Chapter 2 Elementary Programming

Introducing with an Example

Computing the Area of a Circle *Algorithm*.

1. Read in the radius.
2. Compute the area using the following formula:

$$area = radius \times radius \times \pi$$

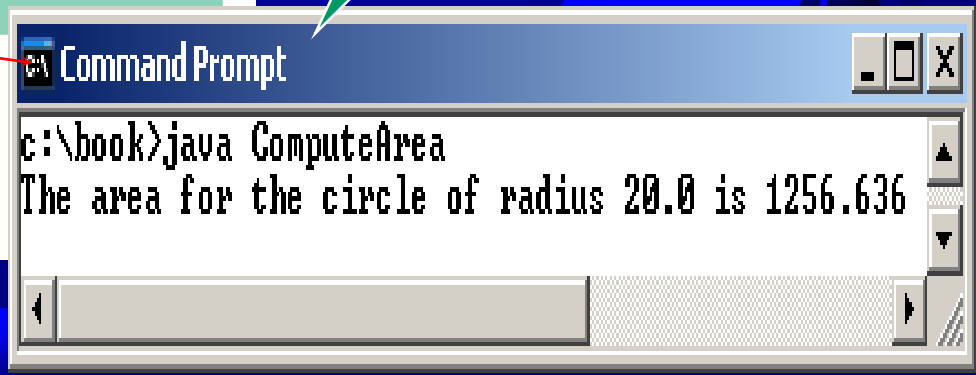
3. Display the area.

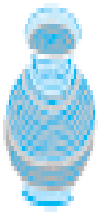
Trace a Program Execution

```
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

- System class:
  - predefined in java.lang package, implicitly imported
- System.out:
  - standard output device
  - Simply use the println method to display a value to the console





Caution

A string constant cannot cross lines in the source code. Thus the following statement would result in a compile error:

```
System.out.println("Introduction to Java Programming,
  by Y. Daniel Liang");
```

To fix the error, break the string into separate substrings, and use the concatenation operator (+) to combine them:

```
System.out.println("Introduction to Java Programming, " +
  "by Y. Daniel Liang");
```

Reading Input from the Console

LISTING 2.2 ComputeAreaWithConsoleInput.java

```
1 import java.util.Scanner; // Scanner is in the java.util package
2
3 public class ComputeAreaWithConsoleInput {
4   public static void main(String[] args) {
5     // Create a Scanner object
6     Scanner input = new Scanner(System.in);
7
8     // Prompt the user to enter a radius
9     System.out.print("Enter a number for radius: ");
10    double radius = input.nextDouble() ;
11
12    // Compute area
13    double area = radius * radiu
14
15    // Display result
16    System.out.println("The area
17      radius + " is " + area);
18  }
19 }
```

import class

create a **Scanner**

read a **double**

```
Enter a number for radius: 2.5
The area for the circle of radius
```

- Console input
  - not directly supported in Java
  - but use the Scanner class to create an object to read input from keyboard

LISTING 2.3 ComputeAverage.java

import class

create a **Scanner**

read a **double**

```
1 import java.util.Scanner; // Scanner is in the java.util package
2
3 public class ComputeAverage {
4   public static void main(String[] args) {
5     // Create a Scanner object
6     Scanner input = new Scanner(System.in);
7
8     // Prompt the user to enter three numbers
9     System.out.print("Enter three numbers: ");
10    double number1 = input.nextDouble();
11    double number2 = input.nextDouble();
12    double number3 = input.nextDouble();
13
14    // Compute average
15    double average = (number1 + number2 + number3) / 3;
16
17    // Display result
18    System.out.println("The average of " + number1 + " " + number2
19      + " " + number3 + " is " + average);
20  }
21 }
```

enter input in one line

```
Enter three numbers: 1 2 3 Enter
The average of 1.0 2.0 3.0 is 2.0
```

enter input in multiple lines

