Chapter 1

Getting Started

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Introduction To Java

- Most people are familiar with Java as a language for Internet applications
- We will study Java as a general purpose programming language
  - The syntax of expressions and assignments will be similar to that of other high-level languages
  - Details concerning the handling of strings and console output will probably be new

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 made its Web browser capable of running Java programs (1995)
  - Other companies follow suit

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*

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

Name of class (program)

The `main` method

```
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
8          System.out.println("Let's demonstrate a simple calculation.");
9          int answer;
10         answer = 2 + 2;
11         System.out.println("2 plus 2 is " + answer);
12     }
13 }
```

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");
```

Variable declarations

- Variable declarations in Java are similar to those in other programming languages
  - Simply give the type of the variable followed by its name and a semicolon

```
int answer;
```


Using = and +

- In Java, the equal sign (=) is used as the *assignment operator*
  - The variable on the left side of the assignment operator is *assigned the value* of the expression on the right side of the assignment operator

```
answer = 2 + 2;
```

- In Java, the plus sign (+) can be used to denote addition (as above) or *concatenation*
  - Using +, two strings can be connected together

```
System.out.println("2 plus 2 is " + answer);
```


Computer Language Levels

- *High-level language*: A language that people can read, write, and understand
  - A program written in a high-level language must be translated into a language that can be understood by a computer before it can be run
- *Machine language*: A language that a computer can understand
- *Low-level language*: Machine language or any language similar to machine language
- *Compiler*: A program that translates a high-level language program into an equivalent low-level language program
  - This translation process is called *compiling*

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

Program terminology

- *Code*: A program or a part of a program
- *Source code* (or *source program*): A program written in a high-level language such as Java
  - The input to the compiler program
- *Object code*: The translated low-level program
  - The output from the compiler program, e.g., Java byte-code
  - In the case of Java byte-code, the input to the Java byte-code interpreter

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
```


Syntax and Semantics

- *Syntax*: The arrangement of words and punctuations that are legal in a language, the *grammar rules* of a language
- *Semantics*: The meaning of things written while following the syntax rules of a language

Tip: Error Messages

- *Bug*: A mistake in a program
  - The process of eliminating bugs is called *debugging*
- *Syntax error:* A grammatical mistake in a program
  - The compiler can detect these errors, and will output an error message saying what it thinks the error is, and where it thinks the error is

Tip: Error Messages

- *Run-time error:* An error that is not detected until a program is run
  - The compiler cannot detect these errors: an error message is not generated after compilation, but after execution
- *Logic error:* A mistake in the underlying algorithm for a program
  - *The compiler cannot detect these errors, and no error message is generated after compilation or execution, but the program does not do what it is supposed to do*

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, classes, 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 $\pm 4.94065645841246544 \times 10^{-324}$

Assignment Statements With Primitive Types

- In Java, the assignment statement is used to change the value of a variable
  - The equal sign (**=**) is used as the assignment operator
  - An assignment statement consists of a variable on the left side of the operator, and an *expression* on the right side of the operator

```
Variable = Expression;
```

  - An *expression* consists of a variable, number, or mix of variables, numbers, operators, and/or method invocations

```
temperature = 98.6;
count = numberOfBeans;
```


Assignment Statements With Primitive Types

- When an assignment statement is executed, the expression is first evaluated, and then the variable on the left-hand side of the equal sign is set equal to the value of the expression

```
distance = rate * time;
```

- Note that a variable can occur on both sides of the assignment operator

```
count = count + 2;
```

- The assignment operator is automatically executed from right-to-left, so assignment statements can be chained

```
number2 = number1 = 3;
```


Tip: Initialize Variables

- A variable that has been declared but that has not yet been given a value by some means is said to be *uninitialized*
- In certain cases an uninitialized variable is given a default value
  - It is best not to rely on this
  - Explicitly initialized variables have the added benefit of improving program clarity

Tip: Initialize Variables

- The declaration of a variable can be combined with its initialization via an assignment statement

```
int count = 0;
double distance = 55 * .5;
char grade = 'A';
```

  - Note that some variables can be initialized and others can remain uninitialized in the same declaration

```
int initialCount = 50, finalCount;
```


Shorthand Assignment Statements

- Shorthand assignment notation combines the *assignment operator* (**=**) and an *arithmetic operator*
- It is used to change the value of a variable by adding, subtracting, multiplying, or dividing by a specified value
- The general form is

Variable Op = Expression

which is equivalent to

Variable = Variable Op (Expression)

  - The **Expression** can be another variable, a constant, or a more complicated expression
  - Some examples of what **Op** can be are **+**, **-**, *****, **/**, or **%**

