

Chapter 2 Elementary Programming

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Introducing Programming with an Example

Ex 2.1 Computing the Area of a Circle

ComputeArea

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);  
    }  
}
```

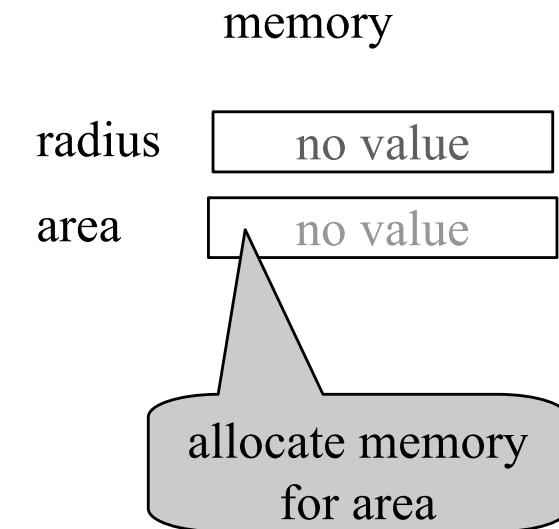
radius

allocate memory
for radius

no value

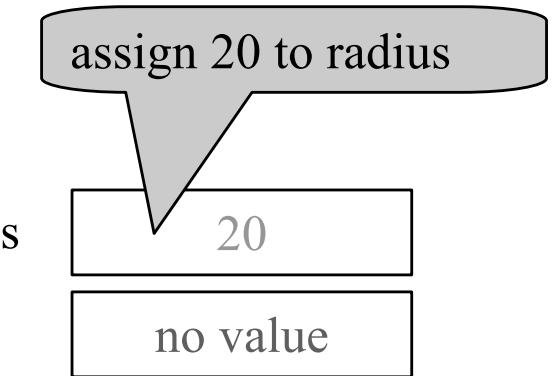
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                           " +  
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Trace a Program Execution

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        System.out.println("The area for the circle of radius  
                           " +  
                           radius + " is " + 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;
```

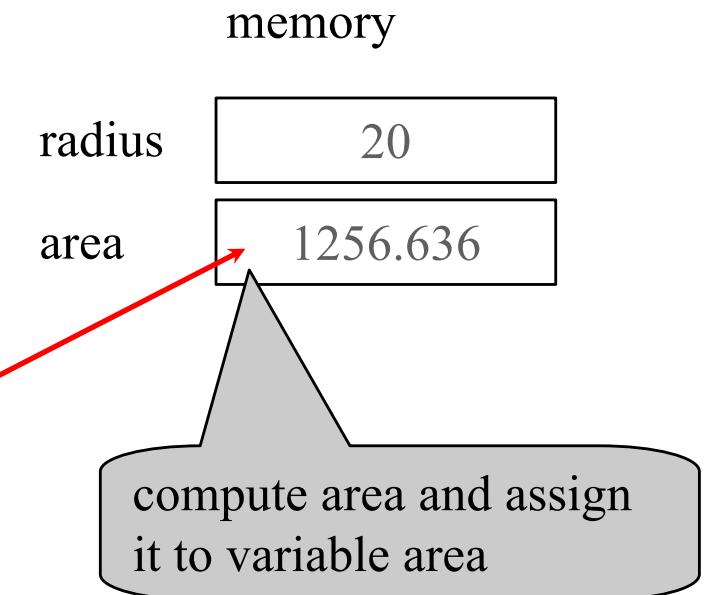
```
        // Display results
```

```
        System.out.println("The area for the circle of radius
```

```
        " +
```

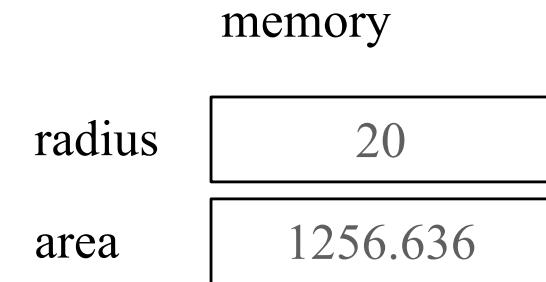
```
        radius + " is " + area);
```

```
}
```



Trace a Program Execution

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



print a message to the
console

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

ComputeAverage

Identifiers

- ◆ An identifier is a sequence of characters that consist of letters, digits, underscores (_), and dollar signs (\$).
 - ◆ Character.isJavaIdentifierPart() returns true
 - ◆ In Unicode Charsets: Characters bigger than 0xC0
- ◆ An identifier must start with a letter, an underscore (_), or a dollar sign (\$). It cannot start with a digit.
 - ◆ Character.isJavaIdentifierStart() returns true
- ◆ An identifier cannot be a reserved word.
- ◆ An identifier cannot be true, false, or null.
- ◆ An identifier can be of any length.

- Correct Identifiers:
 - ◆ Body , _test , \$hello
- Wrong Identifiers:
 - ◆ 5Test , hello* , world# , class

Keywords

Some noteworthy points regarding Java keywords:

- **const** and **goto** are reserved words but not used.
- **true**, **false** and **null** are literals, not keywords.
- all keywords are in lower-case.

var is not a keyword, but rather an identifier with special meaning as the type of a local variable declaration

The following table shows the keywords grouped by category:

Category	Keywords
<i>Access modifiers</i>	private, protected, public
<i>Class, method, variable modifiers</i>	abstract, class, extends, final, implements, interface, native, new, static, strictfp, synchronized, transient, volatile
<i>Flow control</i>	break, case, continue, default, do, else, for, if, instanceof, return, switch, while
<i>Package control</i>	import, package
<i>Primitive types</i>	boolean, byte, char, double, float, int, long, short
<i>Error handling</i>	assert, catch, finally, throw, throws, try
<i>Enumeration</i>	enum
<i>Others</i>	super, this, void
<i>Unused</i>	const, goto

Variables

```
// Compute the first area  
radius = 1.0;  
area = radius * radius * 3.14159;  
System.out.println("The area is " +  
    area + " for radius "+radius);  
  
// Compute the second area  
radius = 2.0;  
area = radius * radius * 3.14159;  
System.out.println("The area is " +  
    area + " for radius "+radius);
```

Declaring 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;
```

var is a type name, which was introduced in Java 10

Assignment Statements

