2. Basic Computation

[ITP20003] Java Programming

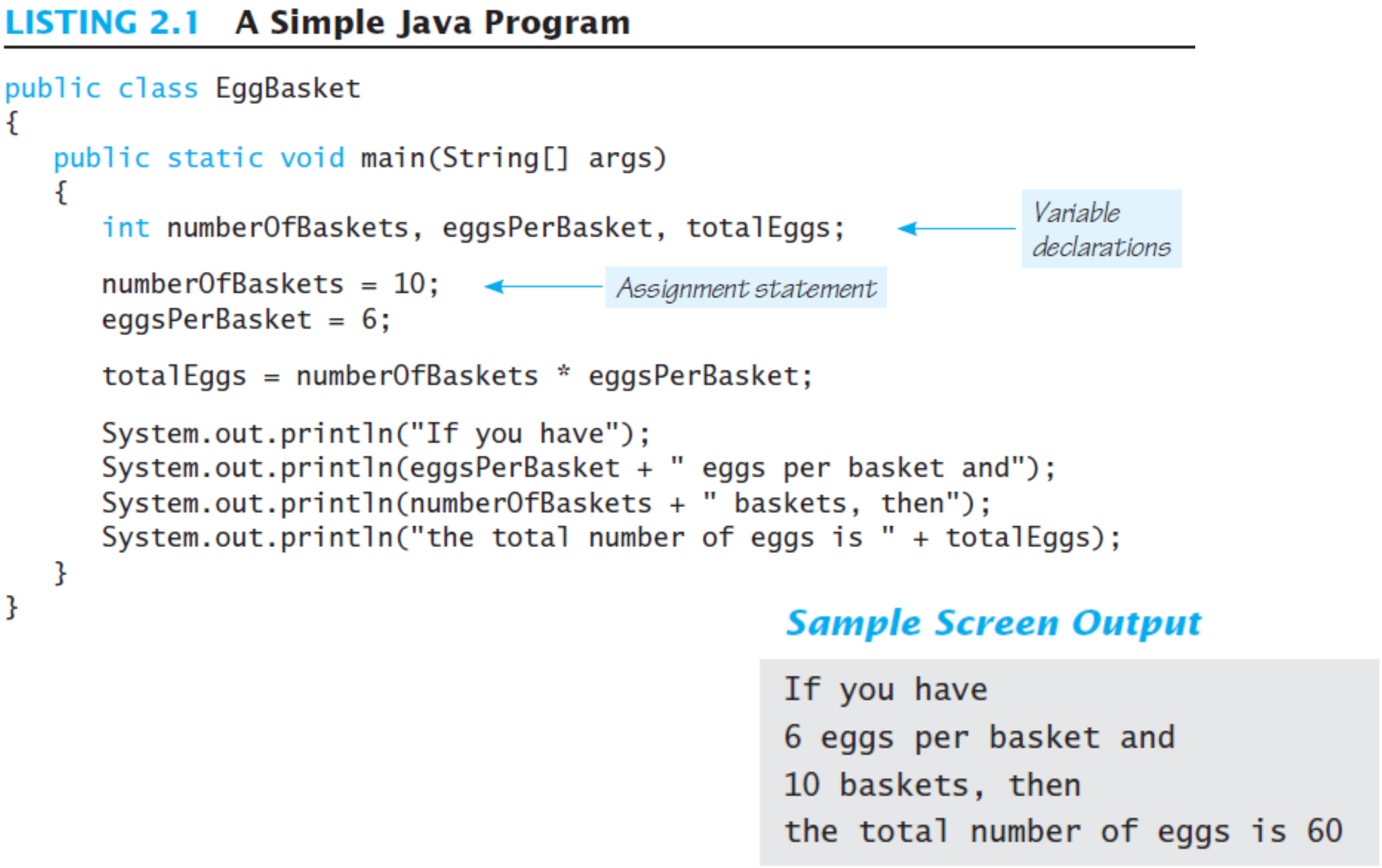
Agenda

- Variables and Expressions
- The Class String
- Keyboard and Screen I/O
- Documentation and Style
- Graphics Supplement

Variables

- **Variables** in a program are used to store data such as numbers and letters.
  - **Places** to store data.
    - They are implemented as **memory locations**.
  - Store a particular type of data.
  - The data stored by a variable is called its **value**.
  - A variable must be declared before it is used.

EggBasket



LISTING 2.1 A Simple Java Program

```
public class EggBasket
{
    public static void main(String[] args)
    {
        int numberOfBaskets, eggsPerBasket, totalEggs;

        numberOfBaskets = 10;
        eggsPerBasket = 6;

        totalEggs = numberOfBaskets * eggsPerBasket;

        System.out.println("If you have");
        System.out.println(eggsPerBasket + " eggs per basket and");
        System.out.println(numberOfBaskets + " baskets, then");
        System.out.println("the total number of eggs is " + totalEggs);
    }
}
```

Variable declarations

Assignment statement

Sample Screen Output

```
If you have
6 eggs per basket and
10 baskets, then
the total number of eggs is 60
```

Naming and Declaring Variables

- Variable declaration:

  Type Variable_1, Variable_2, ...;

  ```
  Ex) int numberOfBaskets;
      int eggsPerBasket;
      int totalEggs;
  ```

  - A variable's type determines what kinds of values it can hold (int, double, char, etc.).
  - Choose names that are helpful such as *count* or *speed*, but not *c* or *s*.
  - Variable declaration can be concatenated by comma operator

  ```
  Ex) int numberOfBaskets, eggsPerBasket, totalEggs;
  ```

Storing Values to Variables

- Assignment

  Variable = Expression;

  - The "equal sign" is called the assignment operator.

  Cf. Mathematical equal operator: '=='

  - *Expression* can be one of followings
    - □ Another variable
    - □ A literal or constant (such as a number)
    - □ Something more complicated which combines variables and literals using operators (such as + and -)

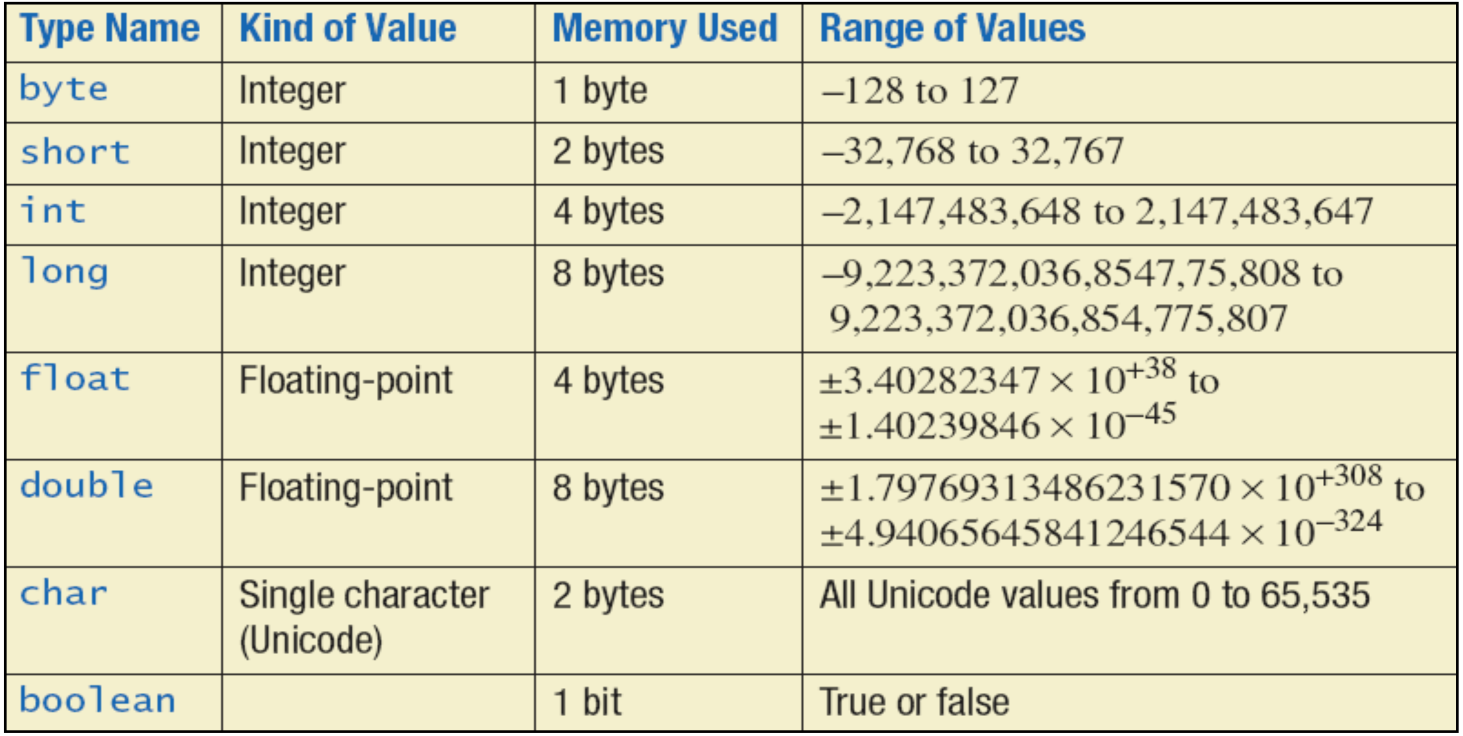
```
Ex) numberOfBaskets = 10;
    eggsPerBasket = 6;
    score = numberOfCards + handicap;
    eggsPerBasket = eggsPerBasket - 2;
```

Data Types

- A **class type** is used for a class of objects (data + methods).
  - "Java is fun" is a value of class type String
  - ➔ Type for complex data

