

# Chapter 2 Elementary Programming



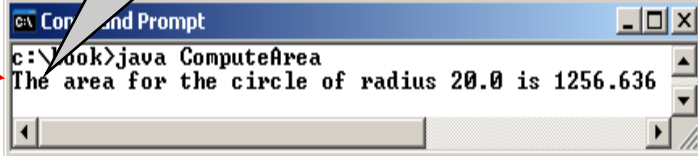
# Trace a Program Execution

```
public class ComputeArea {  
    /** Main method */  
    public static void main(String[] args) {  
        double radius;  
        double area;  
  
        // Assign a radius  
        radius = 20;  
  
        // Compute area  
        area = radius * radius * 3.14159;  
  
        // Display results  
        System.out.println("The area for the circle of radius " +  
            radius + " is " + area);  
    }  
}
```

memory

radius	20
area	1256.636

print a message to the console



```
CA Command Prompt  
c:\book>java ComputeArea  
The area for the circle of radius 20.0 is 1256.636
```

# Reading Input from the Console

1. Create a Scanner object

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

2. Use the method `nextDouble()` to obtain to a double value. For example,

```
System.out.print("Enter a double value: ");  
Scanner input = new Scanner(System.in);  
double d = input.nextDouble();
```

ComputeAreaWithConsoleInput

Run

ComputeAverage

Run

# Identifiers

- An identifier is a sequence of characters that consist of letters, digits, underscores (`_`), and dollar signs (`$`).
- An identifier must start with a letter, an underscore (`_`), or a dollar sign (`$`). It cannot start with a digit.
- An identifier cannot be a reserved word. (See Appendix A, “Java Keywords,” for a list of reserved words).
- An identifier cannot be `true`, `false`, or `null`.
- An identifier can be of any length.

# Variables

```
int x;           // Declare x to be an
                 // integer variable;

double radius;  // Declare radius to
                 // be a double variable;

char a;         // Declare a to be a
                 // character variable;

x = 1;          // Assign 1 to x;

radius = 1.0;   // Assign 1.0 to radius;

a = 'A';        // Assign 'A' to a;
```

# Declaring and Initializing in One Step

☞ `int x = 1;`

☞ `double d = 1.4;`

☞ Named Constants

```
final datatype CONSTANTNAME = VALUE;
```

```
final double PI = 3.14159;
```

```
final int SIZE = 3;
```

# Naming Conventions

- ☞ Choose meaningful and descriptive names.
- ☞ Variables and method names:
  - Use lowercase.
  - If the name consists of several words, concatenate all in one, use lowercase for the first word, and capitalize the first letter of each subsequent word in the name.
  - For example, the variables `radius` and `area`, and the method `computeArea`.

# Naming Conventions, cont.

## ☞ Class names:

- Capitalize the first letter of each word in the name. For example, the class name `ComputeArea`.

## ☞ Constants:

- Capitalize all letters in constants, and use underscores to connect words. For example, the constant `PI` and `MAX_VALUE`



# Character Data Type

```
char letter = 'A';      (ASCII)
```

```
char numChar = '4';    (ASCII)
```

```
char letter = '\u0041'; (Unicode)
```

```
char numChar = '\u0034'; (Unicode)
```

NOTE: The increment and decrement operators can also be used on **char** variables to get the next or preceding Unicode character. For example, the following statements display character **b**.

```
char ch = 'a';
```

```
System.out.println(++ch);
```

# Numerical Data Types

Name	Range	Storage Size
<code>byte</code>	$-2^7$ to $2^7 - 1$ (-128 to 127)	8-bit signed
<code>short</code>	$-2^{15}$ to $2^{15} - 1$ (-32768 to 32767)	16-bit signed
<code>int</code>	$-2^{31}$ to $2^{31} - 1$ (-2147483648 to 2147483647)	32-bit signed
<code>long</code>	$-2^{63}$ to $2^{63} - 1$ (i.e., -9223372036854775808 to 9223372036854775807)	64-bit signed
<code>float</code>	Negative range: -3.4028235E+38 to -1.4E-45 Positive range: 1.4E-45 to 3.4028235E+38	32-bit IEEE 754
<code>double</code>	Negative range: -1.7976931348623157E+308 to -4.9E-324  Positive range: 4.9E-324 to 1.7976931348623157E+308	64-bit IEEE 754