```
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;
```

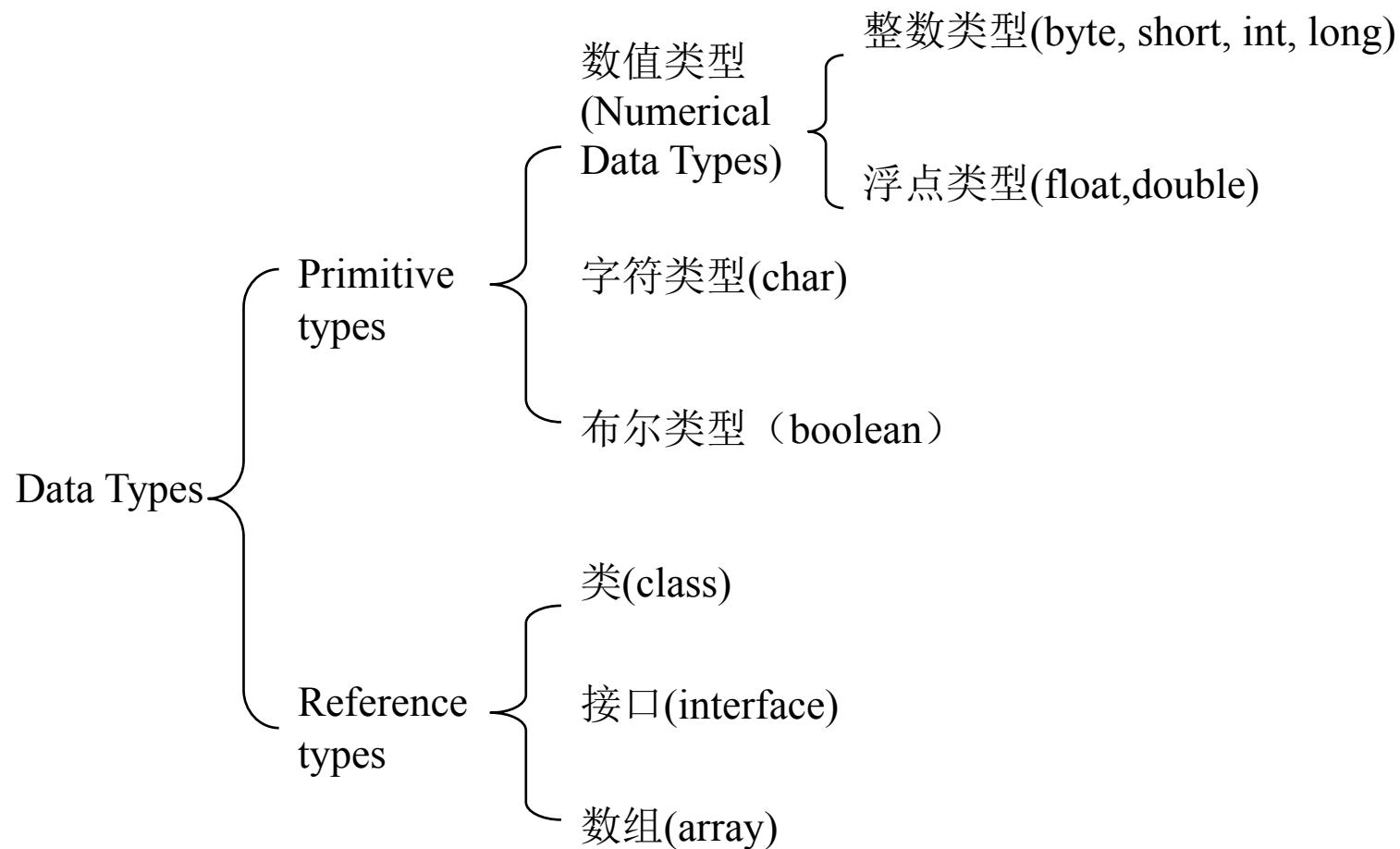
Naming Conventions

- ♦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`

Data Types



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

There is **NO UNSIGNED** integer type in Java

Integer

- **Decimal :** 124, -100;
- **Octal:** 0 as prefix, followed by 0~7 : ex. 0134;
- **Hexadecimal:** 0x or 0X as prefix, followed by 0~9 or A~F.

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

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	20 % 3	2

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)

Problem: Displaying Time

Write a program that obtains minutes and remaining seconds from seconds.

DisplayTime

Floating-Point numbers

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

calculations with integers yield a precise integer result.

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);
```