- A **primitive type** is used for simple, non-decomposable values such as an individual number or individual character.
  - int, double, and char are primitive types.
  - ➔ Type for simple data

Primitive Types



Type Name	Kind of Value	Memory Used	Range of Values
byte	Integer	1 byte	–128 to 127
short	Integer	2 bytes	–32,768 to 32,767
int	Integer	4 bytes	–2,147,483,648 to 2,147,483,647
long	Integer	8 bytes	–9,223,372,036,8547,75,808 to 9,223,372,036,854,775,807
float	Floating-point	4 bytes	$\pm 3.40282347 \times 10^{+38}$ to $\pm 1.40239846 \times 10^{-45}$
double	Floating-point	8 bytes	$\pm 1.79769313486231570 \times 10^{+308}$ to $\pm 4.94065645841246544 \times 10^{-324}$
char	Single character (Unicode)	2 bytes	All Unicode values from 0 to 65,535
boolean		1 bit	True or false

```
Ex) short day = 10;
    float cost = 195.20;
    char initial = ‘i’; // 2 bytes
    boolean flag = true;
```

Primitive Types

- Integer types (byte, short, int, and long)

  Ex) 0, -1, 365, 12000

  - int is most common

- Floating-point types (float and double)

  Ex) 0.99, -22.8, 3.14159, 5.0

  - double is more common
  - Floating-point numbers often are only approximations since they are stored with a finite number of bits.

    Ex) 1.0/3.0 is slightly less than 1/3

- Character type (char)

  Ex) 'a' 'A' '#' ' '

- Boolean type (boolean)

  true or *false*

Java Identifiers

- An **identifier** is a name, such as the name of a variable.
- Identifiers may contain only
  - Letters
  - Digits (0 through 9)
  - The underscore character (_)
  - And the dollar sign symbol ($) which has a special meaning
    - Mainly for auto-generated names.
- The first character cannot be a digit.
- Java is case sensitive

  Ex) stuff, Stuff, and STUFF are different identifiers.
- An identifier cannot be a keyword (or reserved word) used for special, predefined meanings in Java.

  Ex) int, static, public, for, return, …

Naming Conventions

- Class types begin with an uppercase letter (e.g. String).
- Primitive types begin with a lowercase letter (e.g. int).
- Variables of both class and primitive types begin with a lowercase letters (e.g. myName, myBalance).
- Multiword names are "punctuated" using uppercase letters. (e.g. studentName)

Where to Declare Variables

- Declare a variable
  - Just before it is used or
  - At the beginning of the section of your program that is enclosed in {}.

```
public static void main(String[] args)
{
    /* declare variables here */
    . . .
}
```

Initializing Variables

- A variable that has been declared, but not yet given a value, is said to be uninitialized.
  - Uninitialized class variables have the value null.
  - Uninitialized primitive variables may have a default value.
    - It's good practice not to rely on a default value.

- To protect against an uninitialized variable (and to keep the compiler happy), assign a value at the time the variable is declared.

  Ex) int count = 0;

  char grade = 'A';

Simple Input

- Data can be entered from the keyboard using

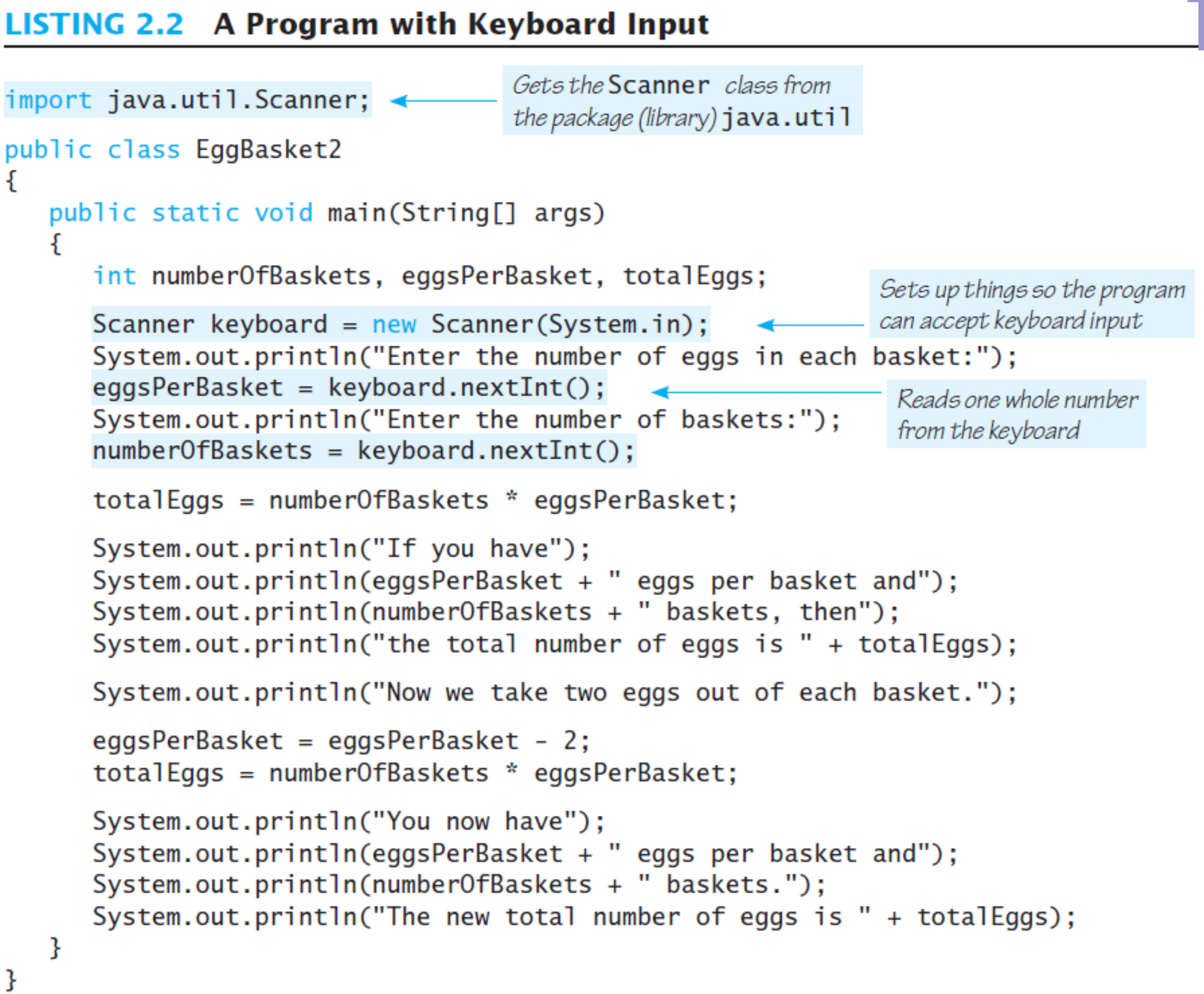
```
Scanner keyboard =  new Scanner(System.in);
```

- Followed, for example, by

```
eggsPerBasket = keyboard.nextInt();
```

  - Reads one int value from the keyboard and assigns it to eggsPerBasket.

Simple Input



LISTING 2.2 A Program with Keyboard Input

```
import java.util.Scanner;

public class EggBasket2
{
    public static void main(String[] args)
    {
        int numberOfBaskets, eggsPerBasket, totalEggs;

        Scanner keyboard = new Scanner(System.in);
        System.out.println("Enter the number of eggs in each basket:");
        eggsPerBasket = keyboard.nextInt();
        System.out.println("Enter the number of baskets:");
        numberOfBaskets = keyboard.nextInt();

        totalEggs = numberOfBaskets * eggsPerBasket;

        System.out.println("If you have");
        System.out.println(eggsPerBasket + " eggs per basket and");
        System.out.println(numberOfBaskets + " baskets, then");
        System.out.println("the total number of eggs is " + totalEggs);

        System.out.println("Now we take two eggs out of each basket.");

        eggsPerBasket = eggsPerBasket - 2;
        totalEggs = numberOfBaskets * eggsPerBasket;

        System.out.println("You now have");
        System.out.println(eggsPerBasket + " eggs per basket and");
        System.out.println(numberOfBaskets + " baskets.");
        System.out.println("The new total number of eggs is " + totalEggs);
    }
}
```

Gets the `Scanner` *class from the package (library)* `java.util`

Sets up things so the program can accept keyboard input

Reads one whole number from the keyboard

Simple Screen Output

- Syntax

```
System.out.println(<contents to display>);
```

```
Ex) System.out.println("The count is " + count);
```

  - Outputs the sting literal "the count is "
  - Followed by the current value of the variable count.

Constants

- Literal expressions such as 2, 3.7, or 'y' are called constants.
  - Numeral constants can be preceded by a + or – sign

- Floating-point constants can be written
  - With digits after a decimal point or
  - Using *e* notation.

    Ex) 865000000.0 ➔ 8.65e8 // denotes $8.65*10^{8}$

    0.000483 ➔ 4.83e-4 // denotes $4.83*10^{-4}$

    - The number in front of the *e* does not need to contain a decimal point.

- Named constants

  public static final Type Variable = Constant;

  Ex) public static final double PI = 3.14159;

Assignment Compatibilities

- Java is said to be strongly typed.

  Ex) You can't assign a floating point value to a variable declared to store an integer.

- Sometimes conversions between numbers are possible.

  Ex) doubleVariable = 7;

  - byte → short → int → long → float → double
    - But not to a variable of any type further to the left.
  - char → int

Type Casting

- A type cast temporarily changes the value of a variable from the declared type to some other type.