# Reading Numbers from the Keyboard

```
Scanner input = new Scanner(System.in) ;
int value = input.nextInt() ;
```

Method	Description
<code>nextByte ()</code>	reads an integer of the <b>byte</b> type.
<code>nextShort ()</code>	reads an integer of the <b>short</b> type.
<code>nextInt ()</code>	reads an integer of the <b>int</b> type.
<code>nextLong ()</code>	reads an integer of the <b>long</b> type.
<code>nextFloat ()</code>	reads a number of the <b>float</b> type.
<code>nextDouble ()</code>	reads a number of the <b>double</b> type.

# Strings

☞ The char type only represents **one** character. To represent a string of characters, use the data type called **String**. For example:

```
String message = "Welcome to Java!";
```

☞ String is actually a predefined class in the Java library.

☞ The String type is not a primitive type. It is known as a *reference type*.

# More on Strings

// Three strings are concatenated

```
String message = "Welcome " + "to " + "Java";
```

// String Chapter is concatenated with number 2

```
String s = "Chapter" + 2; // s becomes Chapter2
```

- ☞ You can use the **Scanner** class for console input.
- ☞ Java uses **System.in** to refer to the standard input device (i.e. Keyboard).

```
public class Test{
    public static void main(String[] s){
        Scanner input = new Scanner(System.in);
        System.out.println("Enter text : ");
        int x = input.nextLine();
        System.out.println("You entered: "+ x);
    }
}
```

# Integer Division

+, -, \*, /, and %

$5 / 2$  yields an integer 2.

$5.0 / 2$  yields a double value 2.5

$5 \% 2$  yields 1 (the remainder of the division)

# Remainder Operator

Remainder is very useful in programming. For example, an even number % 2 is always 0 and an odd number % 2 is always 1. So you can use this property to determine whether a number is even or odd. Suppose today is Saturday and you and your friends are going to meet in 10 days. What day is in 10 days? You can find that day is Tuesday using the following expression:

Saturday is the 6<sup>th</sup> day in a week

$(6 + 10) \% 7$  is 2

A week has 7 days

The 2<sup>nd</sup> day in a week is Tuesday

After 10 days

# NOTE

Calculations involving floating-point numbers are approximated because these numbers are not stored with complete accuracy. For example,

```
System.out.println(1.0 - 0.1 - 0.1 - 0.1 - 0.1 - 0.1);
```

displays 0.50000000000000000001, not 0.5, and

```
System.out.println(1.0 - 0.9);
```

displays 0.099999999999999999998, not 0.1. Integers are stored precisely. Therefore, calculations with integers yield a precise integer result.



# Exponent Operations

```
System.out.println(Math.pow(2, 3));  
// Displays 8.0  
System.out.println(Math.pow(4, 0.5));  
// Displays 2.0  
System.out.println(Math.pow(2.5, 2));  
// Displays 6.25  
System.out.println(Math.pow(2.5, -2));  
// Displays 0.16
```

# Integer Literals

An integer literal can be assigned to an integer variable as long as it can fit into the variable. A compilation error would occur if the literal were too large for the variable to hold. For example, the statement `byte b = 1000` would cause a compilation error, because 1000 cannot be stored in a variable of the byte type.

An integer literal is assumed to be of the `int` type, whose value is between  $-2^{31}$  (-2147483648) to  $2^{31}-1$  (2147483647). To denote an integer literal of the long type, append it with the letter `L` or `l`. `L` is preferred because `l` (lowercase `L`) can easily be confused with `1` (the digit one).

# Floating-Point Literals

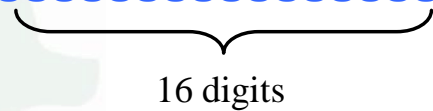
Floating-point literals are written with a decimal point. By default, a floating-point literal is treated as a double type value. For example, 5.0 is considered a double value, not a float value. You can make a number a float by appending the letter f or F, and make a number a double by appending the letter d or D. For example, you can use 100.2f or 100.2F for a float number, and 100.2d or 100.2D for a double number.

