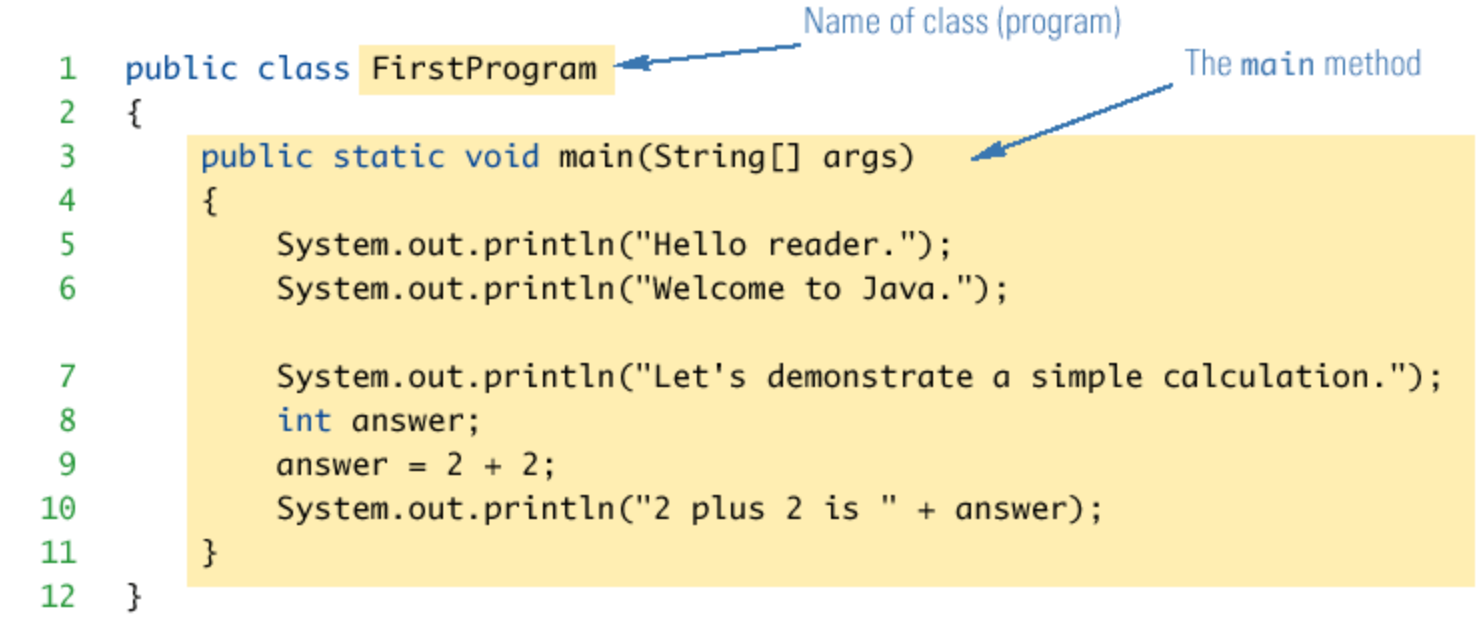
- There are two types of Java programs: *applications* and *applets*
- A Java *application program* or "regular" Java program is a class with a method named **`main`**
  - When a Java application program is run, the *run-time system* automatically invokes the method named **`main`**
  - All Java application programs start with the **`main`** method

Applets

- A Java *applet* (*little Java application*) is a Java program that is meant to be run from a Web browser
  - Can be run from a location on the Internet
  - Can also be run with an applet viewer program for debugging
  - Applets always use a windowing interface
    - (In contrast, application programs may use a windowing interface or console (i.e., text) I/O)

A Sample Java Application Program

Display 1.1 A Sample Java Program




```
1  public class FirstProgram
2  {
3      public static void main(String[] args)
4      {
5          System.out.println("Hello reader.");
6          System.out.println("Welcome to Java.");
7          System.out.println("Let's demonstrate a simple calculation.");
8          int answer;
9          answer = 2 + 2;
10         System.out.println("2 plus 2 is " + answer);
11     }
12 }
```

SAMPLE DIALOGUE 1

```
Hello reader.
Welcome to Java.
Let's demonstrate a simple calculation.
2 plus 2 is 4
```