Ex)

```
double distance = 9.0;
int points = (int)distance;
```

  - Illegal without (int)

- The value of (int)distance is 9,
  - Any nonzero value to the right of the decimal point is truncated rather than rounded.
- The value of distance, both before and after the cast, is 9.0.

Arithmetic Operators

- Arithmetic expressions can be formed using
  - Operators, such as +, -, *, and /
  - Operands, such as variables or numbers

- Type of expression
  - When both operands are of the same type, the result is of that type.
  - When one of the operands is a floating-point type and the other is an integer, the result is a floating point type.

```
Ex) int hoursWorked = 40;
 double payRate = 8.25;
```

➔ hoursWorked * payRate is a double with a value of 500.0.

Arithmetic Operations

- Expressions with two or more operators can be viewed as a series of steps, each involving only two operands.

  Ex) balance + (balance * rate)

  - The result is the rightmost type from the following list that occurs in the expression.

    byte → short → int → long → float → double

Arithmetic Operators

- Division operator
  - When both operands are integer types, the result is truncated, not rounded.

    Ex) 99/100 has a value of 0.

- The mod (%) operator is used with operators of integer type to obtain the remainder after integer division.

  Ex) 14 % 4 is equal to 2.   // 14 = 4 * 3 + 2.

  - The mod operator has many uses, including
    - Determining if an integer is odd or even
    - Determining if one integer is evenly divisible by another integer.

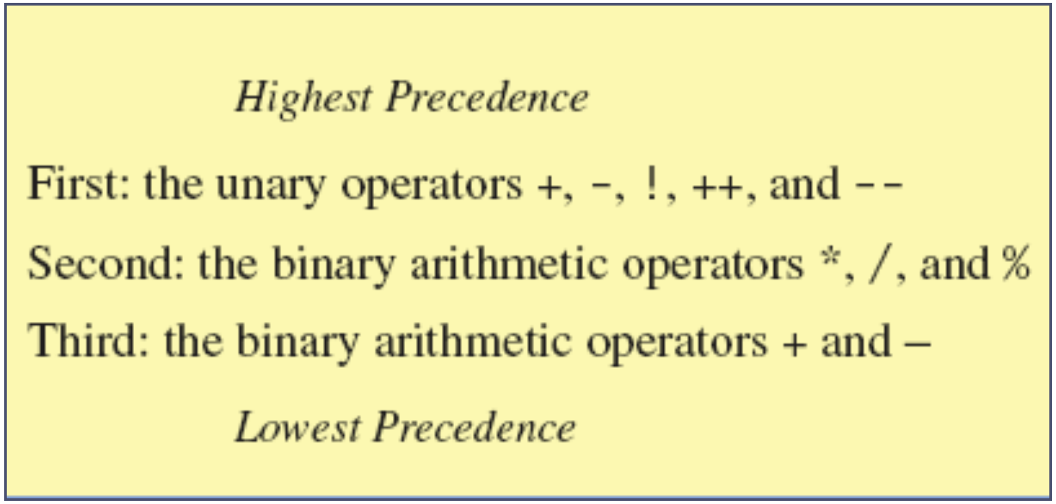
Parentheses and Precedence rules

- Parentheses can communicate the order in which arithmetic operations are performed.

  Ex) (cost + tax) * discount

  cost + (tax * discount)

- Without parentheses, an expressions is evaluated according to the rules of precedence.



Highest Precedence

First: the unary operators +, -, !, ++, and --

Second: the binary arithmetic operators *, /, and %

Third: the binary arithmetic operators + and –

Lowest Precedence

Precedence Rules

- When binary operators have equal precedence
  - Left to right precedence

  Ex) 5 + 3 - 2

- When unary operators have equal precedence.
  - Right to left precedence

  Ex) - ++a   // ! ++a is NOT a valid Java expression

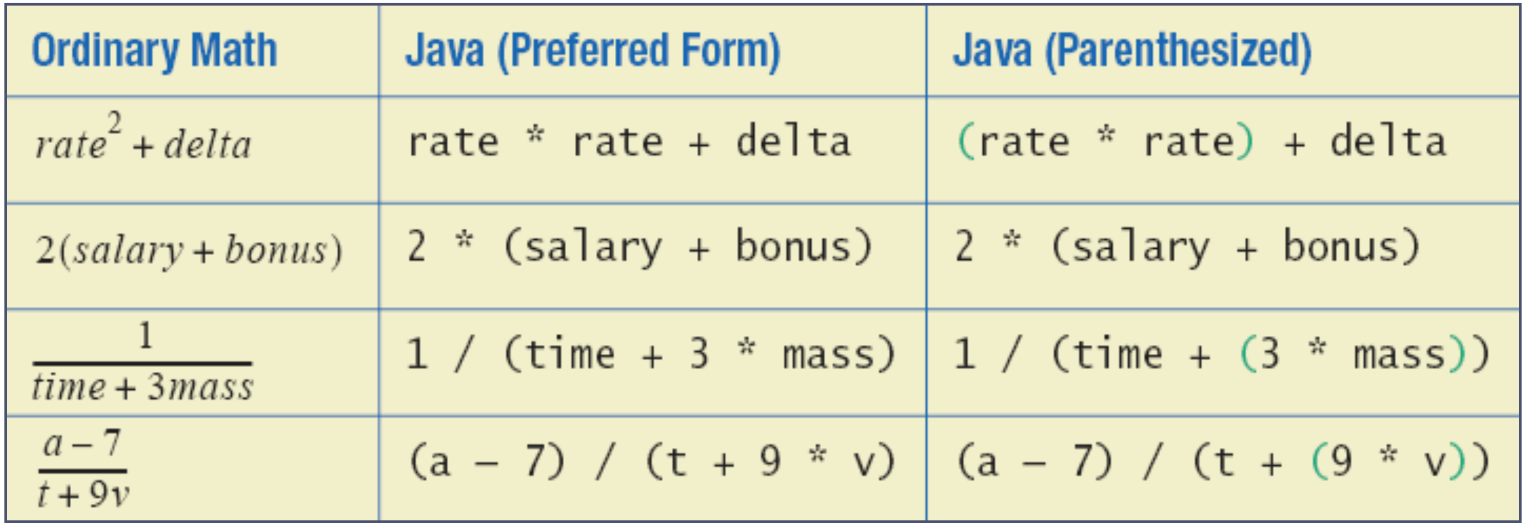
Making Code Clearer

- Even when parentheses are not needed, they can be used to make the code clearer.
  - balance + (interestRate * balance)

- Spaces also make code clearer

  Ex) balance + interestRate*balance

Sample Expressions



Ordinary Math	Java (Preferred Form)	Java (Parenthesized)
$rate^2 + delta$	rate * rate + delta	(rate * rate) + delta
$2(salary + bonus)$	2 * (salary + bonus)	2 * (salary + bonus)
$\frac{1}{time + 3mass}$	1 / (time + 3 * mass)	1 / (time + (3 * mass))
$\frac{a - 7}{t + 9v}$	(a - 7) / (t + 9 * v)	(a - 7) / (t + (9 * v))

Specialized Assignment Operators

- Assignment operators can be combined with arithmetic operators (including -, *, /, and %, discussed later).

Ex) amount = amount + 5;

  - can be written as

```
amount += 5;
```

Increment and Decrement Operators

- Used to increase (or decrease) the value of a variable by 1
  - Easy to use, important to recognize
- The increment operator
  - count++ or ++count
- The decrement operator
  - count-- or --count

Increment and Decrement Operators

- Equivalent operations
  - count++;
  - ++count;
  - count = count + 1;

  - count--;
  - --count;
  - count = count - 1;
  - count -= 1

Increment and Decrement Operators

In expressions

Ex)

```
int m = 4;
int result = 3 * (++m);
```

➔ After executing, result has a value of 15 and m has a value of 5

Ex)

```
int m = 4;
int result = 3 * (m++)
```

➔ After executing, result has a value of 12 and m has a value of 5

Agenda

- Variables and Expressions
- **The Class String**
- Keyboard and Screen I/O
- Documentation and Style
- Graphics Supplement

The Class String

- A value of type String is a
  - Sequence of characters
  - Treated as a single item.

Ex) "Enter a whole number from 1 to 99.“

String Constants and Variables

- Declaring

```
String variale_name;

Ex) String greeting;
        greeting = "Hello!";
        or
        String greeting = "Hello!";
        or
        String greeting = new String("Hello!");
```

- Printing

```
System.out.println(greeting);
```

Concatenation of Strings

- Two strings are concatenated using the + operator.

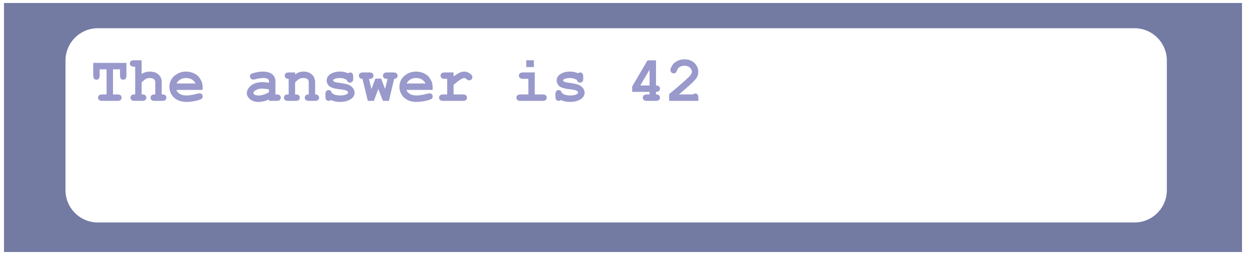
```
String greeting = "Hello";
String sentence;
sentence = greeting + " officer";
System.out.println(sentence);
```

- Any number of strings can be concatenated using the + operator.