```
Enter three numbers: 10.5 Enter
11 Enter
11.5 Enter
The average of 10.5 11.0 11.5 is 11.0
```

Identifiers

- a sequence of characters
  - consist of letters, digits, underscores (_), and dollar signs ($).
  - start with a letter, an underscore (_), or a dollar sign ($). It cannot start with a digit.
- cannot be
  - a reserved word.
  - `true`, `false`, or `null`
- can be of any length.

- Valid identifiers?
  - $2, ComputeArea, radius, class, showMessageDialog, 2A, d+4

Variables

```
// Compute the first area
radius = 1.0;
area = radius * radius * 3.14159;
System.out.println("The area is "
  + area + " for radius "+radius);
```

Note

By convention, variable names are in lowercase.

Declaring and Initializing in One Step

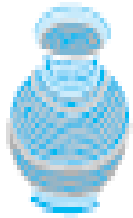
- `int x = 1;`
  - `int x = 1;`
  - `int x = 1;`
- `double d = 1.4;`
- `char a = 'A';`
- …

Constants

Must be declared and initialized.

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

```
final double PI = 3.14159;
final int SIZE = 3;
```



Caution

By convention, constants are named in uppercase: `PI`, not `pi` or `Pi`.

Numerical Data Types

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

NOTE

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

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

  displays 0.09999999999999998, not 0.1.
- System.out.println (1.0 - 0.1 - 0.1 - 0.1 - 0.1 - 0.1);

  displays 0.5000000000000001, not 0.5,

Integers are stored precisely. Therefore, calculations with integers yield a precise integer result.

Numeric Operators

Name	Meaning	Example	Result
+	Addition	34 + 1	35
-	Subtraction	34.0 - 0.1	33.9
*	Multiplication	300 * 30	9000
/	Division	1.0 / 2.0	0.5
%	Remainder 取余	20 % 3	2

Integer Division

5 / 2 yields ?

5.0 / 2 yields ?

5 % 2 yields 1

Remainder is very useful in programming.

One 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.

Problem: Displaying Time

Write a program that obtains minutes and remaining seconds from an amount of time in seconds.

LISTING DisplayTime.java

import Scanner
create a Scanner
read an integer
divide
remainder

```
1 import java.util.Scanner;
2
3 public class DisplayTime {
4   public static void main(String[] args) {
5     Scanner input = new Scanner(System.in);
6     // Prompt the user for input
7     System.out.print("Enter an integer for seconds: ");
8     int seconds = input.nextInt() ;
9
10    int minutes = seconds / 60 ; // Find minutes in seconds
11    int remainingSeconds = seconds % 60 ; // Seconds remaining
12    System.out.println(seconds + " seconds is " + minutes +
13      " minutes and " + remainingSeconds + " seconds");
14  }
15 }
```

```
Enter an integer for seconds: 500 Enter
500 seconds is 8 minutes and 20 seconds
```

Number Literals

A *literal* is a constant value that appears directly in the program.

```
int i = 34;
long x = 1000000;
double d = 5.0;
```

Scientific Notation

Floating-point literals can also be specified in scientific notation

for example, 1.234e+2, same as 1.234e2,

is equivalent to 123.4

1.234e-2 is equivalent to 0.01234.

E (or e) represents an exponent and it can be either in lowercase or uppercase.

Problem: Converting Temperatures

Write a program that converts a Fahrenheit degree to Celsius using the formula: $celsius = (\frac{5}{9})(fahrenheit - 32)$

LISTING FahrenheitToCelsius.java

```
1 import java.util.Scanner;
2
3 public class FahrenheitToCelsius {
4   public static void main(String[] args) {
5     Scanner input = new Scanner(System.in);
6
7     System.out.print("Enter a degree in Fahrenheit: ");
8     double fahrenheit = input.nextDouble();
9
10    // Convert Fahrenheit to Celsius
11    double celsius = (5.0 / 9) * (fahrenheit - 32);
12    System.out.println("Fahrenheit " + fahrenheit + " is " +
13      celsius + " in Celsius");
14  }
15 }
```

divide