Shorthand Assignment Statements

Example:	Equivalent To:
`count += 2;`	`count = count + 2;`
`sum -= discount;`	`sum = sum – discount;`
`bonus *= 2;`	`bonus = bonus * 2;`
`time /= rushFactor;`	`time = time / rushFactor;`
`change %= 100;`	`change = change % 100;`
`amount *= count1 + count2;`	`amount = amount * (count1 + count2);`

Assignment Compatibility

- In general, the value of one type cannot be stored in a variable of another type

```
int intVariable = 2.99; //Illegal
```

  - The above example results in a type mismatch because a **double** value cannot be stored in an **int** variable
- However, there are exceptions to this

```
double doubleVariable = 2;
```

  - For example, an **int** value can be stored in a **double** type

Assignment Compatibility

- More generally, a value of any type in the following list can be assigned to a variable of any type that appears to the right of it

```
byte→short→int→long→float→double
char
```

  - Note that as your move down the list from left to right, the range of allowed values for the types becomes larger
- An explicit *type cast* is required to assign a value of one type to a variable whose type appears to the left of it on the above list (e.g., `double` to `int`)
- Note that in Java an `int` cannot be assigned to a variable of type `boolean`, nor can a `boolean` be assigned to a variable of type `int`

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

Arithmetic Operators and Expressions

- As in most languages, *expressions* can be formed in Java using variables, constants, and arithmetic operators
  - These operators are `+` (addition), `-` (subtraction), `*` (multiplication), `/` (division), and `%` (modulo, remainder)
  - An expression can be used anyplace it is legal to use a value of the type produced by the expression

Arithmetic Operators and Expressions

- If an arithmetic operator is combined with **`int`** operands, then the resulting type is **`int`**
- If an arithmetic operator is combined with one or two **`double`** operands, then the resulting type is **`double`**
- If different types are combined in an expression, then the resulting type is the right-most type on the following list that is found within the expression

  `byte`→**`short`**→**`int`**→**`long`**→**`float`**→**`double`**

  `char`
  - Exception: If the type produced should be **`byte`** or **`short`** (according to the rules above), then the type produced will actually be an **`int`**

Parentheses and Precedence Rules

- An expression can be *fully parenthesized* in order to specify exactly what subexpressions are combined with each operator
- If some or all of the parentheses in an expression are omitted, Java will follow *precedence* rules to determine, in effect, where to place them
  - However, it's best (and sometimes necessary) to include them

Precedence Rules

Display 1.3 Precedence Rules

Highest Precedence

First: the unary operators: +, –, ++, ––, and !
Second: the binary arithmetic operators: *, /, and %
Third: the binary arithmetic operators: + and –

Lowest Precedence

Precedence and Associativity Rules

- When the order of two adjacent operations must be determined, the operation of higher precedence (and its apparent arguments) is grouped before the operation of lower precedence

  `base + rate * hours` is evaluated as
  `base + (rate * hours)`
- When two operations have equal precedence, the order of operations is determined by *associativity* rules

Precedence and Associativity Rules

- Unary operators of equal precedence are grouped right-to-left
  `+-+rate` is evaluated as `+(-(+rate))`
- Binary operators of equal precedence are grouped left-to-right
  `base + rate + hours` is evaluated as
  `(base + rate) + hours`
- Exception: A string of assignment operators is grouped right-to-left
  `n1 = n2 = n3;` is evaluated as `n1 = (n2 = n3);`

Pitfall: Round-Off Errors in Floating-Point Numbers

- Floating point numbers are only approximate quantities
  - Mathematically, the floating-point number 1.0/3.0 is equal to 0.3333333 . . .
  - A computer has a finite amount of storage space
    - It may store 1.0/3.0 as something like 0.3333333333, which is slightly smaller than one-third
  - Computers actually store numbers in binary notation, but the consequences are the same: floating-point numbers may lose accuracy

Integer and Floating-Point Division

- When one or both operands are a floating-point type, division results in a floating-point type
  `15.0/2` evaluates to `7.5`
- When both operands are integer types, division results in an integer type
  - Any fractional part is discarded
  - The number is not rounded
    `15/2` evaluates to `7`
- Be careful to make at least one of the operands a floating-point type if the fractional portion is needed

The % Operator

- The `%` operator is used with operands of type `int` to recover the information lost after performing integer division
  `15/2` evaluates to the quotient `7`
  `15%2` evaluates to the remainder `1`
- The `%` operator can be used to count by 2's, 3's, or any other number
  - To count by twos, perform the operation `number % 2`, and when the result is `0`, `number` is even

Type Casting

- A *type cast* takes a value of one type and produces a value of another type with an "equivalent" value
  - If `n` and `m` are integers to be divided, and the fractional portion of the result must be preserved, at least one of the two must be type cast to a floating-point type **before** the division operation is performed

```
double ans = n / (double)m;
```