Concatenating Strings and other types

- You can even use + to connect a String object to any other type of object.
  - The result is always a String object.

```
String solution;
solution = "The answer is " + 42;
System.out.println (solution);
```



```
The answer is 42
```

String Methods

- An object of the String class stores data consisting of a sequence of characters.

- Objects have methods as well as data
  - Note: object = data + operations

The Method length()

- The length() method returns the number of characters in a particular String object.

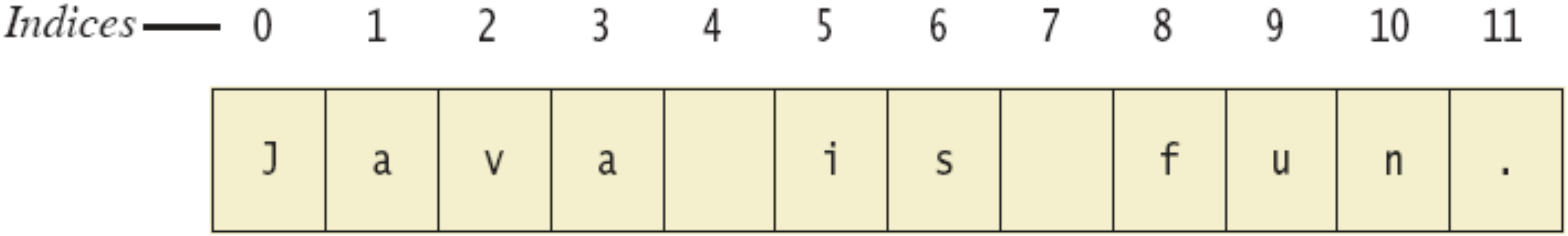
```
String greeting = "Hello";
int n = greeting.length();
```

  - The method length() returns an int.

- You can use a call to method length() anywhere an int can be used.

```
int count = command.length();
System.out.println("Length is " + command.length());
count = command.length() + 3;
```

String Indices



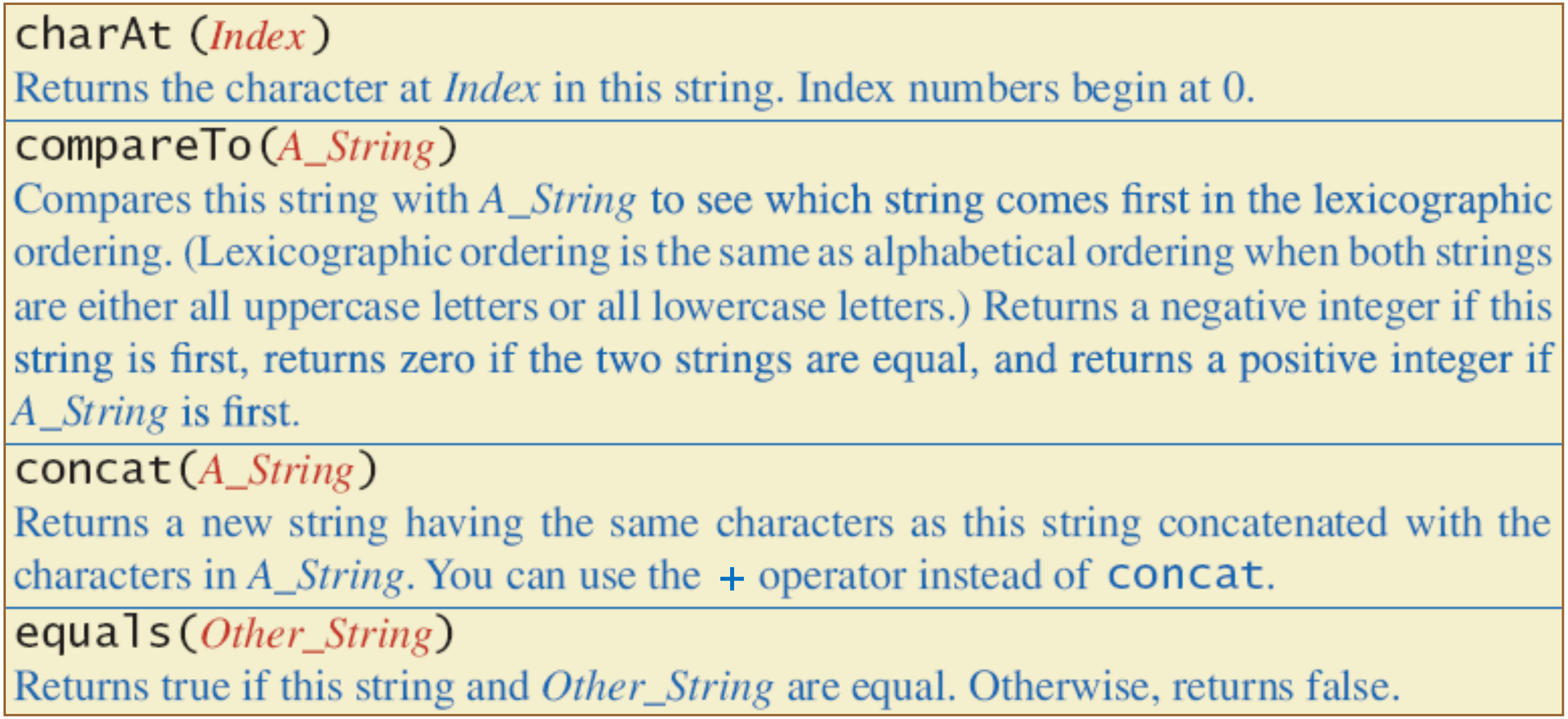
Indices	0	1	2	3	4	5	6	7	8	9	10	11
	J	a	v	a		i	s		f	u	n	.

- A position is referred to as an index.
  - Positions start with 0, not 1.

Ex) The 'J' in "Java is fun." is in position 0

Ex) The 'f' in "Java is fun." is at index 8.

String Methods



`charAt` (*Index*)

Returns the character at *Index* in this string. Index numbers begin at 0.

`compareTo`(*A_String*)

Compares this string with *A_String* to see which string comes first in the lexicographic ordering. (Lexicographic ordering is the same as alphabetical ordering when both strings are either all uppercase letters or all lowercase letters.) Returns a negative integer if this string is first, returns zero if the two strings are equal, and returns a positive integer if *A_String* is first.

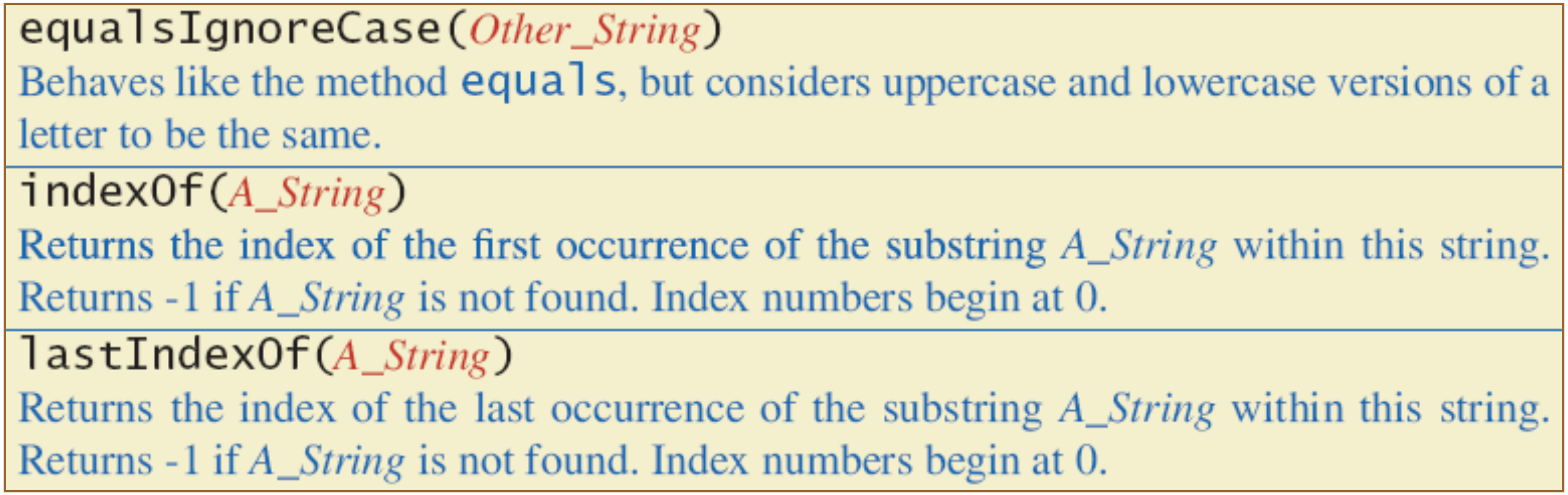
`concat`(*A_String*)

Returns a new string having the same characters as this string concatenated with the characters in *A_String*. You can use the + operator instead of `concat`.

`equals`(*Other_String*)

Returns true if this string and *Other_String* are equal. Otherwise, returns false.

String Methods



`equalsIgnoreCase(`*Other_String*`)`

Behaves like the method `equals`, but considers uppercase and lowercase versions of a letter to be the same.