```
Enter a degree in Fahrenheit: 100 Enter
Fahrenheit 100.0 is 37.77777777777778 in Celsius
```

Shorthand Operators

TABLE Shorthand Operators

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

Increment and Decrement Operators

TABLE Increment and Decrement Operators

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

Increment and Decrement Operators, cont.

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

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

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;
```

Numeric Type Conversion

Consider the following statements:

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

Type Casting

Implicit casting

```
double d = 3;(by default, 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

Keeping Two Digits After Decimal Points

(197.55 * 0.06 = 11.853)

LISTING SalesTax.java

```
1 import java.util.Scanner;
2
3 public class SalesTax {
4   public static void main(String[] args) {
5     Scanner input = new Scanner(System.in);
6
7     System.out.print("Enter purchase amount: ");
8     double purchaseAmount = input.nextDouble();
9
10    double tax = purchaseAmount * 0.06;
11    System.out.println("Sales tax is " + (int)(tax * 100) / 100.0);
12  }
13 }
```

```
Enter purchase amount: 197.55 Enter
Sales tax is 11.85
```

```
tax * 100 is 1185.3
(int)(tax * 100) is 1185
(int)(tax * 100) / 100.0 is 11.85
```

tax: 197.55 * 0.06 = 11.853

Computing Loan Payments

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

monthlyInterestRate = yearlyInterestRate / **12**;
totalPayment = monthlyPayment * numberOfYears * **12**;

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

`pow(a, b)` method in the `Math` class can be used to compute a^b.

enter loan amount

monthlyPayment

totalPayment

```
22      double loanAmount = input.nextDouble();
23
24      // Calculate payment
25      double monthlyPayment  = loanAmount * monthlyInterestRate / (1
26        - 1 / Math.pow(1 + monthlyInterestRate, numberOfYears * 12));
27      double totalPayment = monthlyPayment * numberOfYears * 12;
28
```

The **Math** class is in the **java.lang** package.

All classes in the **java.lang** package are implicitly imported.

```
35  }
```

```
Enter yearly interest rate, for example 8.25: 5.75
Enter number of years as an integer, for example 5: 15
Enter loan amount, for example 120000.95: 250000
The monthly payment is 2076.02
The total payment is 373684.53
```

Programming Style and Documentation

- Appropriate Comments
- Naming Conventions
- Proper Indentation and Spacing Lines
- Block Styles

Appropriate Comments

Include a summary at the beginning of the program to explain what the program does, its key features, its supporting data structures, and any unique techniques it uses.

- Include your name, class section, instructor, date, and a brief description of the program.

- line comments (//): inside a method
- block comment /*…*/
- javadoc comments (/** ... */): entire class/method.

Naming Conventions

- Choose meaningful and descriptive names.
- Variables and method names:
  - Use lowercase.
  - If the name consists of several words, use lowercase for the first word, and capitalize the first letter of each subsequent word.
    - For example, method name:

```
computeArea
```

Naming Conventions, cont.

- Class names:
  - Capitalize the first letter of each word in the name.
  - For example, the class name

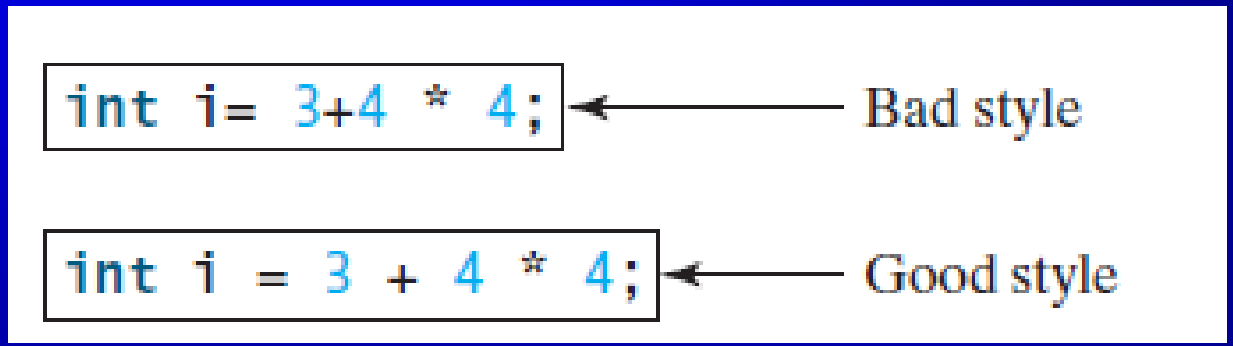
    `ComputeArea`

- Constants:
  - Capitalize all letters in constants, and use underscores to connect words.
  - For example,

    MAX_VALUE

Proper Indentation and Spacing

- Indentation
- Spacing
  - Use whitespace



  - Use blank line to separate segments of the code.

Block Styles

- End-of-line style
  - Save space, help avoid some subtle errors
  - This book, Java API source code
- Next-line style
  - Align braces vertically, make program easy to read
- Both styles are acceptable
  - Mixing style is not recommended

Next-line style

```
public class Test
{
  public static void main(String[] args)
  {
    System.out.println("Block Styles");
  }
}
```

End-of-line style