  - Note that the desired type is placed inside parentheses immediately in front of the variable to be cast
  - Note also that the type and value of the variable to be cast does not change

More Details About Type Casting

- When type casting from a floating-point to an integer type, the number is truncated, not rounded
  - `(int)2.9` evaluates to `2`, not `3`
- When the value of an integer type is assigned to a variable of a floating-point type, Java performs an automatic type cast called a *type coercion*

```
double d = 5;
```

- In contrast, it is illegal to place a `double` value into an `int` variable without an explicit type cast

```
int i = 5.5; // Illegal
int i = (int)5.5 // Correct
```


Increment and Decrement Operators

- The *increment operator* (`++`) adds one to the value of a variable
  - If `n` is equal to `2`, then `n++` or `++n` will change the value of `n` to `3`
- The *decrement operator* (`--`) subtracts one from the value of a variable
  - If `n` is equal to `4`, then `n--` or `--n` will change the value of `n` to `3`

Increment and Decrement Operators

- When either operator precedes its variable, and is part of an expression, then the expression is evaluated using the changed value of the variable
  - If `n` is equal to `2`, then `2*(++n)` evaluates to `6`
- When either operator follows its variable, and is part of an expression, then the expression is evaluated using the original value of the variable, and only then is the variable value changed
  - If `n` is equal to `2`, then `2*(n++)` evaluates to `4`

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

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.

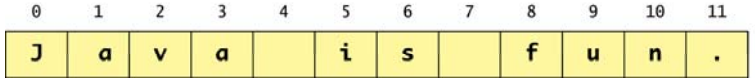
EXAMPLE

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.

String Indexes

Display 1.5 String Indexes

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



Notice that the blanks and the period count as characters in the string.

Escape Sequences

- A backslash (\) immediately preceding a character (i.e., without any space) denotes an *escape sequence* or an *escape character*
  - The character following the backslash does not have its usual meaning
  - Although it is formed using two symbols, it is regarded as a single character

Escape Sequences

Display 1.6 Escape Sequences

```
\" Double quote.
\' Single quote.
\\ Backslash.
\n New line. Go to the beginning of the next line.
\r Carriage return. Go to the beginning of the current line.
\t Tab. White space up to the next tab stop.
```

String Processing

- A **`String`** object in Java is considered to be immutable, i.e., the characters it contains cannot be changed
- There is another class in Java called **`StringBuffer`** that has methods for editing its string objects
- However, it is possible to change the value of a **`String`** variable by using an assignment statement

```
String name = "Soprano";
name = "Anthony " + name;
```


Character Sets

- *ASCII*: A character set used by many programming languages that contains all the characters normally used on an English-language keyboard, plus a few special characters
  - Each character is represented by a particular number
- *Unicode*: A character set used by the Java language that includes all the ASCII characters plus many of the characters used in languages with a different alphabet from English

Naming Constants

- Instead of using "anonymous" numbers in a program, always declare them as named constants, and use their name instead

```
public static final int INCHES_PER_FOOT = 12;
public static final double RATE = 0.14;
```

  - This prevents a value from being changed inadvertently
  - It has the added advantage that when a value must be modified, it need only be changed in one place
  - Note the naming convention for constants: Use all uppercase letters, and designate word boundaries with an underscore character

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

Program Documentation

- Java comes with a program called **`javadoc`** that will automatically extract documentation from block comments in the classes you define
  - As long as their opening has an extra asterisk (`/**`)
- Ultimately, a well written program is self-documenting
  - Its structure is made clear by the choice of identifier names and the indenting pattern
  - When one structure is nested inside another, the inside structure is indented one more level

Comments and a Named Constant

Display 1.8 **Comments and a Named Constant**

```
1  /**
2   Program to show interest on a sample account balance.
3   Author: Jane Q. Programmer.
4   E-mail Address: janeq@somemachine.etc.etc.
5   Last Changed: September 21, 2004.
6  */
7  public class ShowInterest
8  {
9      public static final double INTEREST_RATE = 2.5;

10     public static void main(String[] args)
11     {
12         double balance = 100;
13         double interest; //as a percent

14         interest = balance * (INTEREST_RATE/100.0);
15         System.out.println("On a balance of $" + balance);
16         System.out.println("you will earn interest of $"
17                                                 + interest);
18         System.out.println("All in just one short year.");
19     }
20 }
```

Although it would not be as clear, it is legal to place the definition of INTEREST_RATE here instead.

SAMPLE DIALOGUE

```
On a balance of $100.0
you will earn interest of $2.5
All in just one short year.
```