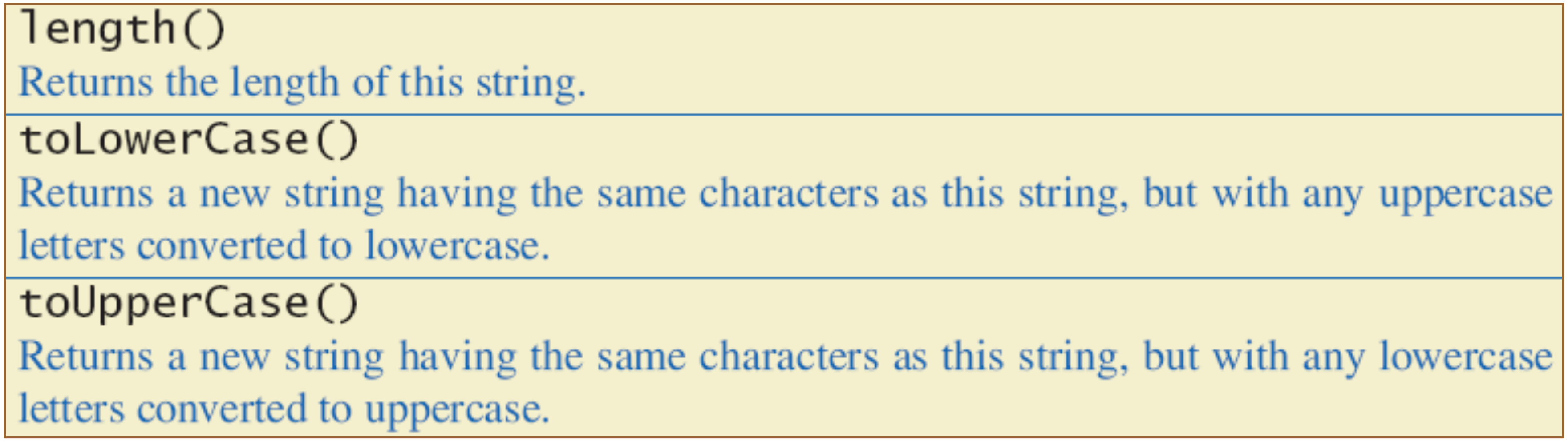
`indexOf(`*A_String*`)`

Returns the index of the first occurrence of the substring *A_String* within this string. Returns -1 if *A_String* is not found. Index numbers begin at 0.

`lastIndexOf(`*A_String*`)`

Returns the index of the last occurrence of the substring *A_String* within this string. Returns -1 if *A_String* is not found. Index numbers begin at 0.

String Methods



`length()`

Returns the length of this string.

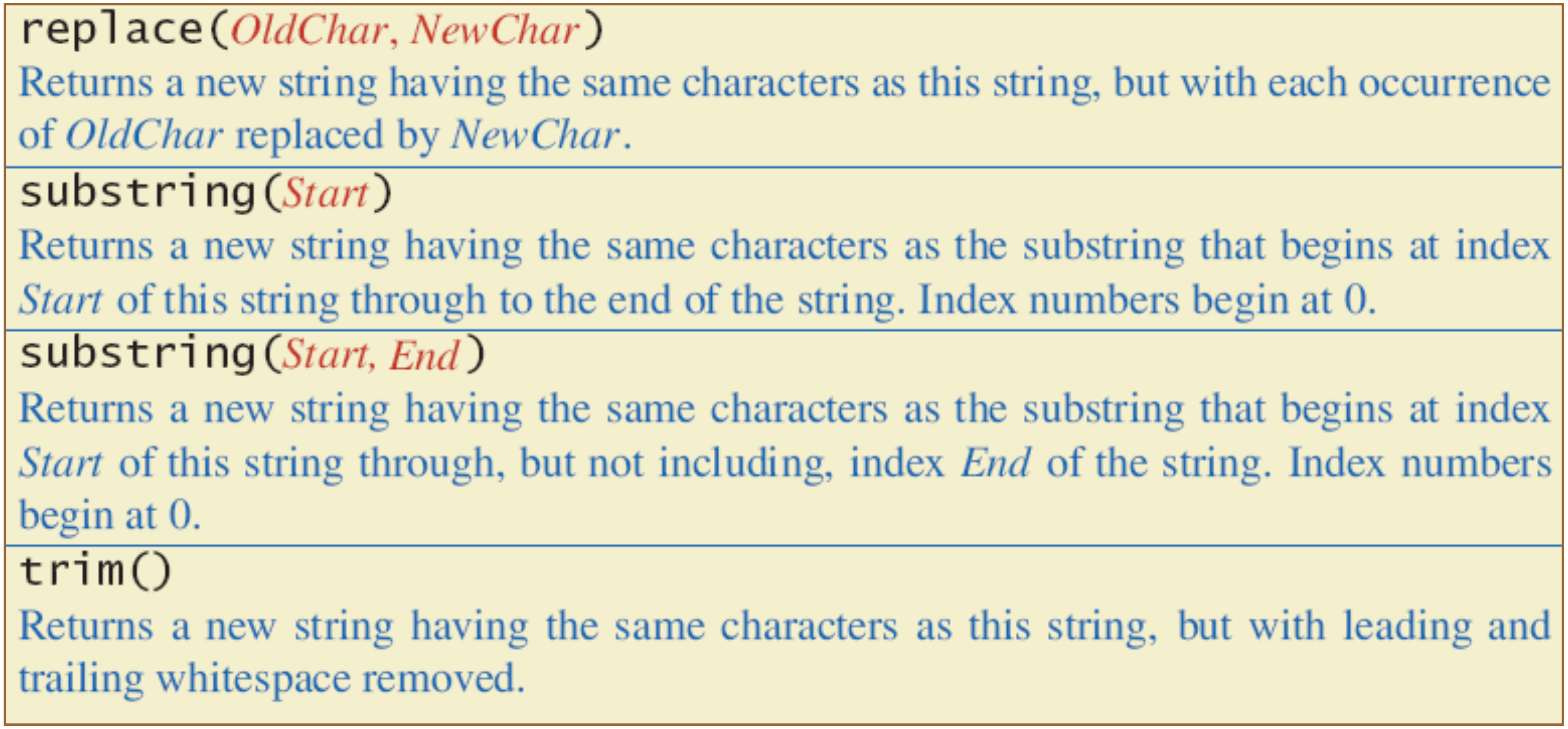
`toLowerCase()`

Returns a new string having the same characters as this string, but with any uppercase letters converted to lowercase.

`toUpperCase()`

Returns a new string having the same characters as this string, but with any lowercase letters converted to uppercase.

String Methods



`replace(`*OldChar*`,` *NewChar*`)`

Returns a new string having the same characters as this string, but with each occurrence of *OldChar* replaced by *NewChar*.

`substring(`*Start*`)`

Returns a new string having the same characters as the substring that begins at index *Start* of this string through to the end of the string. Index numbers begin at 0.

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

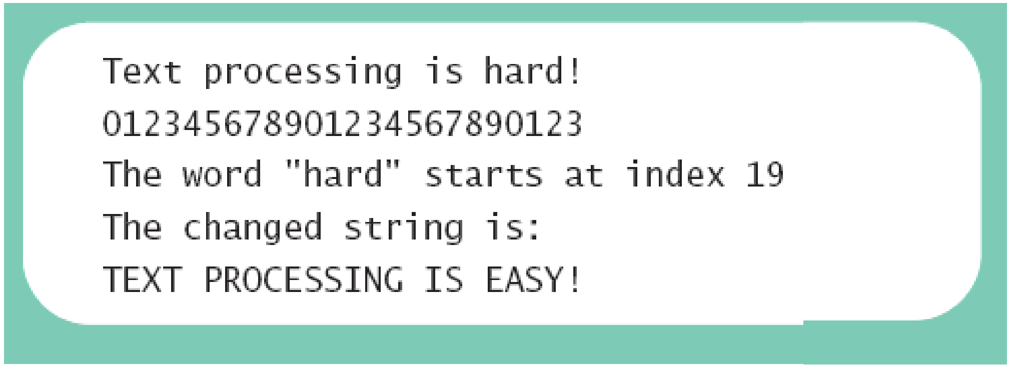
Returns a new string having the same characters as the substring that begins at index *Start* of this string through, but not including, index *End* of the string. Index numbers begin at 0.

`trim()`

Returns a new string having the same characters as this string, but with leading and trailing whitespace removed.

String Processing

```
public class StringDemo
{
    public static void main (String [] args)
    {
        String sentence = "Text processing is hard!";
        int position = sentence.indexOf ("hard");
        System.out.println (sentence);
        System.out.println ("012345678901234567890123");
        System.out.println ("The word \"hard\" starts at index " + position);
        sentence = sentence.substring (0, position) + "easy!";
        sentence = sentence.toUpperCase ();
        System.out.println ("The changed string is:");
        System.out.println (sentence);
    }
}
```



```
Text processing is hard!
012345678901234567890123
The word "hard" starts at index 19
The changed string is:
TEXT PROCESSING IS EASY!
```

Escape Characters

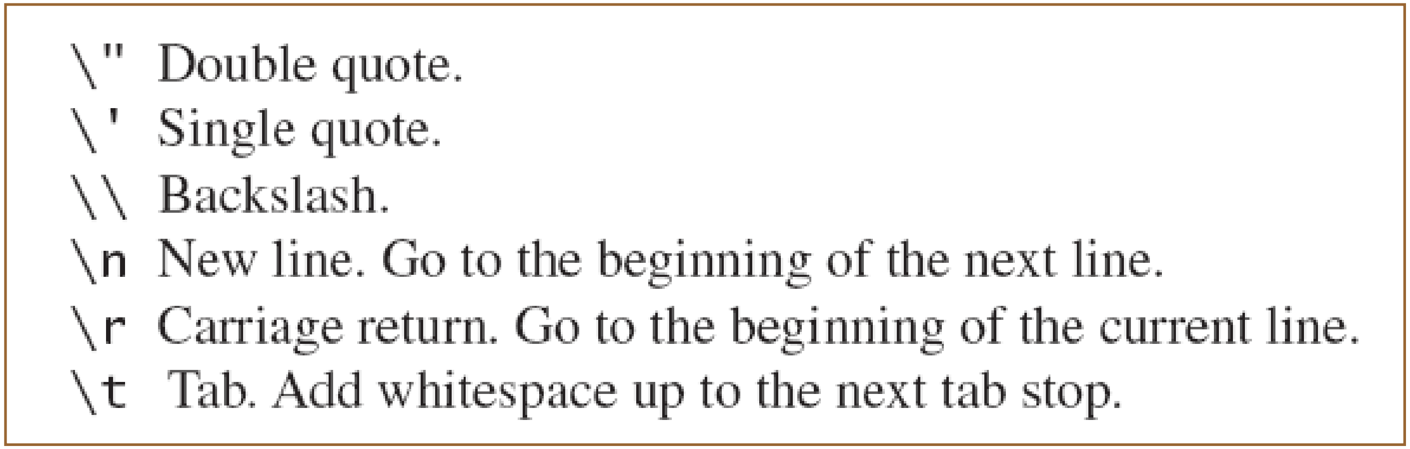
- How would you print the following string?