# double vs. float

The double type values are more accurate than the float type values. For example,

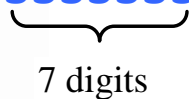
```
System.out.println("1.0 / 3.0 is " + 1.0 / 3.0);
```

displays `1.0 / 3.0 is 0.3333333333333333`



```
System.out.println("1.0F / 3.0F is " + 1.0F / 3.0F);
```

displays `1.0F / 3.0F is 0.33333334`



# Arithmetic Expressions

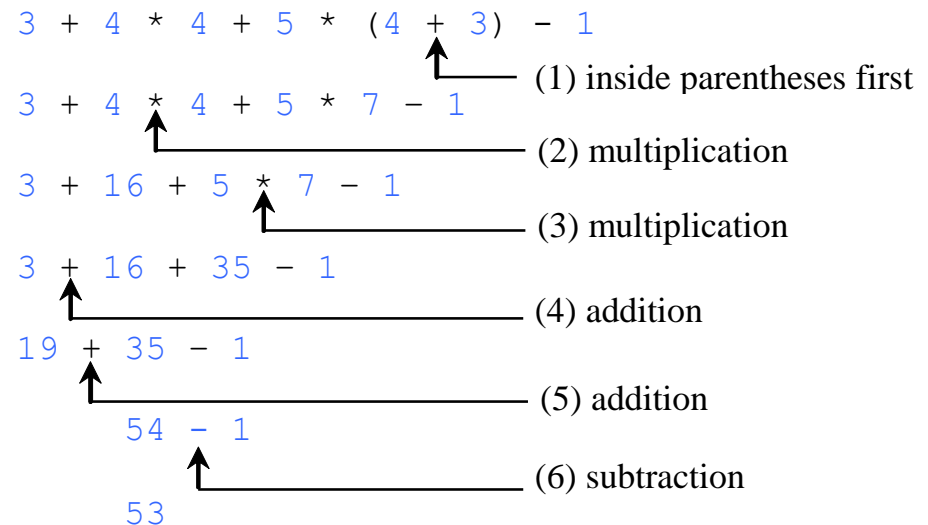
$$\frac{3 + 4x}{5} - \frac{10(y - 5)(a + b + c)}{x} + 9\left(\frac{4}{x} + \frac{9 + x}{y}\right)$$

is translated to

$$(3+4*x)/5 - 10*(y-5)*(a+b+c)/x + 9*(4/x + (9+x)/y)$$

# How to Evaluate an Expression

Though Java has its own way to evaluate an expression behind the scene, the result of a Java expression and its corresponding arithmetic expression are the same. Therefore, you can safely apply the arithmetic rule for evaluating a Java expression.



# Problem: Converting Temperatures

Write a program that converts a Fahrenheit degree to Celsius using the formula:

$$celsius = \left(\frac{5}{9}\right)(fahrenheit - 32)$$

Note: you have to write

$$celsius = (5.0 / 9) * (fahrenheit - 32)$$

FahrenheitToCelsius

Run

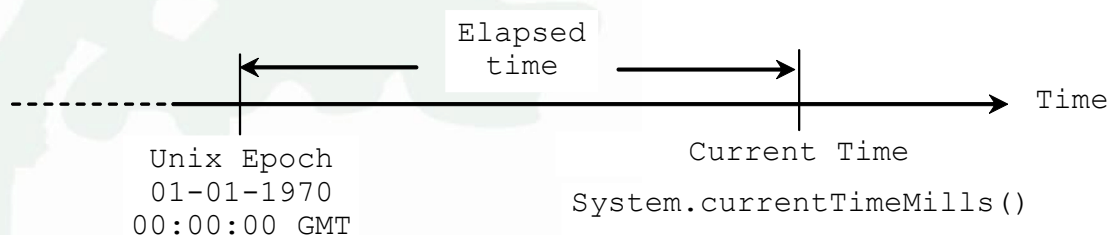
```
➔ public class FahrenheitToCelsius {  
➔     public static void main(String[] args) {  
➔         Scanner input = new Scanner(System.in);  
  
➔         System.out.print("Enter a degree in Fahrenheit: ");  
➔         double fahrenheit = input.nextDouble();  
  
➔         // Convert Fahrenheit to Celsius  
➔         double celsius = (5.0 / 9) * (fahrenheit - 32);  
➔         System.out.println("Fahrenheit " + fahrenheit + " is " +  
➔             celsius + " in Celsius");  
➔     }  
➔ }
```



