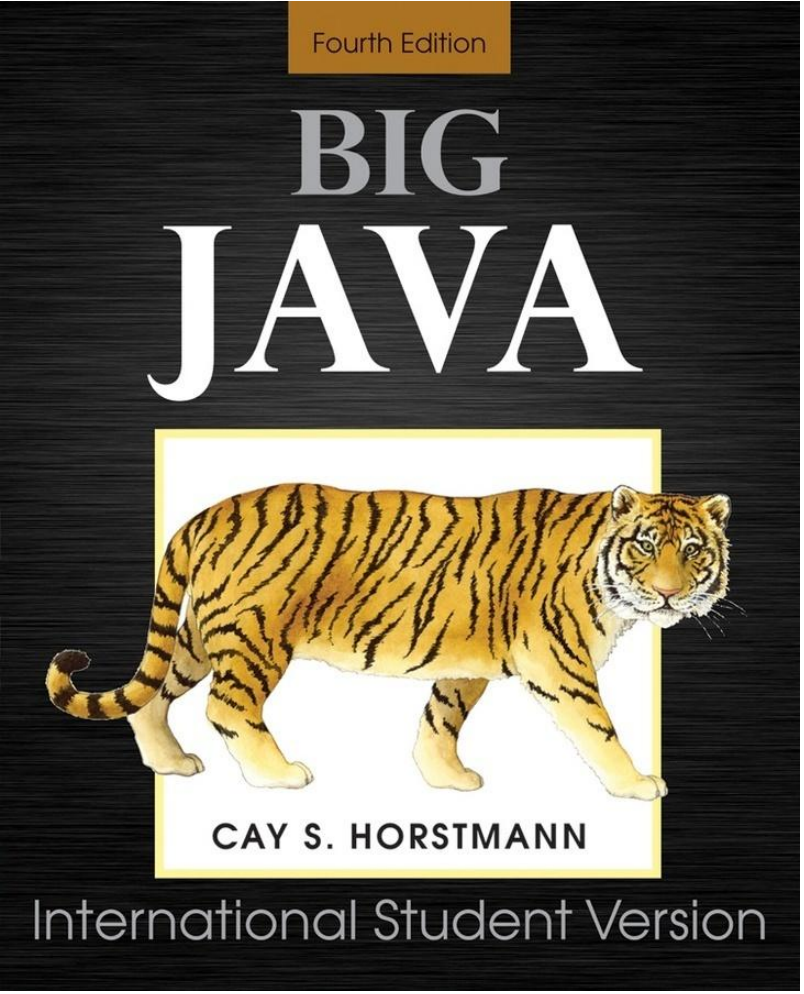


Chapter 1 – Introduction

Chapter Goals

- To understand the activity of programming
- To learn about the architecture of computers
- To learn about machine code and high level programming languages
- To become familiar with your computing environment and your compiler
- To compile and run your first Java program
- To recognize syntax and logic errors
- To write pseudocode for simple algorithms

What Is Programming?

- Computers are programmed to perform tasks
- Different tasks = different programs
- Program
  - *Sequence of basic operations executed in succession*
  - *Contains instruction sequences for all tasks it can execute*
- Sophisticated programs require teams of highly skilled programmers and other professionals

Self Check 1.1

What is required to play a music CD on a computer?

Answer: A program that reads the data on the CD and sends output to the speakers and the screen.

Self Check 1.2

Why is a CD player less flexible than a computer?

Answer: A CD player can do one thing – play music CDs. It cannot execute programs.

Self Check 1.3

Can a computer program develop the initiative to execute tasks in a better way than its programmers envisioned?

Answer: No – the program simply executes the instruction sequences that the programmers have prepared in advance.