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



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
```

Number Literals

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

int i = 34;

long x = 1000000;

double d = 5.0;

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.

An integer literal is assumed to be of the int type, whose value is between -2^{31} (-2147483648) to $2^{31}-1$ (2147483647).

Integer literal of the long type, append it with the letter L or l.

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.

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.

100.2f or 100.2F for a float number

100.2d or 100.2D for a double number

Scientific Notation

Floating-point literals can also be specified in scientific notation,

1.23456e+2, or 1.23456e2, is equivalent to 123.456

1.23456e-2 is equivalent to 0.0123456

Arithmetic Expressions

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

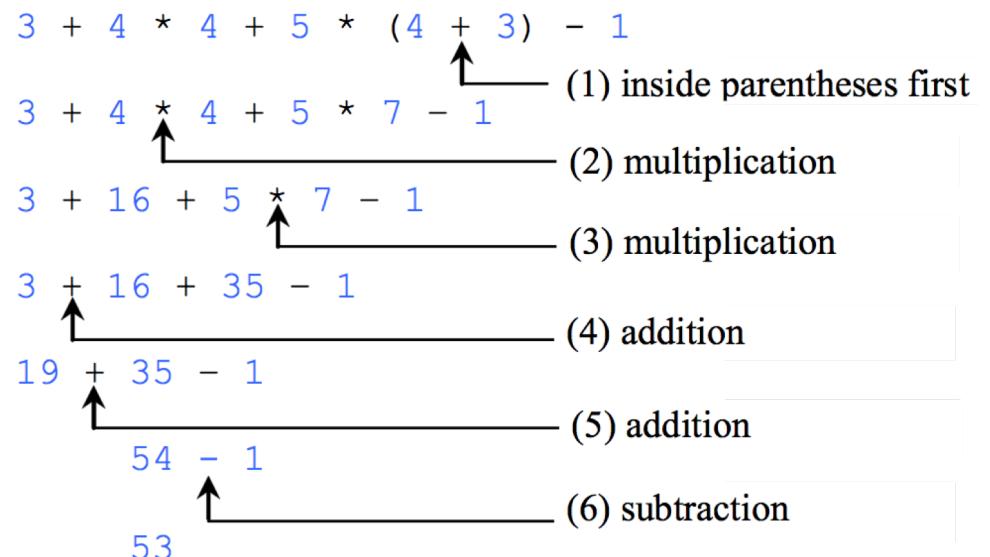
is translated to

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

How to Evaluate an Expression

You can safely apply the arithmetic rule for evaluating a Java expression.

The result of a Java expression and its corresponding arithmetic expression are the same.



Problem: Converting Temperatures

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

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

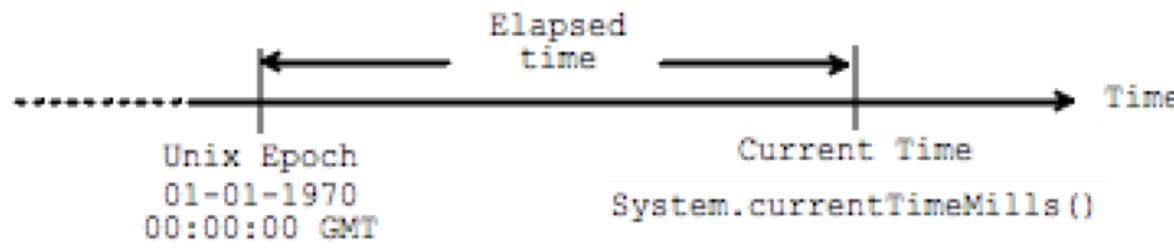
Note: you have to write

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

Problem: Showing Current Time

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

Using *currentTimeMillis()* method in *System* class returns the current time in milliseconds since the midnight, January 1, 1970 GMT.



ShowCurrentTime.java

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>
<code>++var</code>	preincrement	Increment <code>var</code> by <code>1</code> , and use the new <code>var</code> value in the statement	<code>int j = ++i;</code> <code>// j is 2, i is 2</code>
<code>var++</code>	postincrement	Increment <code>var</code> by <code>1</code> , but use the original <code>var</code> value in the statement	<code>int j = i++;</code> <code>// j is 1, i is 2</code>
<code>--var</code>	predecrement	Decrement <code>var</code> by <code>1</code> , and use the new <code>var</code> value in the statement	<code>int j = --i;</code> <code>// j is 0, i is 0</code>
<code>var--</code>	postdecrement	Decrement <code>var</code> by <code>1</code> , and use the original <code>var</code> value in the statement	<code>int j = i--;</code> <code>// j is 1, i is 0</code>

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.

int k = ++i + i.

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. An integer literal can be assigned to an integer variable as long as it can fit into the variable.
5. Otherwise, both operands are converted into int.

Type Casting

Implicit casting

`double d = 3;` (type widening)

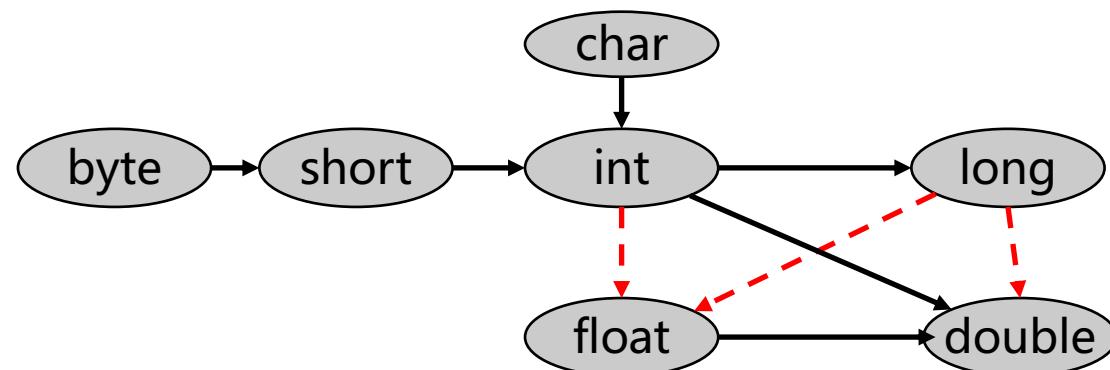
Explicit casting

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

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

What is wrong? `int x = 5 / 2.0;`

Narrowing -----> Widening
byte , short , char--> int--> long--> float--> double



Casting in an Augmented Expression

An augmented expression of the form $x1 \text{ op=} x2$ is implemented as $x1 = (T)(x1 \text{ op } x2)$, where T is the type for x1.

Therefore