`System.out.println`

- Java programs work by having things called *objects* perform actions
  - **`System.out`**: an object used for sending output to the screen
- The actions performed by an object are called *methods*
  - **`println`**: the method or action that the **`System.out`** object performs

System.out.println

- *Invoking* or *calling* a method: When an object performs an action using a method
  - Also called *sending a message* to the object
  - Method invocation syntax (in order): an object, a dot (period), the method name, and a pair of parentheses
  - Arguments: Zero or more pieces of information needed by the method that are placed inside the parentheses

```
System.out.println("This is an argument");
```

Compiling & running java programs

Byte-Code and the Java Virtual Machine

- The compilers for most programming languages translate high-level programs directly into the machine language for a particular computer
  - Since different computers have different machine languages, a different compiler is needed for each one
- In contrast, the Java compiler translates Java programs into *byte-code*, a machine language for a fictitious computer called the *Java Virtual Machine*
  - Once compiled to *byte-code*, a Java program can be used on any computer, making it very portable

Byte-Code and the Java Virtual Machine

- *Interpreter:* The program that translates a program written in Java byte-code into the machine language for a particular computer when a Java program is executed
  - The interpreter translates and immediately executes each byte-code instruction, one after another
  - Translating byte-code into machine code is relatively easy compared to the initial compilation step

Class Loader

- Java programs are divided into smaller parts called *classes*
  - Each class definition is normally in a separate file and compiled separately
- *Class Loader*: A program that connects the byte-code of the classes needed to run a Java program
  - In other programming languages, the corresponding program is called a *linker*

Compiling a Java Program or Class

- Each class definition must be in a file whose name is the same as the class name followed by `.java`
  - The class `FirstProgram` must be in a file named `FirstProgram.java`
- Each class is compiled with the command `javac` followed by the name of the file in which the class resides

```
javac FirstProgram.java
```

  - The result is a byte-code program whose filename is the same as the class name followed by `.class`

```
FirstProgram.class
```

Running a Java Program

- A Java program can be given the *run command* (**`java`**) after all its classes have been compiled
  - Only run the class that contains the **`main`** method (the system will automatically load and run the other classes, if any)
  - The **`main`** method begins with the line:

```
public static void main(String[ ] args)
```

  - Follow the run command by the name of the class only (no **`.java`** or **`.class`** extension)

```
java FirstProgram
```

Identifier, variables, constants, primitive-types

Identifiers

- *Identifier*: The name of a variable or other item (class, method, object, etc.) defined in a program
  - A Java identifier must not start with a digit, and all the characters must be letters, digits, or the underscore symbol
  - Java identifiers can theoretically be of any length
  - Java is a case-sensitive language: `Rate`, `rate`, and `RATE` are the names of three different variables

Identifiers

- Keywords and Reserved words: Identifiers that have a predefined meaning in Java
  - **Do not use** them to name anything else

```
public    class    void    static
```

- Predefined identifiers: Identifiers that are defined in libraries required by the Java language standard
  - Although they can be redefined, this could be confusing and dangerous if doing so would change their standard meaning

```
System    String    println
```

Naming Conventions

- Start the names of variables, methods, and objects with a lowercase letter, indicate "word" boundaries with an uppercase letter, and restrict the remaining characters to digits and lowercase letters

  `topSpeed` `bankRate1` `timeOfArrival`

- Start the names of classes with an uppercase letter and, otherwise, adhere to the rules above

  `FirstProgram` `MyClass` `String`

Variable Declarations

- Every variable in a Java program must be *declared* before it is used
  - A variable declaration tells the compiler what kind of data (type) will be stored in the variable
  - The type of the variable is followed by one or more variable names separated by commas, and terminated with a semicolon
  - Variables are typically declared just before they are used or at the start of a block (indicated by an opening brace **{**)
  - Basic types in Java are called *primitive types*

```
int numberOfBeans;
double oneWeight, totalWeight;
```

Primitive Types

Display 1.2 Primitive Types

TYPE NAME	KIND OF VALUE	MEMORY USED	SIZE RANGE
`boolean`	`true` or `false`	1 byte	not applicable
`char`	single character (Unicode)	2 bytes	all Unicode characters
`byte`	integer	1 byte	−128 to 127
`short`	integer	2 bytes	−32768 to 32767
`int`	integer	4 bytes	−2147483648 to 2147483647
`long`	integer	8 bytes	−9223372036854775808 to 9223372036854775807
`float`	floating-point number	4 bytes	$-3.40282347 \times 10^{+38}$ to $-1.40239846 \times 10^{-45}$
`double`	floating-point number	8 bytes	$\pm 1.76769313486231570 \times 10^{+308}$ to $\pm 4.94065645841246544 \times 10^{-324}$