The Anatomy of a Computer

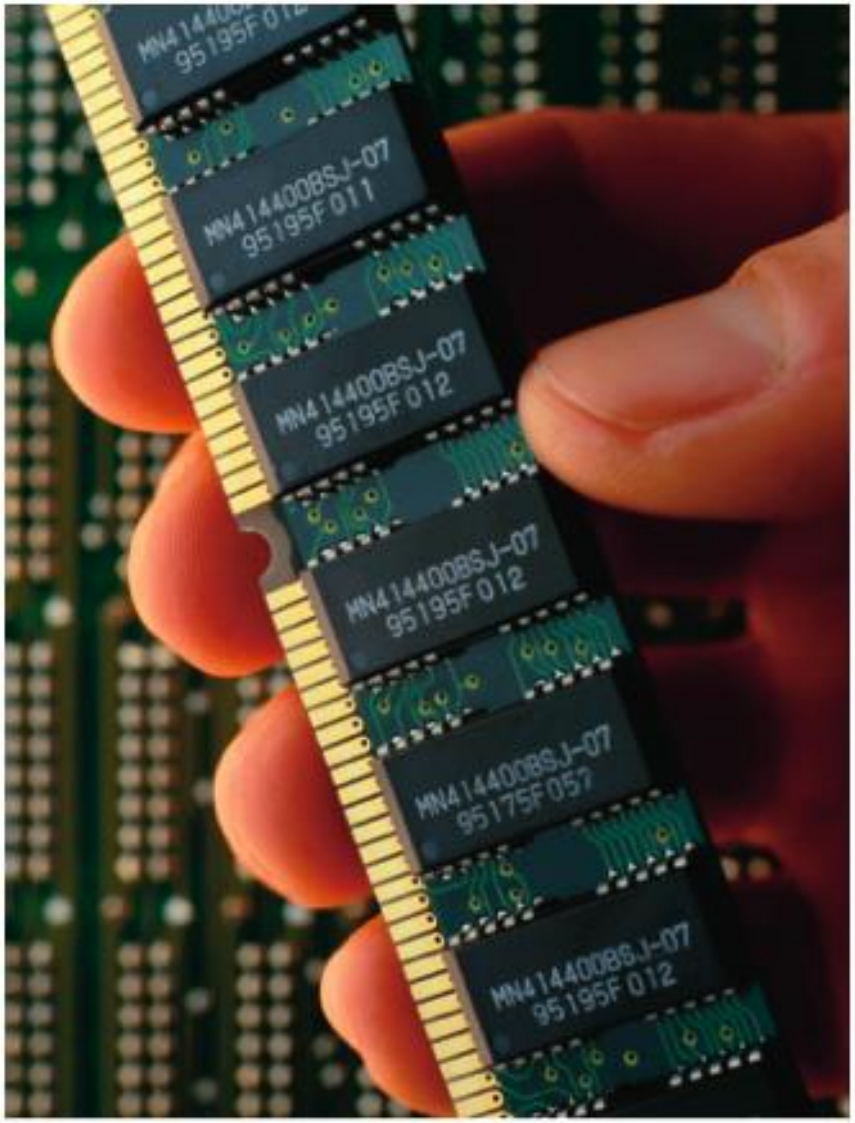
- Central processing unit
  - *Chip*
  - *Transistors*
- Storage
  - *Primary storage: Random-access memory (RAM)*
  - *Secondary storage: e.g. hard disk*
  - *Removable storage devices: e.g.: floppy disks, tapes, CDs*
- Peripherals
- Executes very simple instructions
- Executes instructions very rapidly
- General purpose device