# Problem: Displaying Current Time

Write a program that displays current time in GMT in the format hour:minute:second such as 1:45:19.

The `currentTimeMillis` method in the `System` class returns the current time in milliseconds since the midnight, January 1, 1970 GMT. (1970 was the year when the Unix operating system was formally introduced.) You can use this method to obtain the current time, and then compute the current second, minute, and hour as follows.



ShowCurrentTime

Run

# Augmented Assignment Operators

<i>Operator</i>	<i>Name</i>	<i>Example</i>	<i>Equivalent</i>
<code>+=</code>	Addition assignment	<code>i += 8</code>	<code>i = i + 8</code>
<code>-=</code>	Subtraction assignment	<code>i -= 8</code>	<code>i = i - 8</code>
<code>*=</code>	Multiplication assignment	<code>i *= 8</code>	<code>i = i * 8</code>
<code>/=</code>	Division assignment	<code>i /= 8</code>	<code>i = i / 8</code>
<code>%=</code>	Remainder assignment	<code>i %= 8</code>	<code>i = i % 8</code>

# Increment and Decrement Operators

<i>Operator</i>	<i>Name</i>	<i>Description</i>	<i>Example (assume i = 1)</i>
<b>++var</b>	preincrement	Increment <b>var</b> by <b>1</b> , and use the new <b>var</b> value in the statement	<pre>int j = ++i; // j is 2, i is 2</pre>
<b>var++</b>	postincrement	Increment <b>var</b> by <b>1</b> , but use the original <b>var</b> value in the statement	<pre>int j = i++; // j is 1, i is 2</pre>
<b>--var</b>	predecrement	Decrement <b>var</b> by <b>1</b> , and use the new <b>var</b> value in the statement	<pre>int j = --i; // j is 0, i is 0</pre>
<b>var--</b>	postdecrement	Decrement <b>var</b> by <b>1</b> , and use the original <b>var</b> value in the statement	<pre>int j = i--; // j is 1, i is 0</pre>

# Increment and Decrement Operators, cont.

```
int i = 10;
int newNum = 10 * i++;
```

Same effect as

```
int newNum = 10 * i;
i = i + 1;
```

```
int i = 10;
int newNum = 10 * (++i);
```

Same effect as

```
i = i + 1;
int newNum = 10 * i;
```

# Increment and Decrement Operators, cont.

Using increment and decrement operators makes expressions short, but it also makes them complex and difficult to read. Avoid using these operators in expressions that modify multiple variables, or the same variable for multiple times such as this: `int k = ++i + i.`

# Assignment Expressions and Assignment Statements

Prior to Java 2, all the expressions can be used as statements. Since Java 2, only the following types of expressions can be statements:

`variable op= expression; // Where op is +, -, *, /, or %`

`++variable;`

`variable++;`

`--variable;`

`variable--;`

# Numeric Type Conversion

Consider the following statements:

```
byte i = 100;  
long k = i * 3 + 4;  
double d = i * 3.1 + k / 2;
```

# Conversion Rules

When performing a binary operation involving two operands of different types, Java automatically converts the operand based on the following rules:

1. If one of the operands is double, the other is converted into double.
2. Otherwise, if one of the operands is float, the other is converted into float.
3. Otherwise, if one of the operands is long, the other is converted into long.
4. Otherwise, both operands are converted into int.