Constants

- *Constant* (or *literal*): An item in Java which has one specific value that cannot change
  - Constants of an integer type may not be written with a decimal point (e.g., `10`)
  - Constants of a floating-point type can be written in ordinary decimal fraction form (e.g., `367000.0` or `0.000589`)
  - Constant of a floating-point type can also be written in *scientific* (or *floating-point*) *notation* (e.g., `3.67e5` or `5.89e-4`)
    - Note that the number before the `e` may contain a decimal point, but the number after the `e` may not

Constants

- Constants of type **`char`** are expressed by placing a single character in single quotes (e.g., **`'Z'`**)
- Constants for strings of characters are enclosed by double quotes (e.g., **`"Welcome to Java"`**)
- There are only two **`boolean`** type constants, **`true`** and **`false`**
  - Note that they must be spelled with all lowercase letters

The class String

The Class `String`

- There is no primitive type for strings in Java
- The class **`String`** is a predefined class in Java that is used to store and process strings
- Objects of type **`String`** are made up of strings of characters that are written within double quotes
  - Any quoted string is a constant of type **`String`**

```
"Live long and prosper."
```

- A variable of type **`String`** can be given the value of a **`String`** object

```
String blessing = "Live long and prosper.";
```

Concatenation of Strings

- *Concatenation*: Using the `+` operator on two strings in order to connect them to form one longer string
  - If `greeting` is equal to `"Hello "`, and `javaClass` is equal to `"class"`, then `greeting + javaClass` is equal to `"Hello class"`
- Any number of strings can be concatenated together
- When a string is combined with almost any other type of item, the result is a string
  - `"The answer is " + 42` evaluates to `"The answer is 42"`

Classes, Objects, and Methods

- A *class* is the name for a type whose values are objects
- *Objects* are entities that store data and take actions
  - Objects of the `String` class store data consisting of strings of characters
- The actions that an object can take are called *methods*
  - Methods can return a value of a single type and/or perform an action
  - All objects within a class have the same methods, but each can have different data values

Classes, Objects, and Methods

- *Invoking* or *calling a method*: a method is called into action by writing the name of the calling object, followed by a dot, followed by the method name, followed by parentheses
  - This is sometimes referred to as *sending a message to the object*
  - The parentheses contain the information (if any) needed by the method
  - This information is called an *argument* (or *arguments*)

String Methods

- The **`String`** class contains many useful methods for string-processing applications
  - A **`String`** method is called by writing a **`String`** object, a dot, the name of the method, and a pair of parentheses to enclose any arguments
  - If a **`String`** method returns a value, then it can be placed anywhere that a value of its type can be used

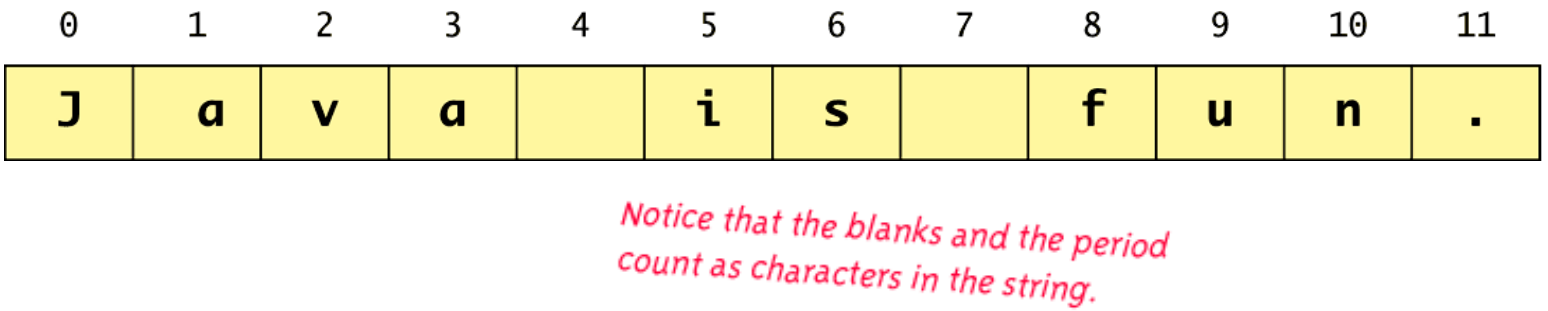
```
String greeting = "Hello";
int count = greeting.length();
System.out.println("Length is " +
  greeting.length());
```