```
public class Test {
  public static void main(String[] args) {
    System.out.println("Block Styles");
  }
}
```

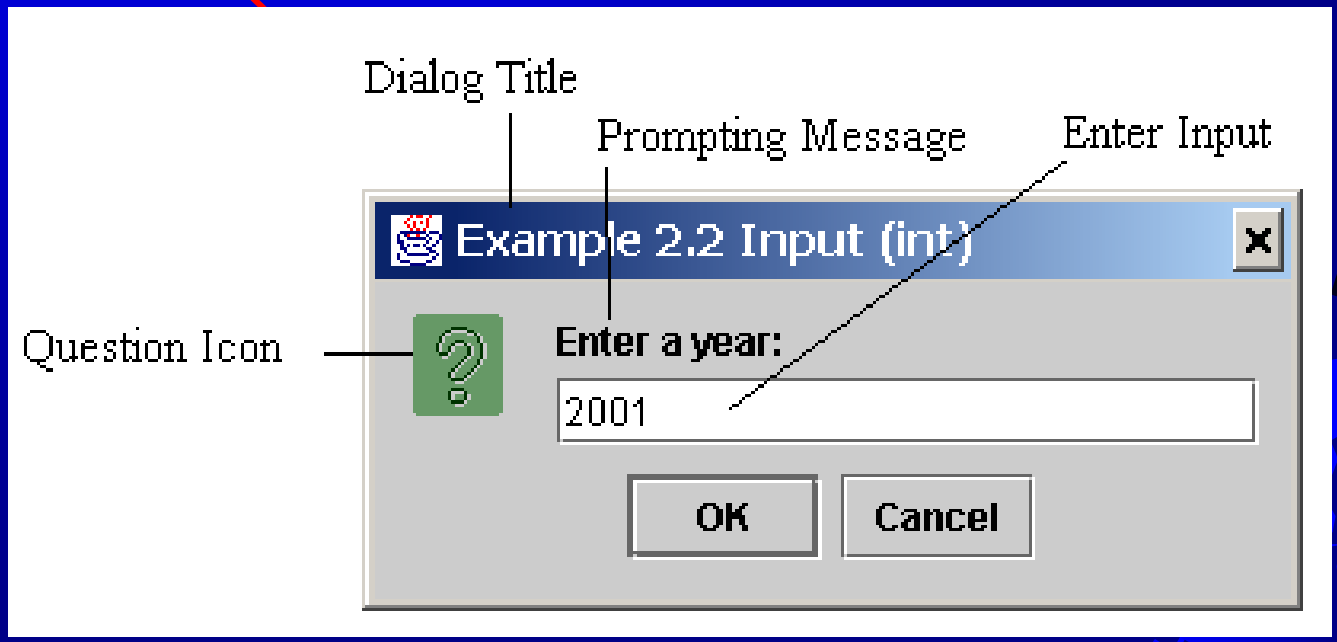
JOptionPane Input

Two ways of obtaining input.

1. Using the Scanner class (console input)
2. Using JOptionPane (input dialogs) , GUI

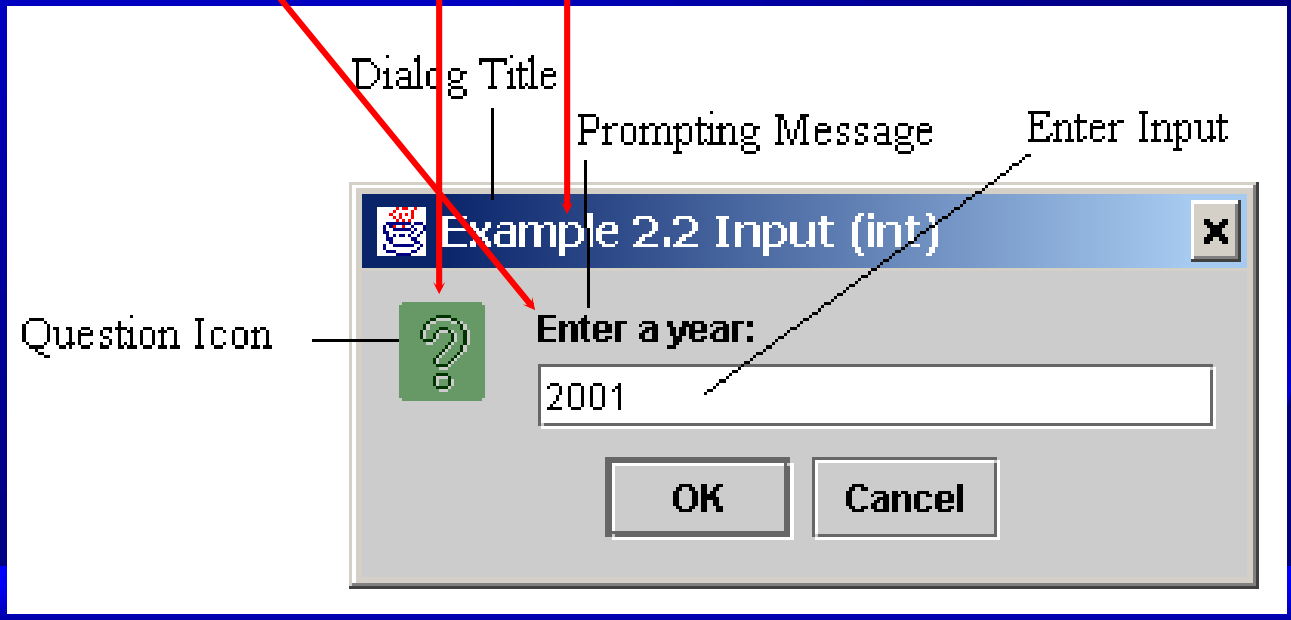
Getting Input from Input Dialog Boxes

```
import javax.swing.*;
String input =  JOptionPane.showInputDialog(
  "Enter a year:");
```



Getting Input from Input Dialog Boxes

```
String string = JOptionPane.showInputDialog(
   null, "Prompting Message",  "Dialog Title",
   JOptionPane.QUESTION_MESSAGE);
```



Conclusion: two Ways to Invoke the JOptionPane.showInputDialog() Method :

1. String string = JOptionPane.showInputDialog(null, x, y, JOptionPane.QUESTION_MESSAGE);

where x is a string for the prompting message, and y is a string for the title of the input dialog box.

2. JOptionPane.showInputDialog(x);

where x is a string for the prompting message.

Converting Strings to Integers

- The input returned from the input dialog box is a string.
  - If you enter a numeric value such as 123,
    it returns “123”.

- To obtain the input as a number, you have to convert a string into a number.