  "Java" refers to a language.

- The compiler needs to be told that the quotation marks (") do not signal the start or end of a string, but instead are to be printed.
  - System.out.println("\"Java\" refers to a language.");

Escape Characters

- Each escape sequence is a single character even though it is written with two symbols.



`\"`	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. Add whitespace up to the next tab stop.

Examples

```
System.out.println("abc\\def");
```

```
abc\def
```

```
System.out.println("new\nline");
```

```
new
line
```

```
char singleQuote = '\'';
System.out.println(singleQuote);
```

```
'
```

The Unicode Character Set

- Most programming languages use the ASCII character set.

- Java uses the Unicode character set which includes the ASCII character set.
  - The Unicode character set includes characters from many different alphabets (but you probably won't use them).

  Ex) Hangul, Chinese characters, Arabic characters, …

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Screen Output

- System.out is an object that is part of Java.
  - println() is one of the methods available to the System.out object.

- The concatenation operator (+) is useful when everything does not fit on one line.

  Ex)
  ```
  System.out.println("Lucky number = " + 13 +
                     "Secret number = " + number);
  ```

- Do not break the line except immediately before or after the concatenation operator (+).

Screen Output

- Alternatively, use print()

```
System.out.print("One, two,");
System.out.print(" buckle my shoe.");
System.out.println(" Three, four,");
System.out.println(" shut the door.");
```

  - ending with a println().

- Result

```
One, two, buckle my shoe. Three, four,
shut the door.
```

Keyboard Input

- Java has reasonable facilities for handling keyboard input.

- These facilities are provided by the Scanner class in the java.util package.
  - A package is a library of classes.

Using the Scanner Class

- Near the beginning of your program, insert

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

- Create an object of the Scanner class

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

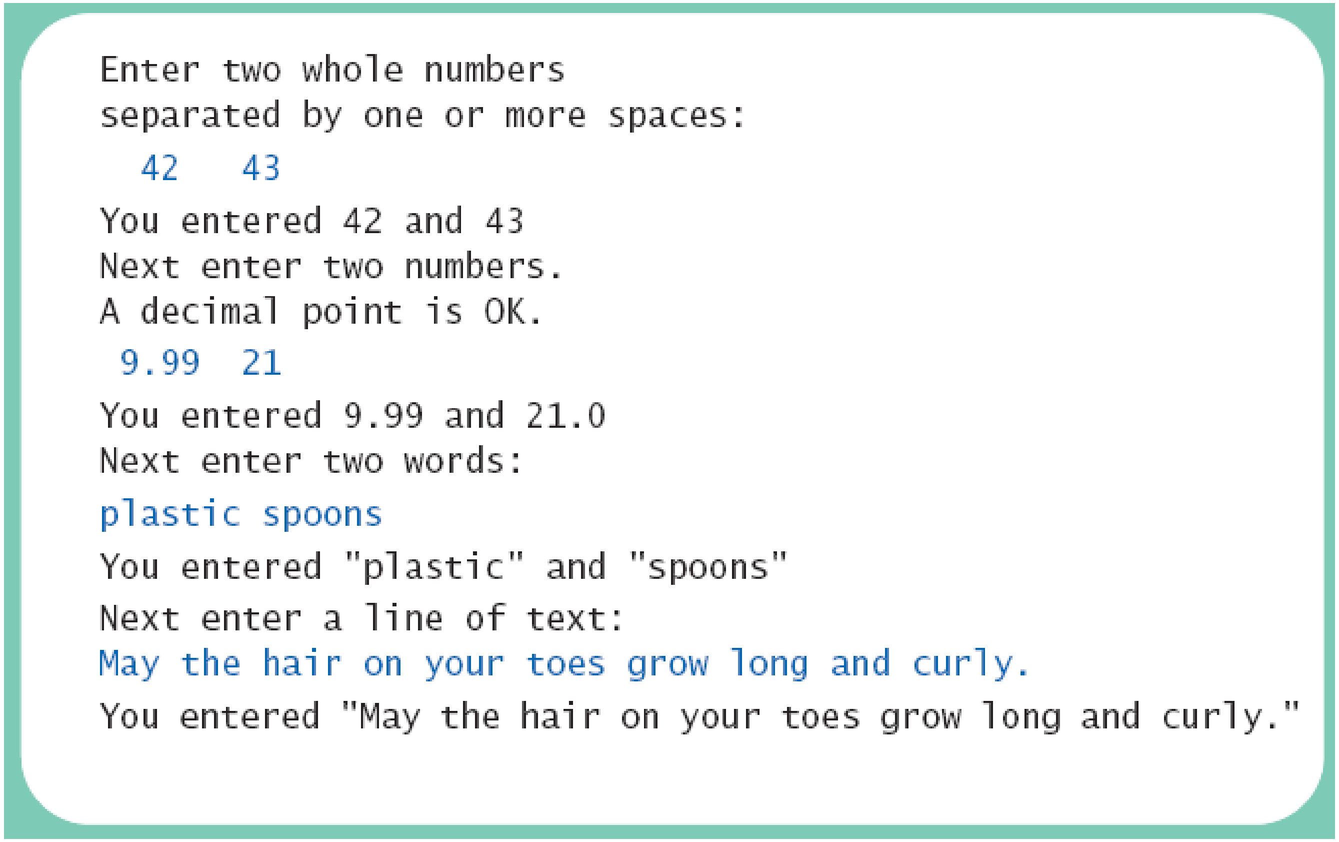
- Read data (an int or a double, for example)

```
int n1 = keyboard.nextInt();
double d1 = keyboard.nextDouble();
```

ScannerDemo (Listing 2.5)

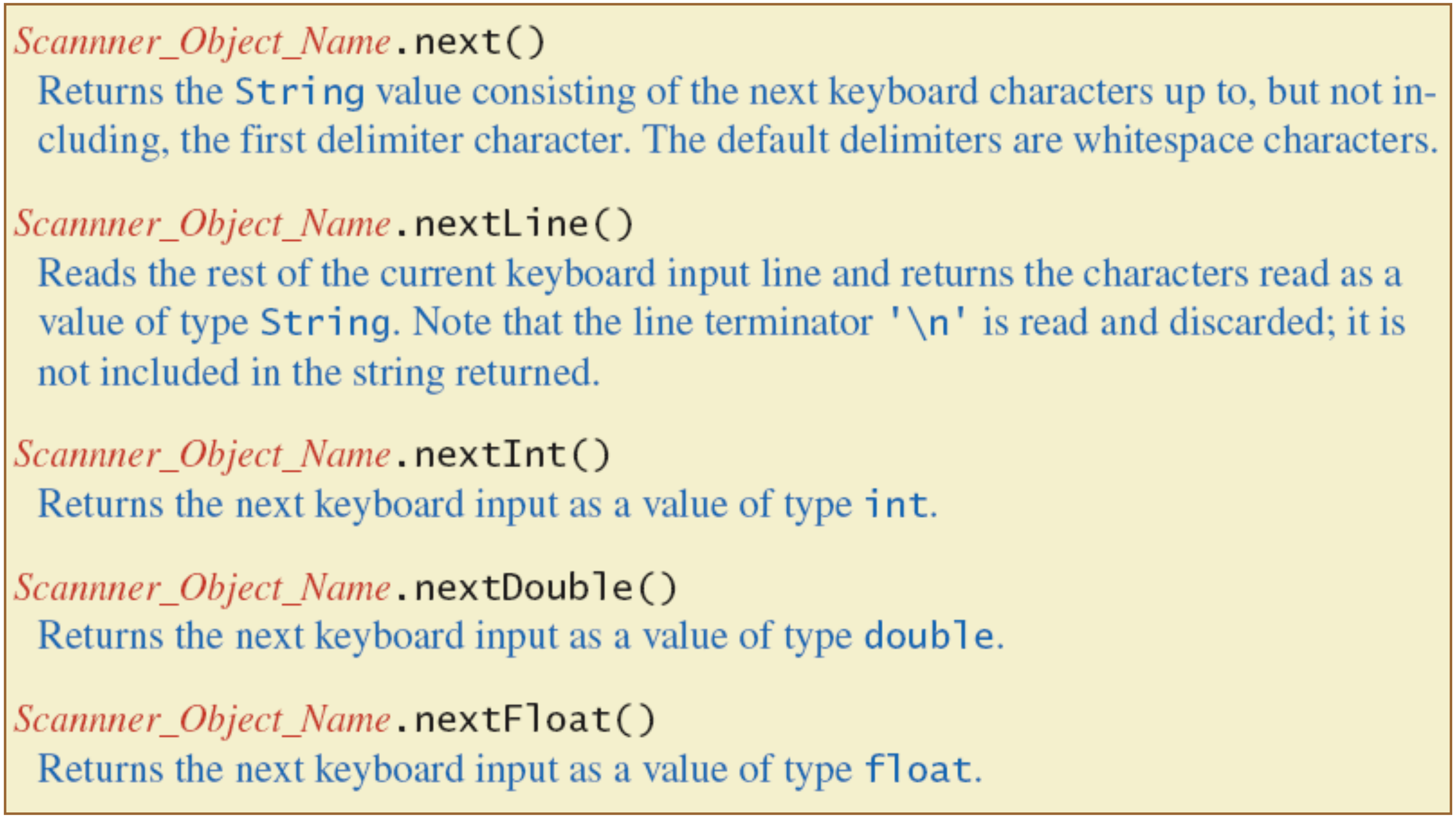
```
import java.util.Scanner;
public class ScannerDemo {
    public static void main (String [] args) {
        Scanner keyboard = new Scanner (System.in);
        System.out.println ("Enter two whole numbers");
        System.out.println ("separated by one or more spaces:");
        int n1, n2;
        n1 = keyboard.nextInt ();
        n2 = keyboard.nextInt ();
        System.out.println ("You entered " + n1 + " and " + n2);
        System.out.println ("Next enter two numbers.");
        System.out.println ("A decimal point is OK.");
        double d1, d2;
        d1 = keyboard.nextDouble ();
        d2 = keyboard.nextDouble ();
        System.out.println ("You entered " + d1 + " and " + d2);
        System.out.println ("Next enter two words:");
        String s1, s2;
        s1 = keyboard.next ();
        s2 = keyboard.next ();
        System.out.println ("You entered \"" + s1 + "\" and \"" + s2 + "\"");
        s1 = keyboard.nextLine (); //To get rid of '\n'
        System.out.println ("Next enter a line of text:");
        s1 = keyboard.nextLine ();
        System.out.println ("You entered: \"" + s1 + "\"");
    }
}
```