```
int sum = 0;  
sum += 4.5;
```

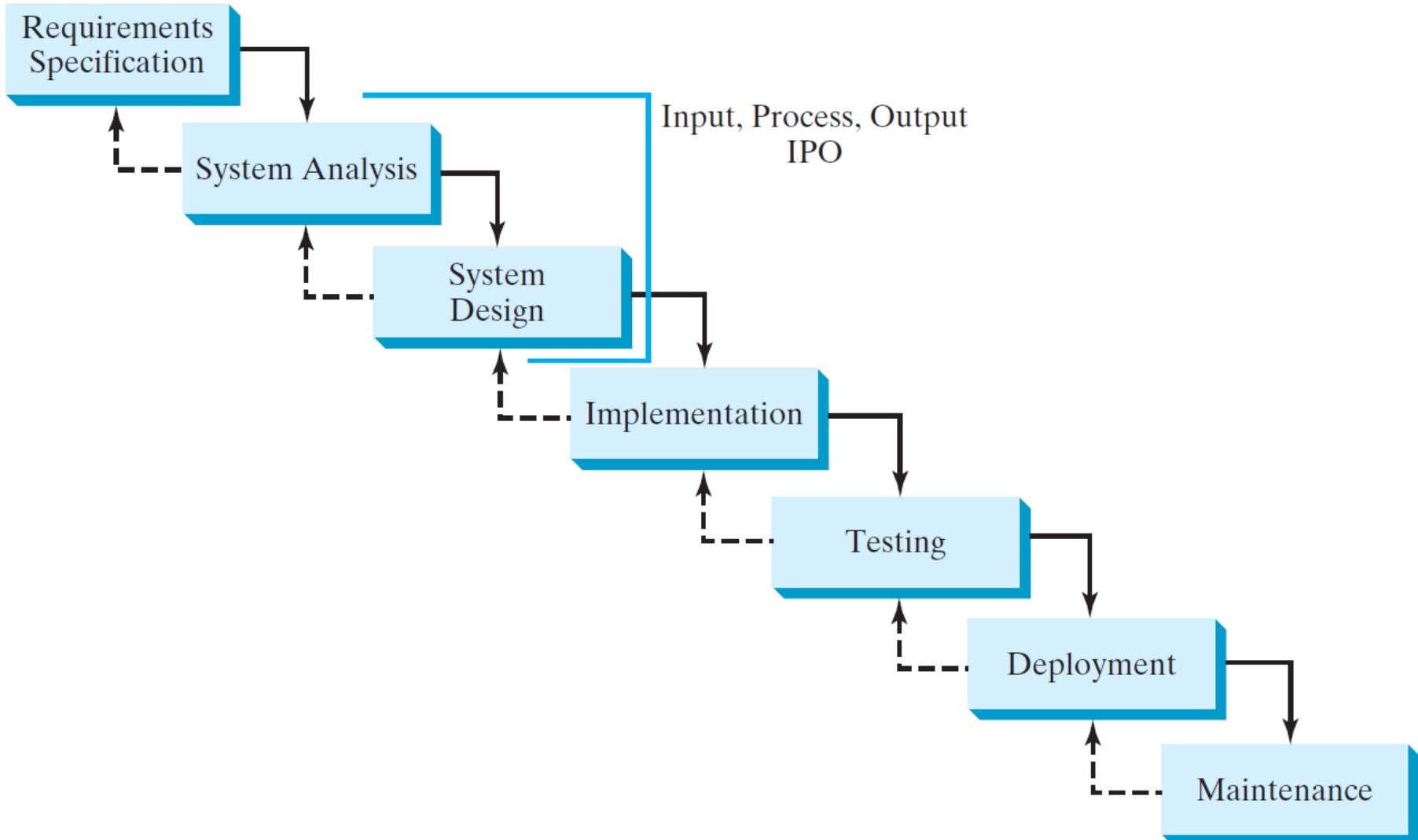
is correct

$\text{sum} += 4.5$ is equivalent to $\text{sum} = (\text{int})(\text{sum} + 4.5)$
// sum becomes 4 after this statement

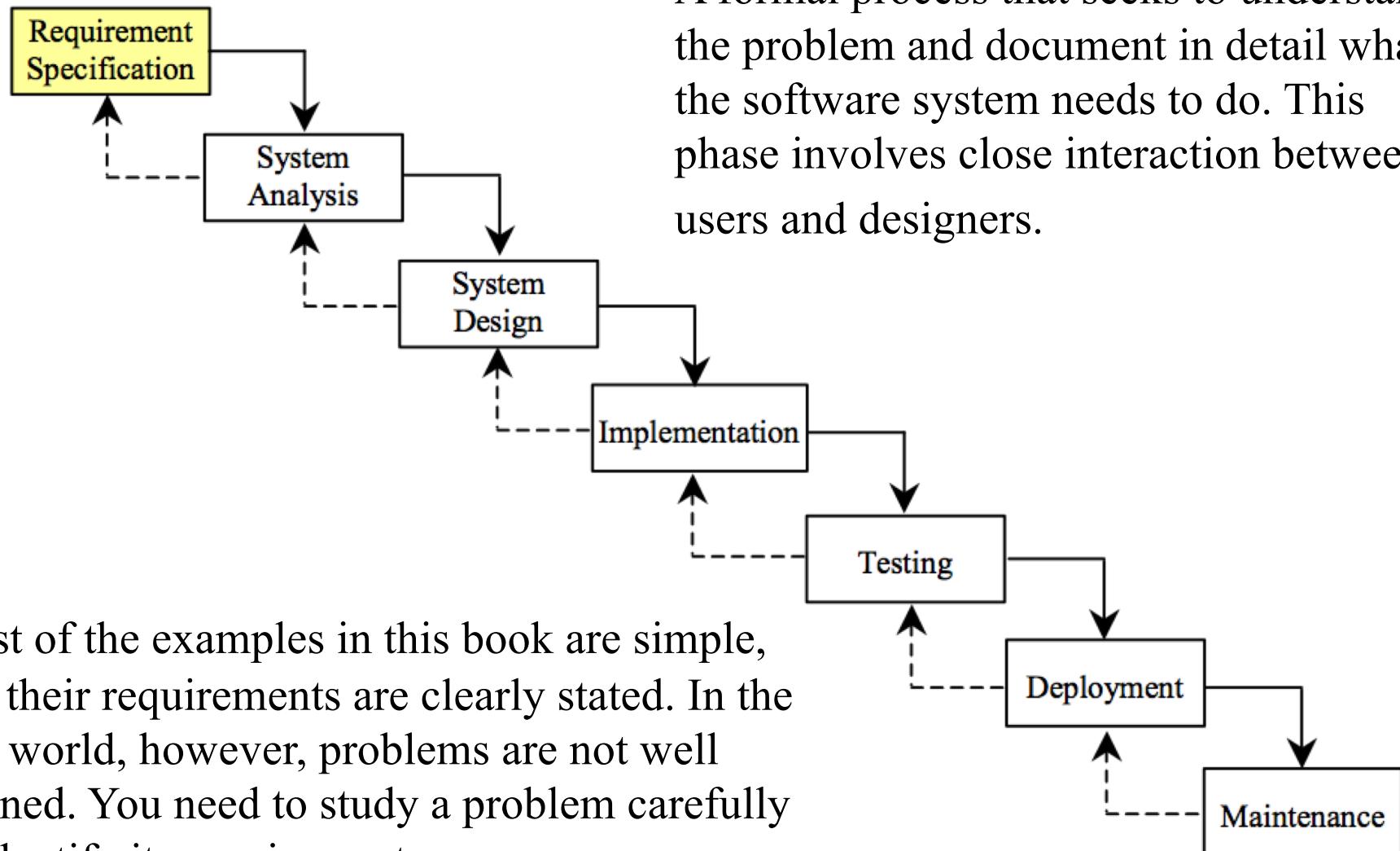
Boolean type and operators