Central Processing Unit

Figure 1
Central Processing Unit

A Memory Module with Memory Chips

Figure 2
A Memory Module with Memory Chips



A Hard Disk

Figure 3 A Hard Disk

Cay Horstmann

A Motherboard

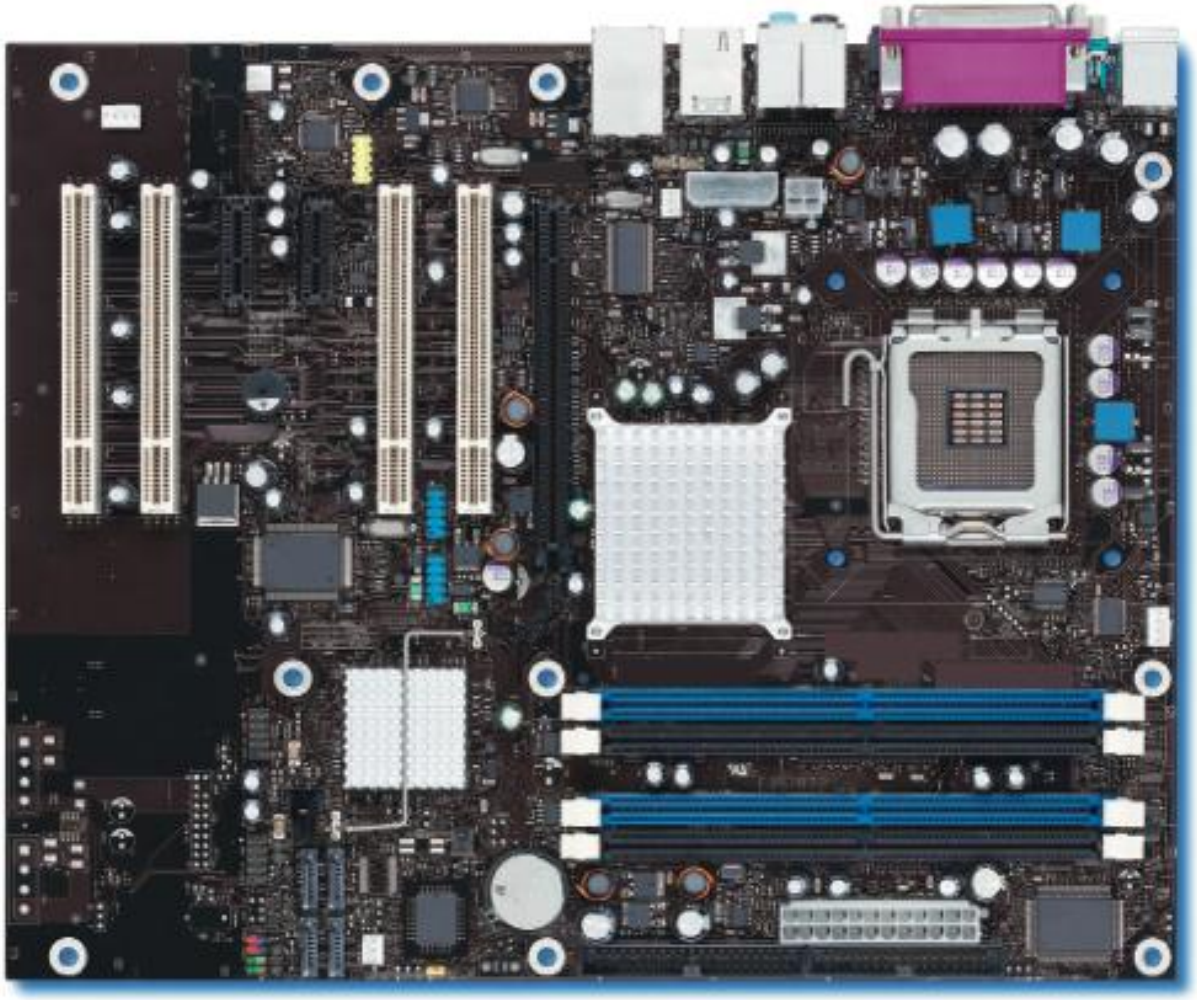


Figure 4 A Motherboard

Schematic Diagram of a Computer

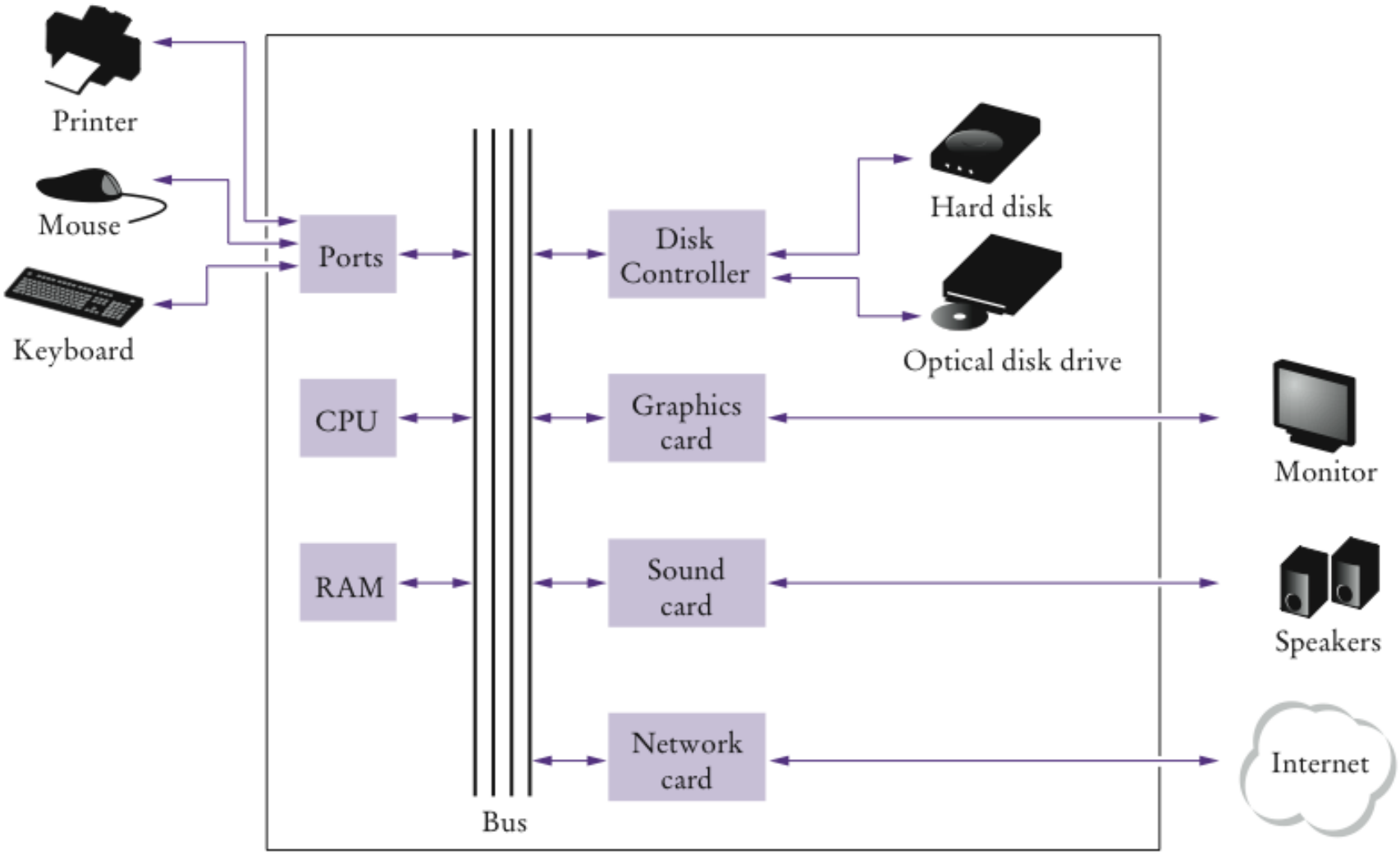
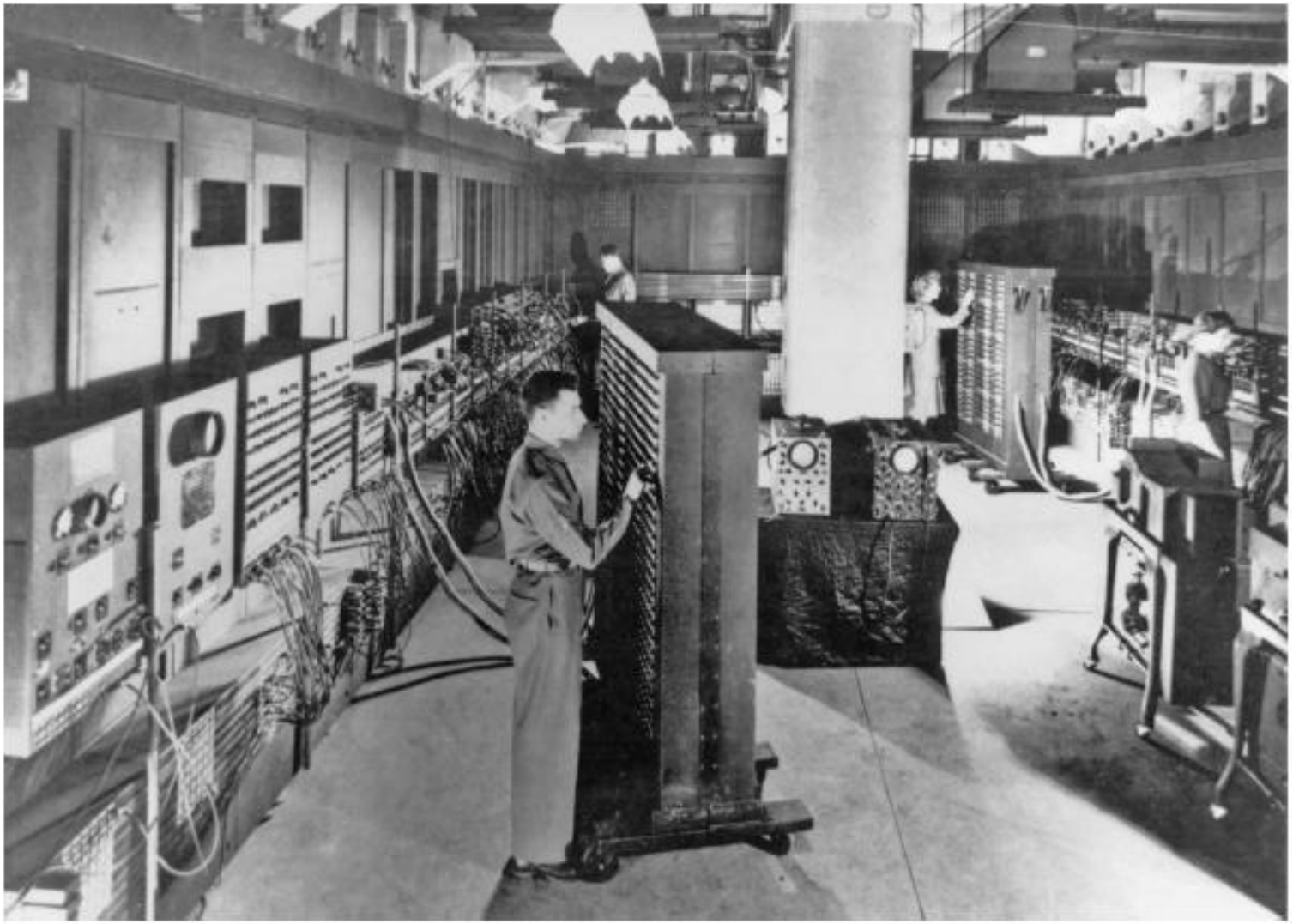