ScannerDemo (Listing 2.5)



```
Enter two whole numbers
separated by one or more spaces:
  42   43
You entered 42 and 43
Next enter two numbers.
A decimal point is OK.
 9.99  21
You entered 9.99 and 21.0
Next enter two words:
plastic spoons
You entered "plastic" and "spoons"
Next enter a line of text:
May the hair on your toes grow long and curly.
You entered "May the hair on your toes grow long and curly."
```

Some *Scanner* Class Methods



Scannner_Object_Name`.next()`

Returns the `String` value consisting of the next keyboard characters up to, but not including, the first delimiter character. The default delimiters are whitespace characters.

Scannner_Object_Name`.nextLine()`

Reads the rest of the current keyboard input line and returns the characters read as a value of type `String`. Note that the line terminator `'\n'` is read and discarded; it is not included in the string returned.

Scannner_Object_Name`.nextInt()`

Returns the next keyboard input as a value of type `int`.

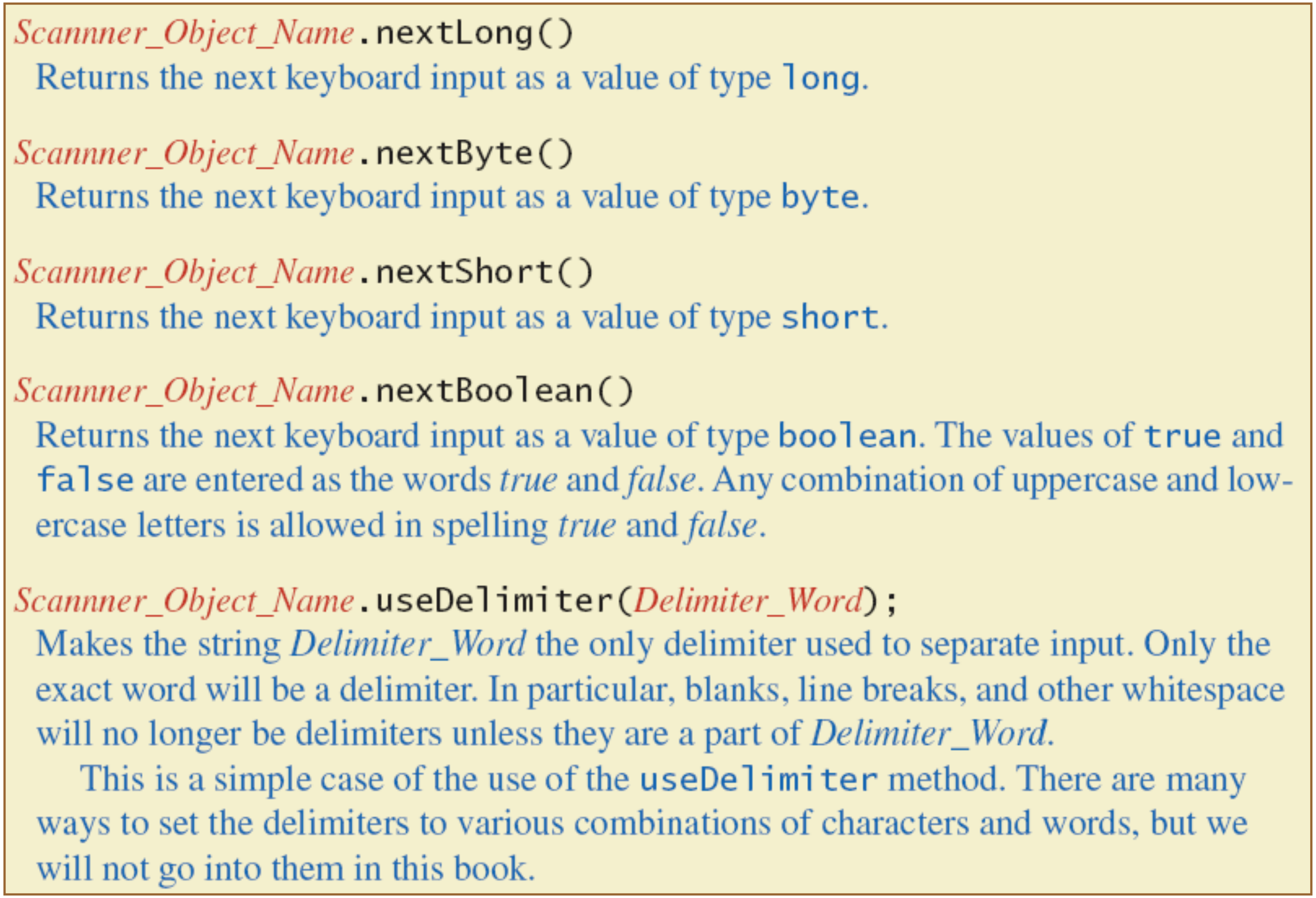
Scannner_Object_Name`.nextDouble()`

Returns the next keyboard input as a value of type `double`.

Scannner_Object_Name`.nextFloat()`

Returns the next keyboard input as a value of type `float`.

Some *Scanner* Class Methods



Scannner_Object_Name`.nextLong()`
Returns the next keyboard input as a value of type `long`.

Scannner_Object_Name`.nextByte()`
Returns the next keyboard input as a value of type `byte`.

Scannner_Object_Name`.nextShort()`
Returns the next keyboard input as a value of type `short`.

Scannner_Object_Name`.nextBoolean()`
Returns the next keyboard input as a value of type `boolean`. The values of `true` and `false` are entered as the words *true* and *false*. Any combination of uppercase and lowercase letters is allowed in spelling *true* and *false*.

Scannner_Object_Name`.useDelimiter(`*Delimiter_Word*`);`
Makes the string *Delimiter_Word* the only delimiter used to separate input. Only the exact word will be a delimiter. In particular, blanks, line breaks, and other whitespace will no longer be delimiters unless they are a part of *Delimiter_Word*.

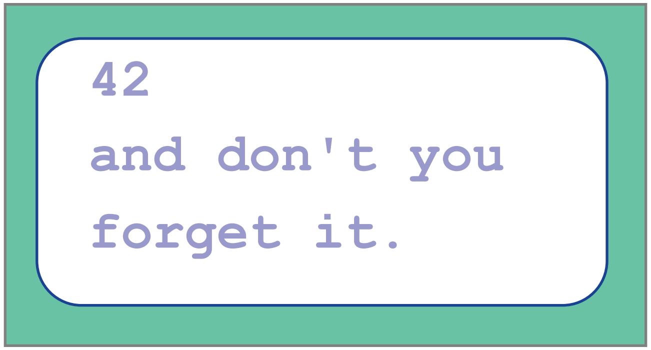
This is a simple case of the use of the `useDelimiter` method. There are many ways to set the delimiters to various combinations of characters and words, but we will not go into them in this book.

nextLine() Method Caution

- The nextLine() method reads
  - The remainder of the current line,
  - Even if it is empty.

Ex)

```
int n;
String s1, s2;
n = keyboard.nextInt();
s1 = keyboard.nextLine();
s2 = keyboard.nextLine();
```



```
42
and don't you
forget it.
```

- Assume input shown
  - n is set to 42
  - but s1 is set to the empty string.

The Empty String

- A string can have any number of characters, including zero.
- The string with zero characters is called the empty string.
- The empty string is useful and can be created in many ways including
  - String s3 = "";

Other Input Delimiters (optional)

- Almost any combination of characters and strings can be used to separate keyboard input.