  - Always count from *zero* when referring to the *position* or *index* of a character in a string

String Indexes

Display 1.5 String Indexes

The 12 characters in the string `"Java is fun."` have indexes 0 through 11.



Some Methods in the Class `String` (Part 1 of 8)

Display 1.4 Some Methods in the Class `String`

`int length()`

Returns the length of the calling object (which is a string) as a value of type `int`.

EXAMPLE

After program executes `String greeting = "Hello!";`
`greeting.length()` returns 6.

`boolean equals(Other_String)`

Returns `true` if the calling object string and the *Other_String* are equal. Otherwise, returns `false`.

EXAMPLE

After program executes `String greeting = "Hello";`
`greeting.equals("Hello")` returns `true`
`greeting.equals("Good-Bye")` returns `false`
`greeting.equals("hello")` returns `false`

Note that case matters. `"Hello"` and `"hello"` are not equal because one starts with an uppercase letter and the other starts with a lowercase letter.

(continued)

Some Methods in the Class `String` (Part 2 of 8)

Display 1.4 Some Methods in the Class `String`

`boolean equalsIgnoreCase(`*Other_String*`)`

Returns `true` if the calling object string and the *Other_String* are equal, considering uppercase and lowercase versions of a letter to be the same. Otherwise, returns `false`.

EXAMPLE

After program executes `String name = "mary!";`
`greeting.equalsIgnoreCase("Mary!")` returns `true`

`String toLowerCase()`

Returns a string with the same characters as the calling object string, but with all letter characters converted to lowercase.

EXAMPLE

After program executes `String greeting = "Hi Mary!";`
`greeting.toLowerCase()` returns `"hi mary!"`.

(continued)

Some Methods in the Class `String` (Part 3 of 8)

Display 1.4 Some Methods in the Class `String`

`String toUpperCase()`

Returns a string with the same characters as the calling object string, but with all letter characters converted to uppercase.

EXAMPLE

After program executes `String greeting = "Hi Mary!";`
`greeting.toUpperCase()` returns `"HI MARY!"`.

`String trim()`

Returns a string with the same characters as the calling object string, but with leading and trailing white space removed. Whitespace characters are the characters that print as white space on paper, such as the blank (space) character, the tab character, and the new-line character `'\n'`.

EXAMPLE

After program executes `String pause = "   Hmm   ";`
`pause.trim()` returns `"Hmm"`.

(continued)

Some Methods in the Class `String` (Part 4 of 8)

Display 1.4 Some Methods in the Class `String`

`char charAt(`*Position*`)`

Returns the character in the calling object string at the *Position*. Positions are counted 0, 1, 2, etc.

EXAMPLE

After program executes `String greeting = "Hello!";`
`greeting.charAt(0)` returns `'H'`, and
`greeting.charAt(1)` returns `'e'`.

`String substring(`*Start*`)`

Returns the substring of the calling object string starting from *Start* through to the end of the calling object. Positions are counted 0, 1, 2, etc. Be sure to notice that the character at position *Start* is included in the value returned.

EXAMPLE

After program executes `String sample = "AbcdefG";`
`sample.substring(2)` returns `"cdefG"`.

(continued)

Some Methods in the Class `String` (Part 5 of 8)

Display 1.4 Some Methods in the Class `String`

`String substring(`*Start*`,` *End*`)`

Returns the substring of the calling object string starting from position *Start* through, but not including, position *End* of the calling object. Positions are counted 0, 1, 2, etc. Be sure to notice that the character at position *Start* is included in the value returned, but the character at position *End* is not included.

EXAMPLE

After program executes `String sample = "AbcdefG";`
`sample.substring(2, 5)` returns `"cde"`.