Figure 5 Schematic Diagram of a Computer

The ENIAC



The ENIAC

Self Check 1.4

Where is a program stored when it is not currently running?

Answer: In secondary storage, typically a hard disk.

Self Check 1.5

Which part of the computer carries out arithmetic operations, such as addition and multiplication?

Answer: The central processing unit.

Machine Code

- Generally, machine code depends on the CPU type
- However, the instruction set of the Java virtual machine (JVM) can be executed on many types of CPU
- Java Virtual Machine (JVM) – a typical sequence of machine instructions is:

  1. *Load the contents of memory location 40.*
  2. *Load the value 100.*
  3. *If the first value is greater than the second value, continue with the instruction that is stored in memory location 240.*

Machine Code

- Machine instructions are encoded as numbers:

```
21 40
16 100
163 240
```

- Compiler translates high-level language to machine code

Self Check 1.6

What is the code for the Java virtual machine instruction “Load the contents of memory location 100”?

Answer: `21 100`

Self Check 1.7

Does a person who uses a computer for office work ever run a compiler?

Answer: No – a compiler is intended for programmers, to translate high-level programming instructions into machine code.

The Java Programming Language

- Simple
- Safe
- Platform-independent (“write once, run anywhere”)
- Rich library (packages)
- Designed for the internet