Ex) Change the delimiter to "##"

```
keyboard2.useDelimiter("##");
```

  - whitespace will no longer be a delimiter for keyboard2 input

Agenda

- Variables and Expressions
- The Class String
- Keyboard and Screen I/O
- **Documentation and Style**
- Graphics Supplement

Documentation and Style

- Most programs are modified over time to respond to new requirements.
- Programs which are easy to read and understand are easy to modify.
- Even if it will be used only once, you have to read it in order to debug it.

Meaningful Variable Names

- A variable's name should suggest its use.
- Observe conventions in choosing names for variables.
  - Use only letters and digits.
  - "Punctuate" using uppercase letters at word boundaries (e.g. taxRate).
  - Start variable names with lowercase letters.
  - Start class names with uppercase letters.

Comments

- Comments are written into a program as needed to explain the program.
  - They are useful to the programmer, but they are ignored by the compiler.

- A comment can begin with //.
  - Everything after these symbols and to the end of the line is treated as a comment and is ignored by the compiler.

```
double radius;        // in centimeters
```

Comments

- A comment can begin with /* and end with */
  - Everything between these symbols is treated as a comment and is ignored by the compiler.

```
/*
    This program should only
    be used on alternate Thursdays,
    except during leap years, when it should
    only be used on alternate Tuesdays.
*/
```

Comments

- A javadoc comment, begins with /** and ends with */.

- It can be extracted automatically from Java software.

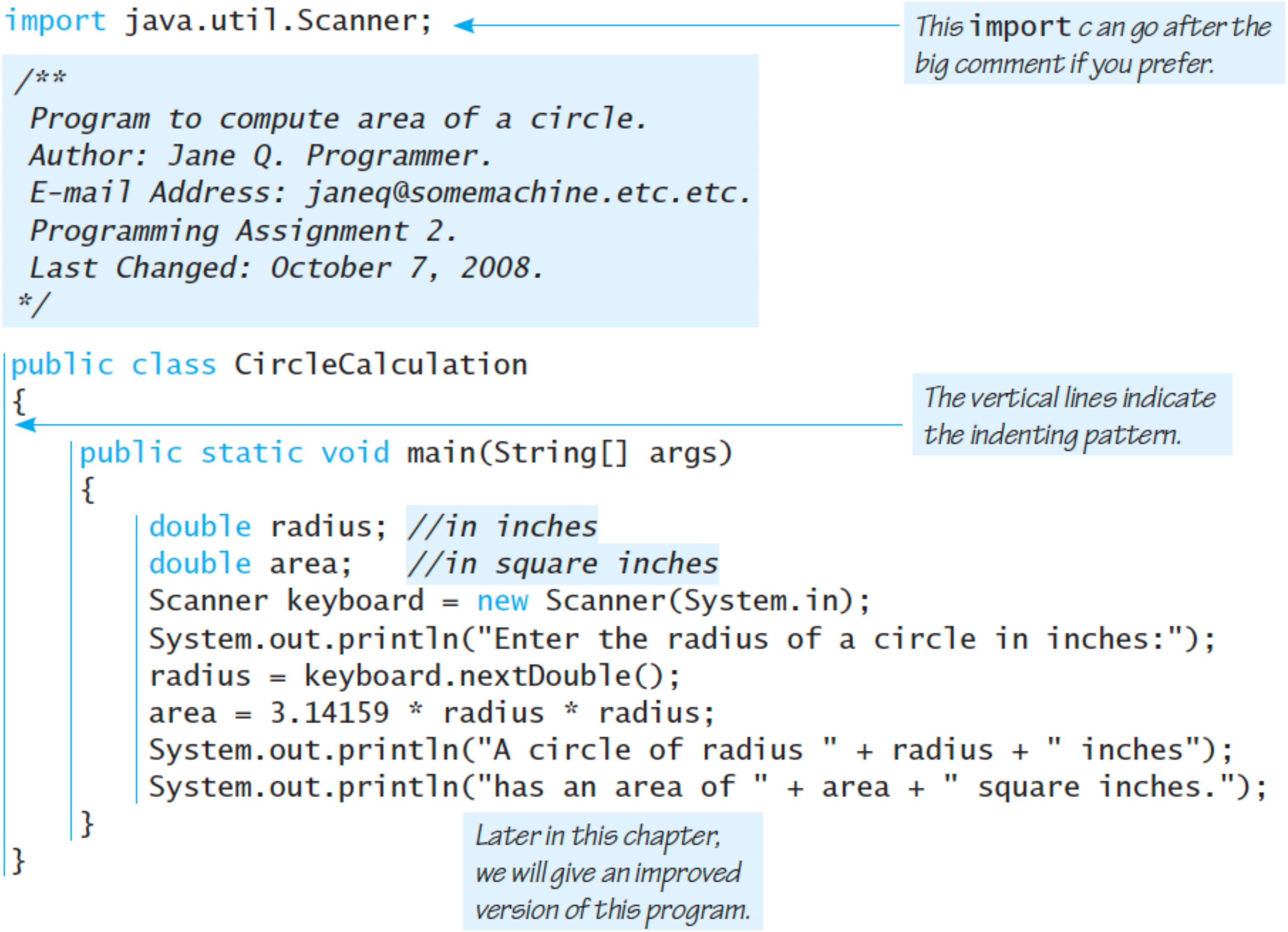
```
/**
	method change requires the number of coins to be nonnegative
*/
```

When to Use Comments

- Begin each program file with an explanatory comment
  - What the program does
  - The name of the author
  - Contact information for the author
  - Date of the last modification.

- Provide only those comments which the expected reader of the program file will need in order to understand it.

Comments Example



```
import java.util.Scanner;

/**
 Program to compute area of a circle.
 Author: Jane Q. Programmer.
 E-mail Address: janeq@somemachine.etc.etc.
 Programming Assignment 2.
 Last Changed: October 7, 2008.
*/

public class CircleCalculation
{
    public static void main(String[] args)
    {
        double radius; //in inches
        double area;   //in square inches
        Scanner keyboard = new Scanner(System.in);
        System.out.println("Enter the radius of a circle in inches:");
        radius = keyboard.nextDouble();
        area = 3.14159 * radius * radius;
        System.out.println("A circle of radius " + radius + " inches");
        System.out.println("has an area of " + area + " square inches.");
    }
}
```

This `import` can go after the big comment if you prefer.

The vertical lines indicate the indenting pattern.

Later in this chapter, we will give an improved version of this program.

Indentation

- Indentation should communicate nesting clearly. (cf. python)
    - Proper indentation helps human readers understand the nested structures of the program
- A good choice is four spaces (or a tab) for each level of indentation.
- Indentation should be consistent.
- Indentation should be used for second and subsequent lines of statements which do not fit on a single line.

Using Named Constants

- To avoid confusion, always name constants (and variables).

  area = PI * radius * radius;

  - is clearer than

  area = 3.14159 * radius * radius;

- Place constants near the beginning of the program.

- Once the value of a constant is set (or changed by an editor), it can be used (or reflected) throughout the program.

  Ex) public static final double INTEREST_RATE = 6.65;

- If a literal (such as 6.65) is used instead, every occurrence must be changed, with the risk than another literal with the same value might be changed unintentionally.

Declaring Constants

- Syntax

  public static final *Variable_Type = Constant*;

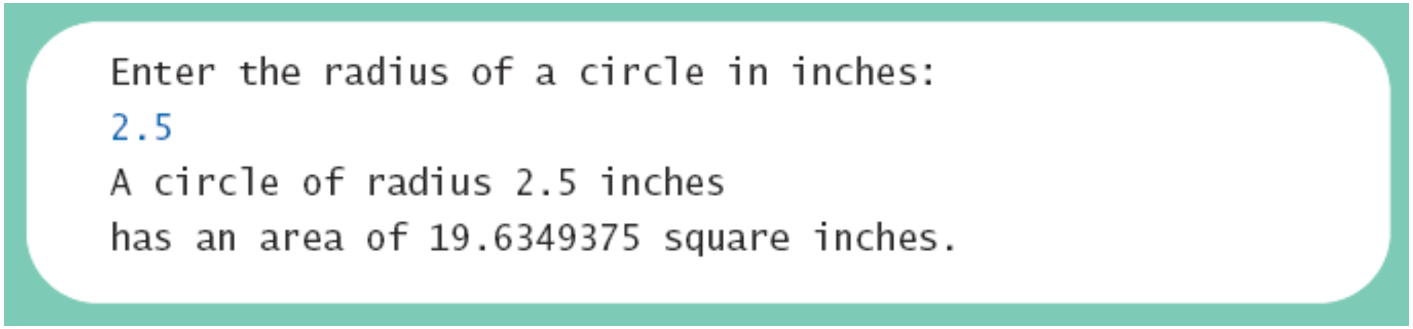
Ex) Examples

```
public static final double PI = 3.14159;
public static final String MOTTO = "The customer is always right.";
```

- By convention, uppercase letters are used for constants.

Named Constants

```
import java.util.Scanner;
public class CircleCalculation2
{
    public static final double PI = 3.14159;
    public static void main (String [] args)
    {
        double radius;                    //in inches
        double area;                      //in square inches
        Scanner keyboard = new Scanner (System.in);
        System.out.println ("Enter the radius of a circle in inches:");
        radius = keyboard.nextDouble ();
        area = PI * radius * radius;
        System.out.println ("A circle of radius " + radius + " inches");
        System.out.println ("has an area of " + area + " square inches.");
    }
}
```



```
Enter the radius of a circle in inches:
2.5
A circle of radius 2.5 inches
has an area of 19.6349375 square inches.
```

questions or comments?

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