# Type Casting

Implicit casting

```
double d = 3; (type widening)
```

Explicit casting

```
int i = (int) 3.0; (type narrowing)
```

```
int i = (int) 3.9; (Fraction part is truncated)
```

What is wrong?

```
int x = 5 / 2.0;
```

range increases



byte, short, int, long, float, double

# Problem: Keeping Two Digits After Decimal Points

Write a program that displays the sales tax with two digits after the decimal point.

```
public class SalesTax {  
    public static void main(String[] args) {  
        Scanner    input = new Scanner(System.in);  
        System.out.print("Enter purchase amount: ");  
        double purchaseAmount = input.nextDouble(); double  
tax = purchaseAmount * 0.06; System.out.println("Sales tax is  
" + (int)(tax * 100) / 100.0);  
    }  
}
```

SalesTax

Run

# Casting in an Augmented Expression

In Java, an augmented expression of the form **x1 op= x2** is implemented as **x1 = (T)(x1 op x2)**, where **T** is the type for **x1**. Therefore, the following code is correct.

```
int sum = 0;
```

```
sum += 4.5; // sum becomes 4 after this statement
```

```
sum += 4.5 is equivalent to sum = (int)(sum + 4.5).
```

# Problem:

## Computing Loan Payments

This program lets the user enter the interest rate, number of years, and loan amount, and computes monthly payment and total payment.

$$\text{monthlyPayment} = \frac{\text{loanAmount} \times \text{monthlyInterestRate}}{1 - \frac{1}{(1 + \text{monthlyInterestRate})^{\text{numberOfYears} \times 12}}}$$

ComputeLoan

Run

```

☞ public class ComputeLoan {
☞     public static void main(String[] args) {
☞         Scanner input = new Scanner(System.in);
☞         System.out.print("Enter yearly interest rate, for example 8.25: ");
☞         double annualInterestRate = input.nextDouble();
☞
☞         double monthlyInterestRate = annualInterestRate / 1200;
☞         System.out.print("Enter number of years as an integer, for example 5: ");
☞         int numberOfYears = input.nextInt();
☞
☞         System.out.print("Enter loan amount, for example 120000.95: ");
☞         double loanAmount = input.nextDouble();
☞
☞         double monthlyPayment = loanAmount * monthlyInterestRate / (1
☞             - 1 / Math.pow(1 + monthlyInterestRate, numberOfYears * 12));
☞         double totalPayment = monthlyPayment * numberOfYears * 12;
☞
☞         System.out.println("The monthly payment is $" +
☞             (int)(monthlyPayment * 100) / 100.0);
☞         System.out.println("The total payment is $" +
☞             (int)(totalPayment * 100) / 100.0);
☞     }
☞ }

```

# Common Errors and Pitfalls

- Common Error 1: Undeclared/Uninitialized Variables and Unused Variables
- Common Error 2: Integer Overflow
- Common Error 3: Round-off Errors
- Common Error 4: Unintended Integer Division
- Common Error 5: Redundant Input Objects
  
- Common Pitfall 1: Redundant Input Objects

# Common Error 1: Undeclared/Uninitialized Variables and Unused Variables

```
double interestRate = 0.05;  
double interest = interestrate * 45;
```

# Common Error 2: Integer Overflow

```
int value = 2147483647 + 1;  
// value will actually be -2147483648
```



# Common Error 3: Round-off Errors

```
System.out.println(1.0 - 0.1 - 0.1 - 0.1 - 0.1 - 0.1);
```

```
System.out.println(1.0 - 0.9);
```

# Common Error 4: Unintended Integer Division

```
int number1 = 1;  
int number2 = 2;  
double average = (number1 + number2) / 2;  
System.out.println(average);
```

(a)

```
int number1 = 1;  
int number2 = 2;  
double average = (number1 + number2) / 2.0;  
System.out.println(average);
```

(b)

# Common Pitfall 1: Redundant Input Objects

```
Scanner input = new Scanner(System.in);  
System.out.print("Enter an integer: ");  
int v1 = input.nextInt();
```

```
Scanner input1 = new Scanner(System.in);  
System.out.print("Enter a double value: ");  
double v2 = input1.nextDouble();
```