Applet on a Web Page

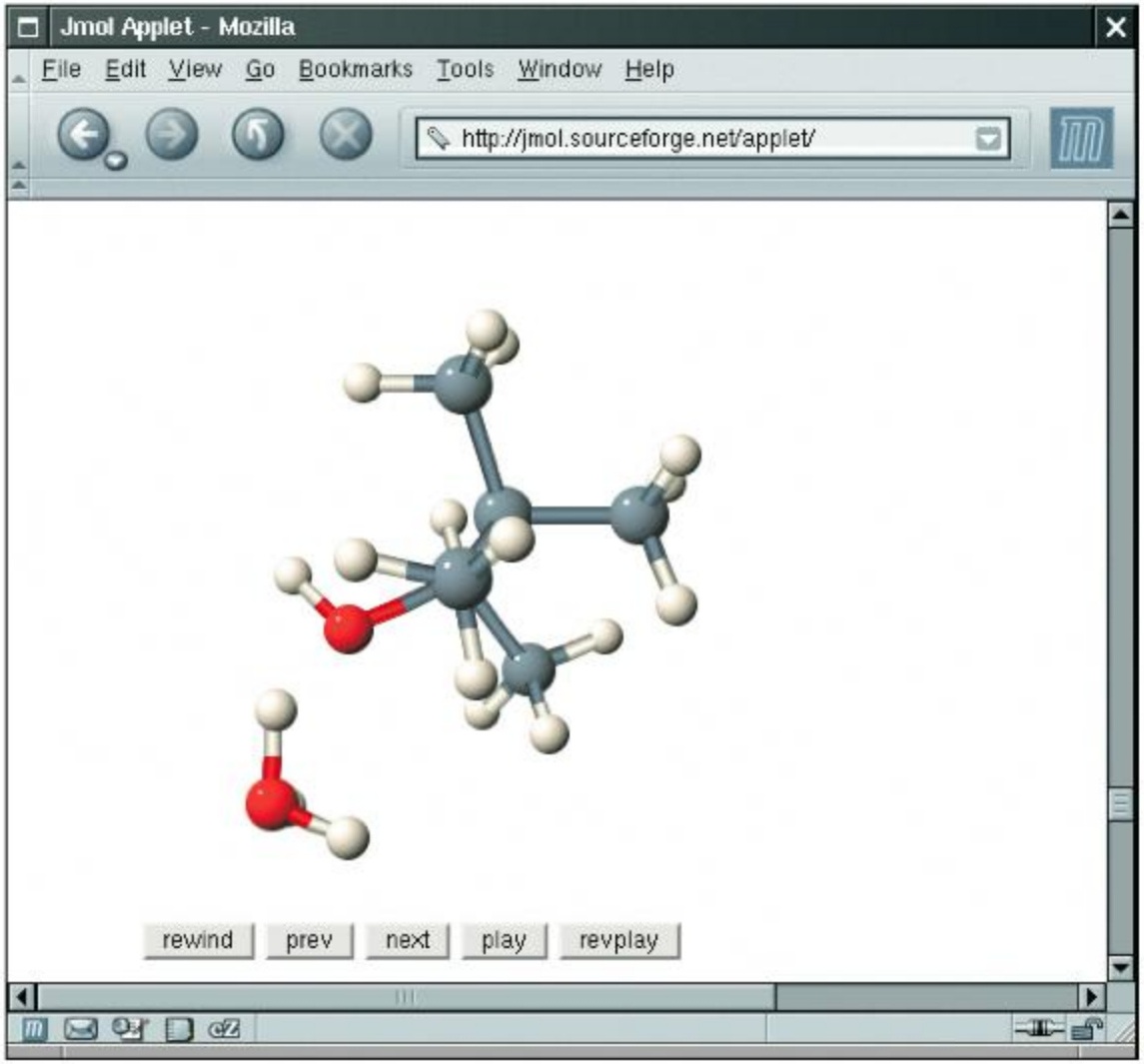


Figure 6 An Applet for Visualizing Molecules Running in a Browser (*http://jmol.sourceforge.net/applet/*)

Java Versions

Version	Year	Important New Features
1.0	1996	
1.1	1997	Inner classes
1.2	1998	Swing, Collections
1.3	2000	Performance enhancements
1.4	2002	Assertions, XML
5	2004	Generic classes, enhanced for loop, auto-boxing, enumerations
6	2006	Library improvements
7	2010	Small language changes and library improvements

Self Check 1.8

What are the two most important benefits of the Java language?

Answer: Safety and portability.

Self Check 1.9

How long does it take to learn the entire Java library?