- *boolean b=false;*
- *true and false are literals*

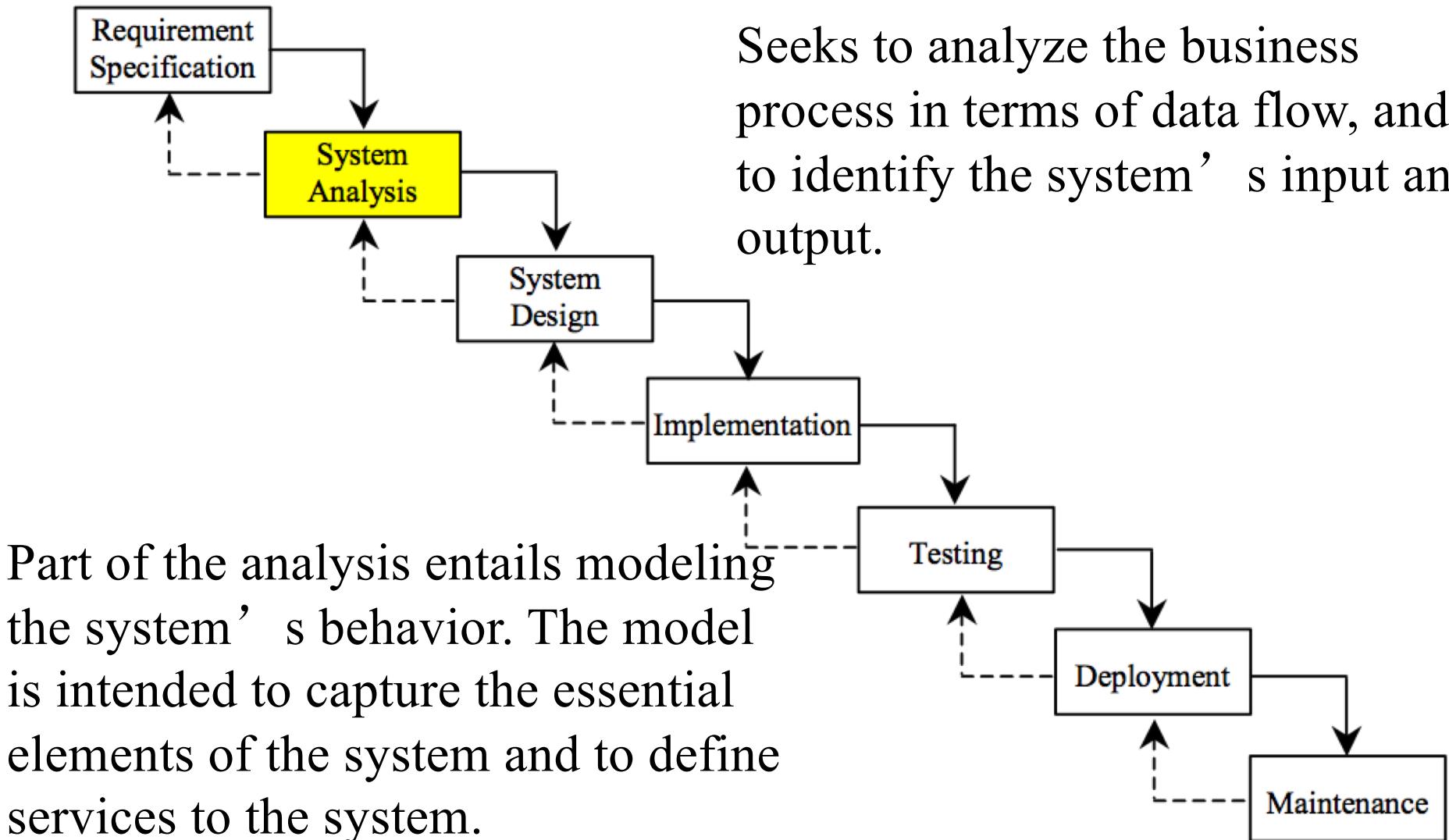
Software Development Process *



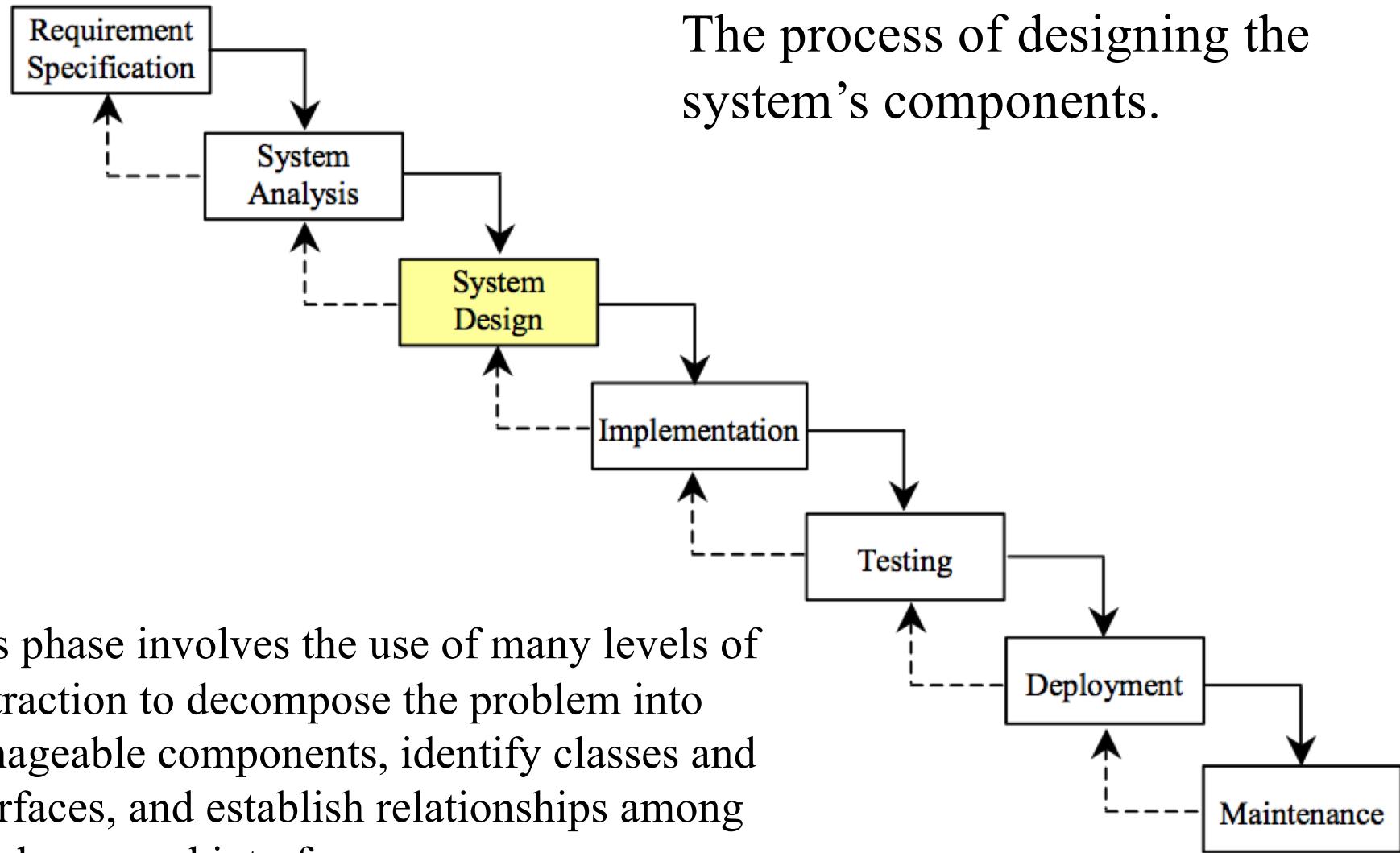
Requirement Specification *



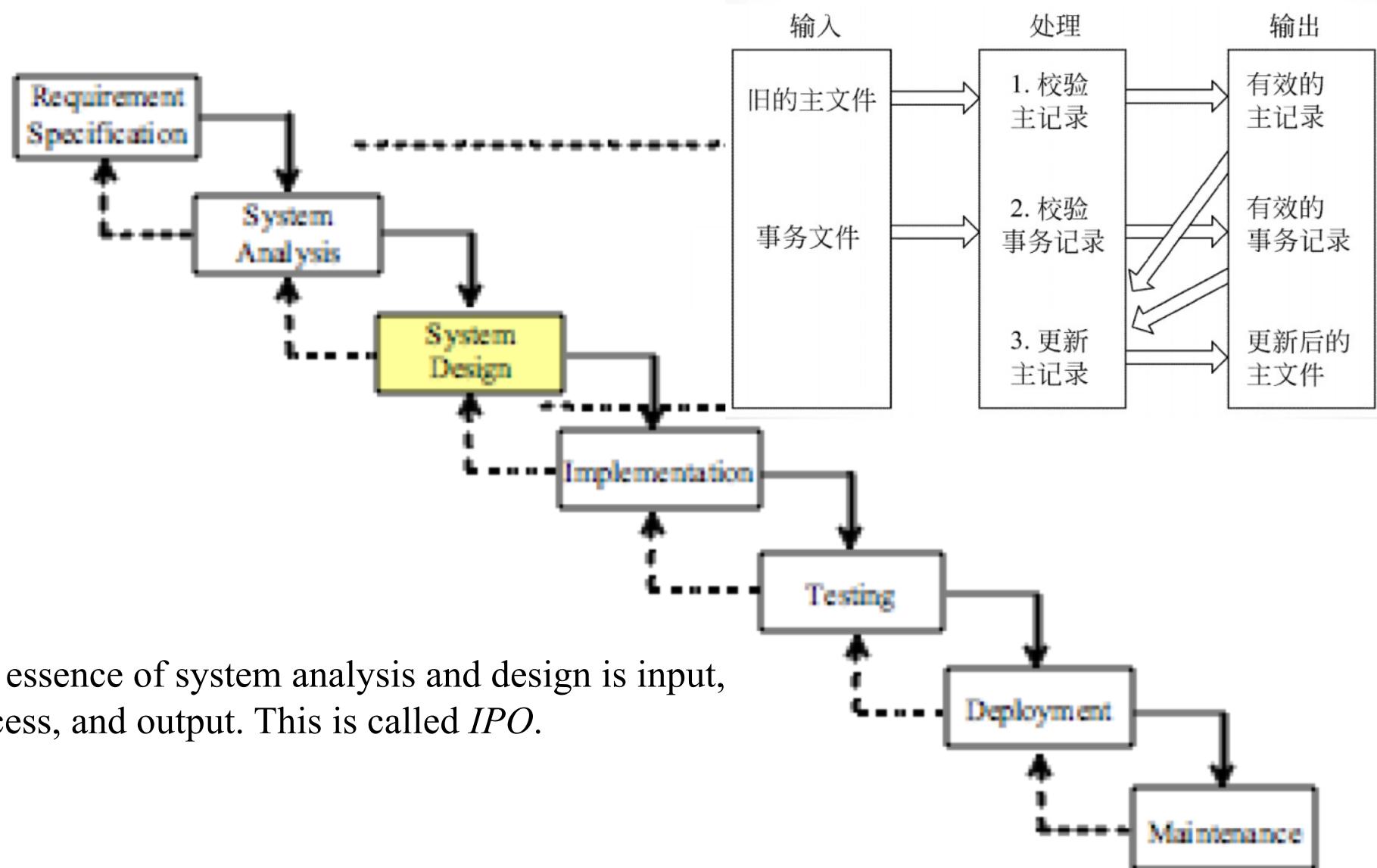
System Analysis *