`int indexOf(`*A_String*`)`

Returns the index (position) of the first occurrence of the string *A_String* in the calling object string. Positions are counted 0, 1, 2, etc. Returns −1 if *A_String* is not found.

EXAMPLE

After program executes `String greeting = "Hi Mary!";`
`greeting.indexOf("Mary")` returns 3, and
`greeting.indexOf("Sally")` returns −1.

(continued)

Some Methods in the Class `String` (Part 6 of 8)

Display 1.4 Some Methods in the Class `String`

`int indexOf(A_String, Start)`

Returns the index (position) of the first occurrence of the string *A_String* in the calling object string that occurs at or after position *Start*. Positions are counted 0, 1, 2, etc. Returns −1 if *A_String* is not found.

EXAMPLE

After program executes `String name = "Mary, Mary quite contrary";`
`name.indexOf("Mary", 1)` returns `6`.
The same value is returned if 1 is replaced by any number up to and including 6.
`name.indexOf("Mary", 0)` returns `0`.
`name.indexOf("Mary", 8)` returns `−1`.

`int lastIndexOf(A_String)`

Returns the index (position) of the last occurrence of the string *A_String* in the calling object string. Positions are counted 0, 1, 2, etc. Returns −1, if *A_String* is not found.

EXAMPLE

After program executes `String name = "Mary, Mary, Mary quite so";`
`greeting.indexOf("Mary")` returns `0`, and
`name.lastIndexOf("Mary")` returns `12`.

(continued)

Some Methods in the Class `String` (Part 7 of 8)

Display 1.4 Some Methods in the Class `String`

`int compareTo(A_String)`

Compares the calling object string and the string argument to see which comes first in the lexicographic ordering. Lexicographic order is the same as alphabetical order but with the characters ordered as in Appendix 3. Note that in Appendix 3 all the uppercase letters are in regular alphabetical order and all the lowercase letters are in alphabetical order, but all the uppercase letters precede all the lowercase letters. So, lexicographic ordering is the same as alphabetical ordering provided both strings are either all uppercase letters or both strings are all lowercase letters. If the calling string is first, it returns a negative value. If the two strings are equal, it returns zero. If the argument is first, it returns a positive number.

EXAMPLE

After program executes `String entry = "adventure";`
`entry.compareTo("zoo")` returns a negative number,
`entry.compareTo("adventure")` returns `0`, and
`entry.compareTo("above")` returns a positive number.

(continued)

Some Methods in the Class `String` (Part 8 of 8)

Display 1.4 Some Methods in the Class `String`

`int compareToIgnoreCase(`*A_String*`)`

Compares the calling object string and the string argument to see which comes first in the lexicographic ordering, treating uppercase and lowercase letters as being the same. (To be precise, all uppercase letters are treated as if they were their lowercase versions in doing the comparison.) Thus, if both strings consist entirely of letters, the comparison is for ordinary alphabetical order. If the calling string is first, it returns a negative value. If the two strings are equal ignoring case, it returns zero. If the argument is first, it returns a positive number.

EXAMPLE

After program executes `String entry = "adventure";`
`entry.compareToIgnoreCase("Zoo")` returns a negative number,
`entry.compareToIgnoreCase("Adventure")` returns `0`, and
`"Zoo".compareToIgnoreCase(entry)` returns a positive number.

Display 1.7 Using the **String** Class

```
public class StringProcessingDemo
{
   public static void main(String[] args)
   {
      String sentence = "I hate text processing!";
      int position = sentence.indexOf("hate");
      String ending = sentence.substring(position + "hate".length( ));

      System.out.println("012345678901234567890123");
      System.out.println(sentence);
      System.out.println("The word \"hate\" starts at index " + position);

      sentence = sentence.substring(0, position) + "adore" + ending;
      System.out.println("The changed string is:");
      System.out.println(sentence);
   }
}
```

```
012345678901234567890123
I hate text processing!
The word "hate" starts at index 2
The changed string is:
I adore text processing!
```

Comments

- A *line comment* begins with the symbols **//**, and causes the compiler to ignore the remainder of the line
  - This type of comment is used for the code writer or for a programmer who modifies the code
- A *block comment* begins with the symbol pair **/***, and ends with the symbol pair ***/**
  - The compiler ignores anything in between
  - This type of comment can span several lines
  - This type of comment provides documentation for the users of the program