```
int intValue = Integer.parseInt(intString);
```

Converting Strings to Doubles

To convert a string into a double value,

```
double doubleValue =Double.parseDouble(doubleString);
```

– where doubleString is a numeric string such as “123.45”.

The `Integer` and `Double` classes are both included in the `java.lang` package, and thus they are automatically imported.

Problem: Computing Loan Payments Using Input Dialogs

the input is entered from the input dialogs and the output is displayed in an message/output dialog.

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

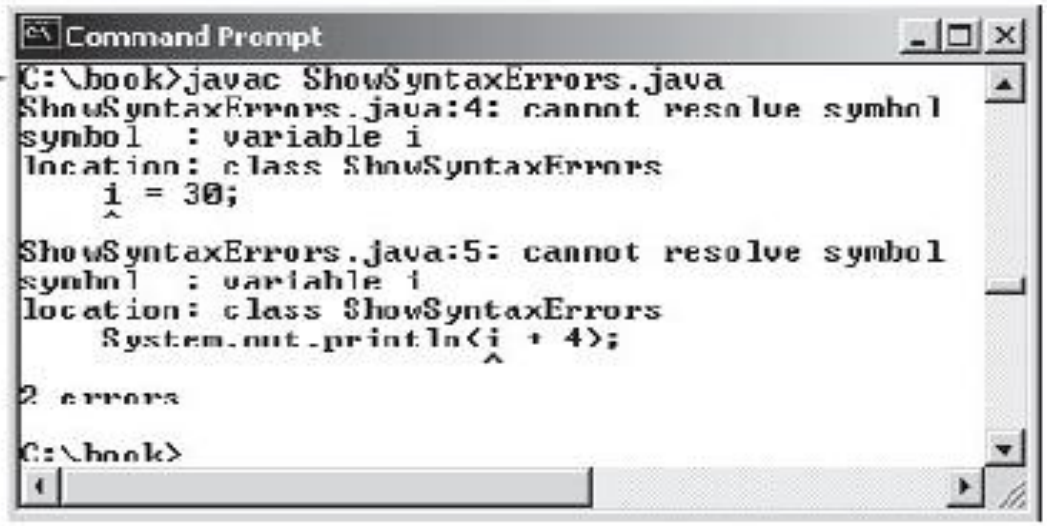
Programming Errors

- Syntax Errors (compile error)
  - Detected by the compiler
- Runtime Errors
  - Causes the program to abort
- Logic Errors
  - Produces incorrect result

Syntax Errors

```
public class ShowSyntaxErrors {
  public static void main(String[] args) {
    i = 30;
    System.out.println(i + 4);
  }
}
```

Compile →



Two errors are detected. Both are the result of not declaring variable i.

Runtime Errors

```
public class ShowRuntimeErrors {
  public static void main(String[] args) {
    int i = 1 / 0;
  }
}
```

Run →

runtime errors is division by zero.

Logic Errors

Logic errors occur when a program does not perform the way it was intended to. Errors of this kind occur for many different reasons. For example, suppose you wrote the following program to add `number1` to `number2`.

```
// ShowLogicErrors.java: The program contains a logic error
public class ShowLogicErrors {
  public static void main(String[] args) {
    // Add number1 to number2
    int number1 = 3;
    int number2 = 3;
    number2 += number1 + number2;
    System.out.println("number2 is " + number2);
  }
}
```

Debugging

Logic errors are called *bugs*.

The process of finding and correcting errors is called debugging

A common approach to debugging is to use a combination of methods to narrow down to the part of the program where the bug is located.

- You can hand-trace the program (i.e., catch errors by reading the program)
- or you can insert print statements in order to show the values of the variables or the execution flow of the program. This approach might work for a short, simple program.
- But for a large, complex program, the most effective approach for debugging is to use a debugger utility.

Debugger

Debugger is a program that facilitates debugging. You can use a debugger to

- Execute a single statement at a time.
- Trace into or stepping over a method.
- Set breakpoints.
- Display variables.
- Display call stack.
- Modify variables.