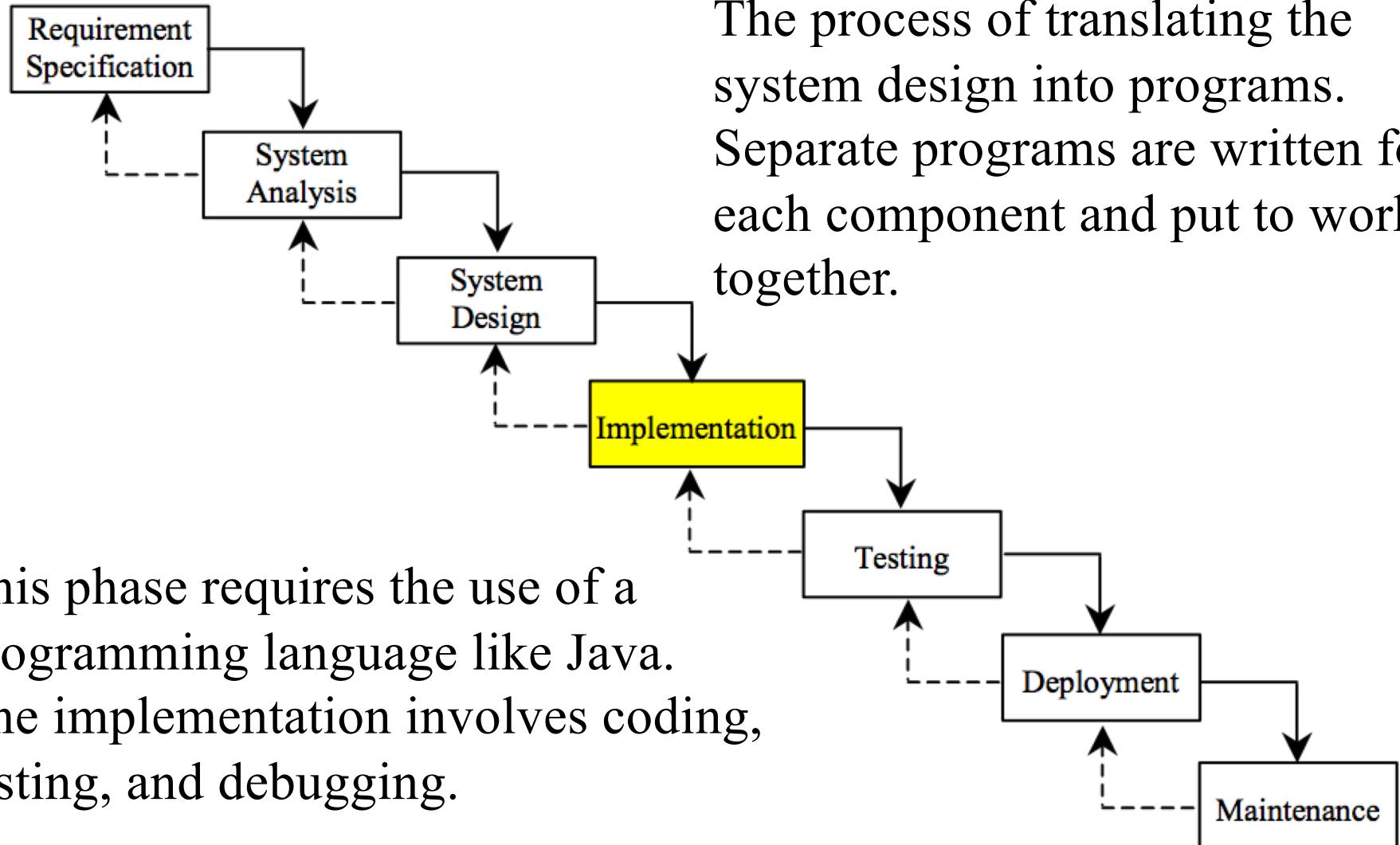
System Design *



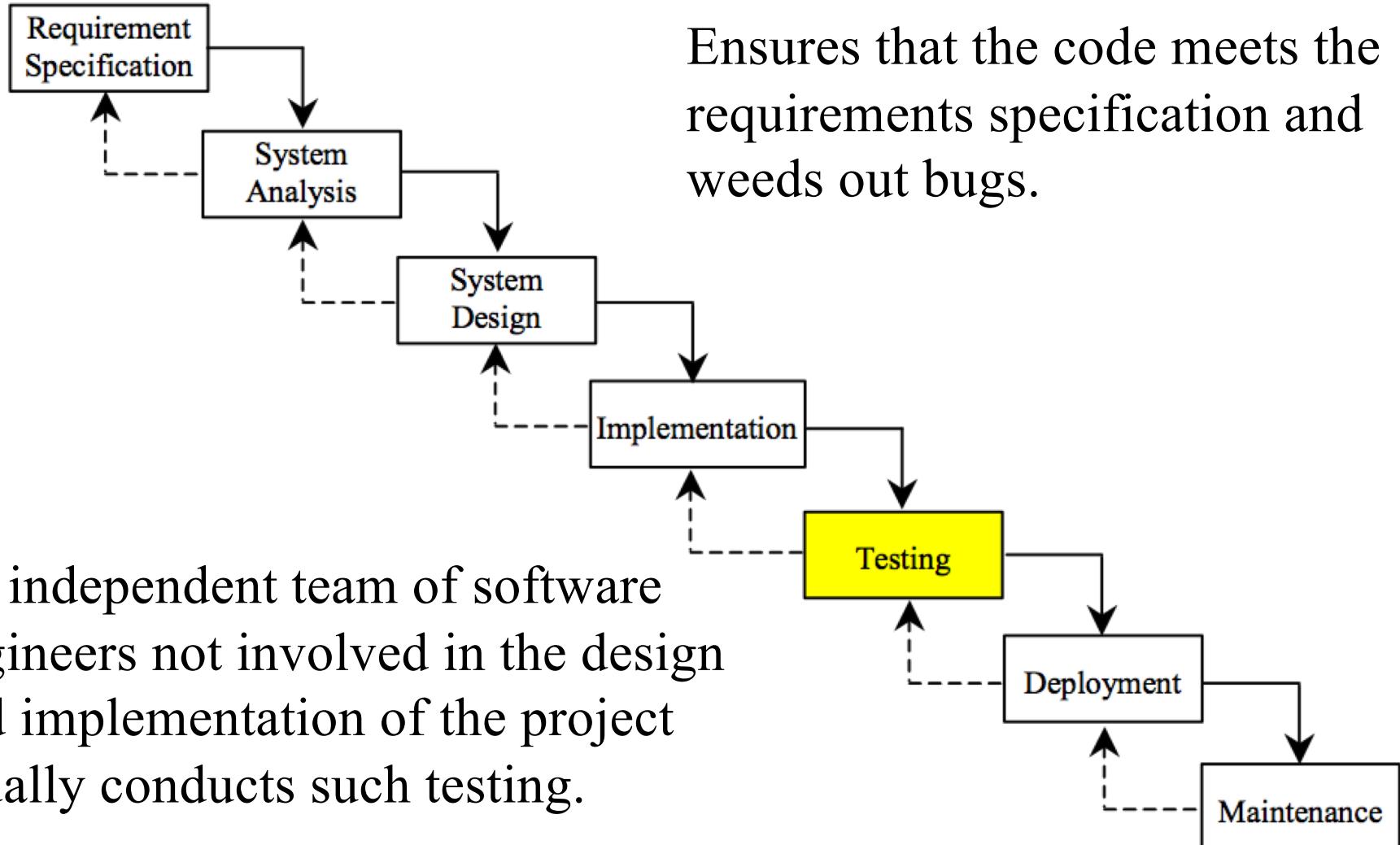
IPO *



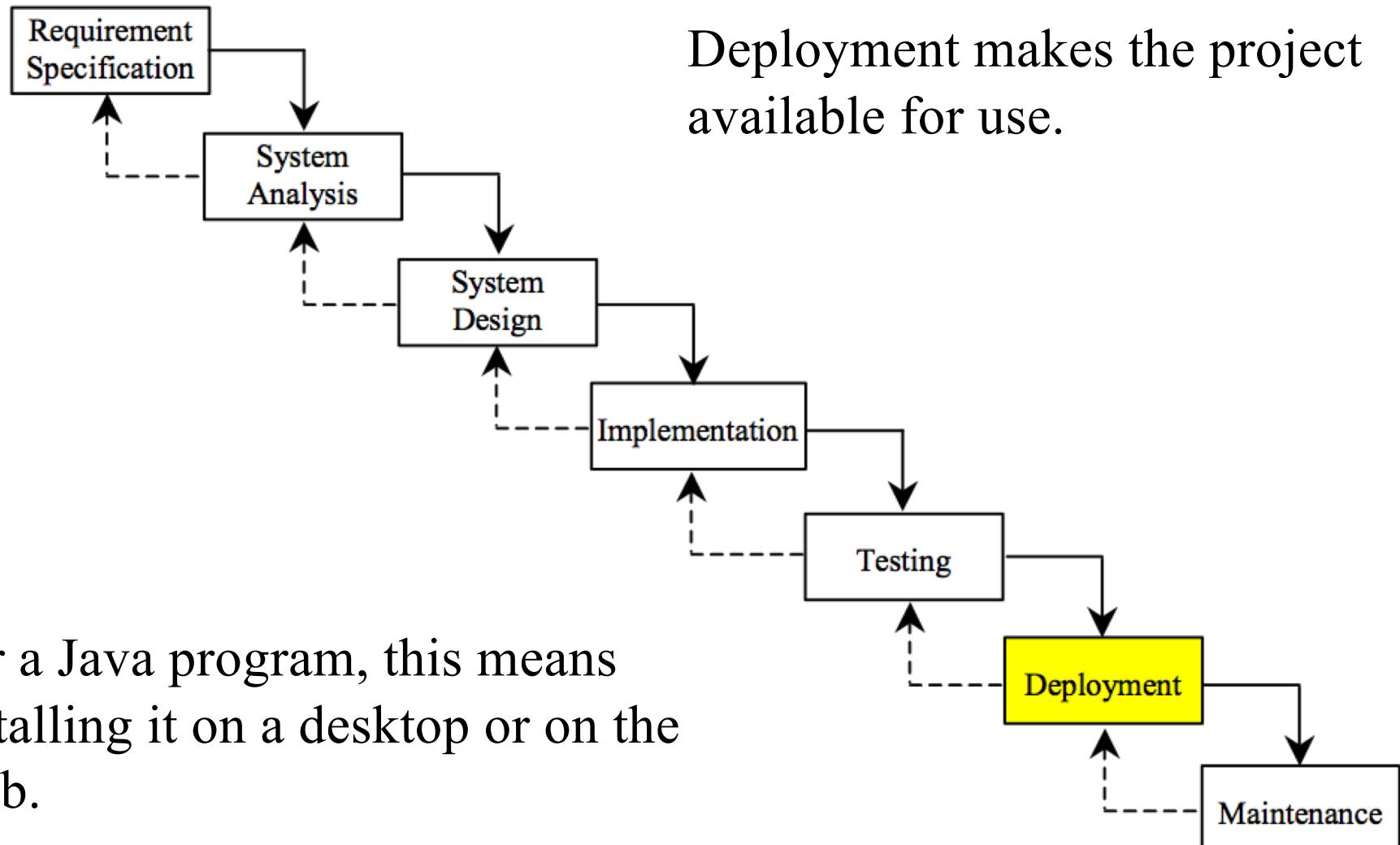
Implementation *



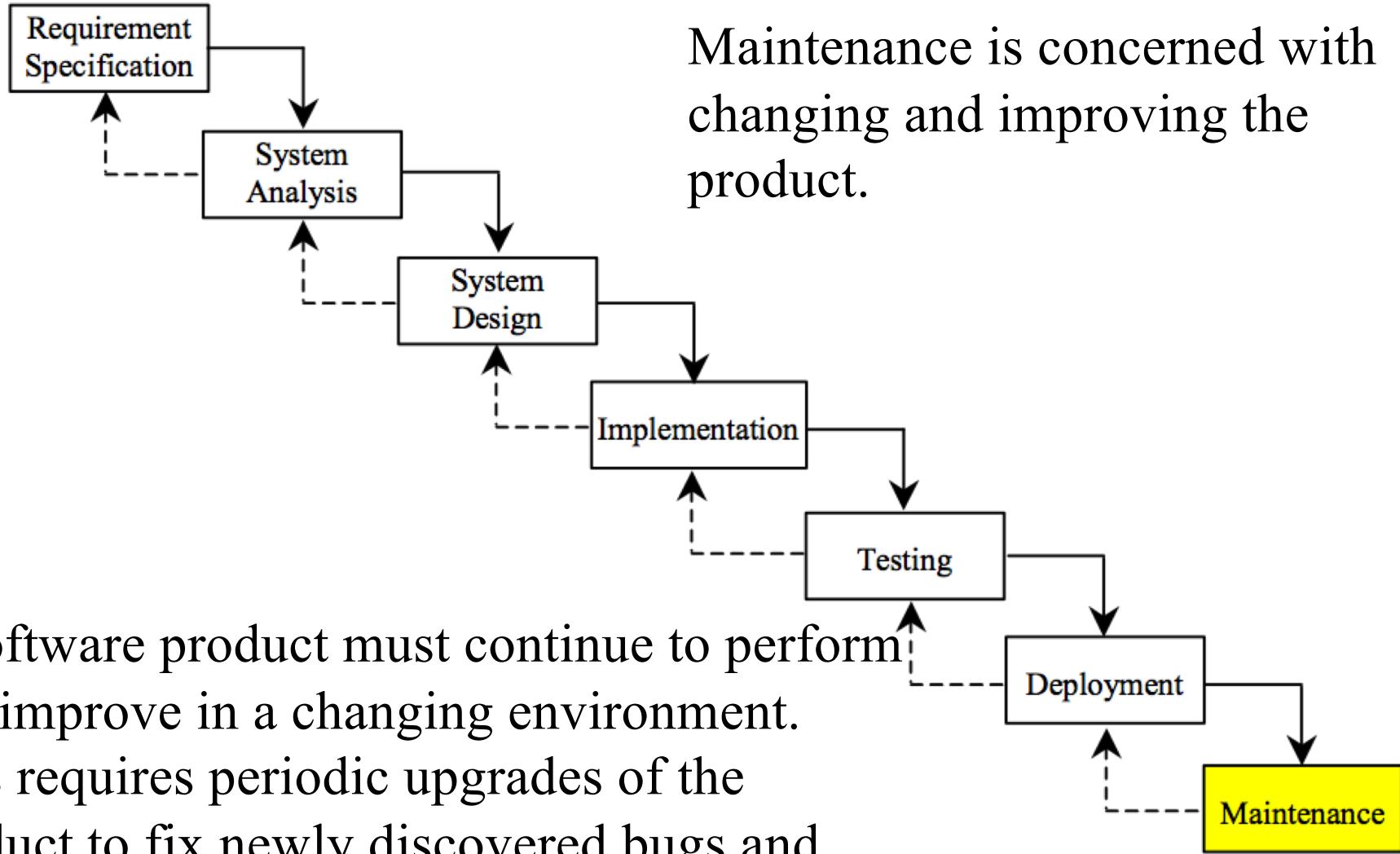
Testing *



Deployment *



Maintenance *



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.

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

Problem: Monetary Units

This program lets the user enter the amount in decimal representing dollars and cents and output a report listing the monetary equivalent in single dollars, quarters, dimes, nickels, and pennies.

Supplement reading: 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 - 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;
```

```
double average=(number1+number2) / 2.0;
```

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();
```