Answer: No one person can learn the entire library – it is too large.

ch01/hello/HelloPrinter.java

```
1  public class HelloPrinter
2  {
3     public static void main(String[] args)
4     {
5        // Display a greeting in the console window
6
7        System.out.println("Hello, World!");
8     }
9  }
```

Program Run:

```
Hello, World!
```

The Structure of a Simple Program: Class Declaration

- Classes are the fundamental building blocks of Java programs:

  ```
  public class HelloPrinter
  ```

  starts a new **class**

- Every source file can contain at most one public class
- The name of the public class must match the name of the file containing the class:
  - *Class* `HelloPrinter` *must be contained in a file named* `HelloPrinter.java`

The Structure of a Simple Program: `main` Method

- Every Java application contains a class with a main method
  - *When the application starts, the instructions in the main method are executed*

- ```
  public static void main(String[] args)
  {
    . . .
  }
  ```

  declares a `main` method
  ```

The Structure of a Simple Program: Comments

- The first line inside the main method is a comment:

```
// Display a greeting in the console window
```

- Compiler ignores any text enclosed between `//` and end of the line
- Use comments to help human readers understand your program

The Structure of a Simple Program: Statements

- The body of the main method contains statements inside the curly brackets (`{ }`)
- Each statement ends in a semicolon (`;`)
- Statements are executed one by one
- Our method has a single statement:

```
System.out.println("Hello, World!");
```

which prints a line of text:

```
Hello, World
```

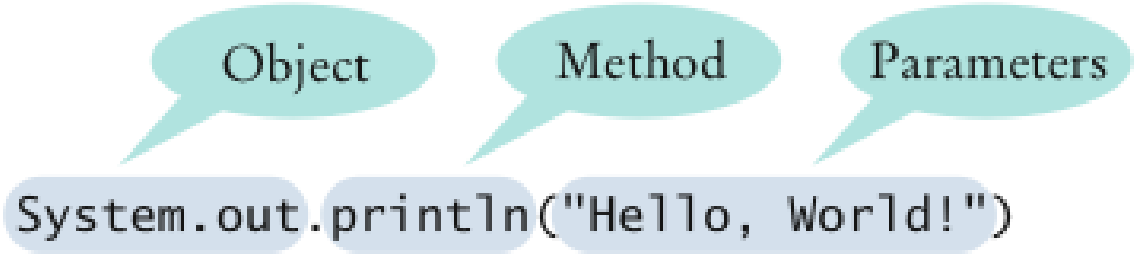
The Structure of a Simple Program: Method Call

- `System.out.println("Hello, World!");`

  is a *method call*

- A method call requires:
  1. *The object that you want to use (in this case, `System.out`)*
  2. *The name of the method you want to use (in this case, `println`)*
  3. ***Parameters** enclosed in parentheses (`()`) containing any other information the method needs (in this case, `"Hello, World!"`)*

Figure 7
Calling a Method



Syntax 1.1 Method Call

Syntax *object.methodName(parameters)*

Example

The method is invoked on this object.

This is the name of the method.

This parameter is passed to the method.

```
System.out.println("Hello")
```

Parameters are enclosed in parentheses.
Multiple parameters are separated by commas.

The Structure of a Simple Program: Strings

- **String:** a sequence of characters enclosed in double quotation marks:

```
"Hello, World!"
```

Self Check 1.10

How would you modify the `HelloPrinter` program to print the words `"Hello,"` and `"World!"` on two lines?

Answer:

```
System.out.println("Hello,");
System.out.println("World!");
```

Self Check 1.11

Would the program continue to work if you omitted the line starting with `//`?

Answer: Yes – the line starting with `//` is a comment, intended for human readers. The compiler ignores comments.

Self Check 1.12

What does the following set of statements print?

```
System.out.print("My lucky number is");
System.out.println(3 + 4 + 5);
```

Answer: The printout is

```
My lucky number is12
```

It would be a good idea to add a space after the `is`.

Editing a Java Program

- Use an editor to enter and modify the program text
- Java is case-sensitive
  - *Be careful to distinguish between upper- and lowercase letters*
- Lay out your programs so that they are easy to read

Compiling and Running a Java Program

- The Java compiler translates source code into class files that contain instructions for the Java virtual machine
- A class file has extension `.class`
- The compiler does not produce a class file if it has found errors in your program
- The Java virtual machine loads instructions from the program's class file, starts the program, and loads the necessary library files as they are required

`HelloPrinter` in a Console Window

```
Terminal
File  Edit  View  Terminal  Tabs  Help
~$ cd BigJava/ch01/hello
~/BigJava/ch01/hello$ javac HelloPrinter.java
~/BigJava/ch01/hello$ java HelloPrinter
Hello, World!
~/BigJava/ch01/hello$
```

Figure 8 Running the `HelloPrinter` Program in a Console Window

`HelloPrinter` in an IDE

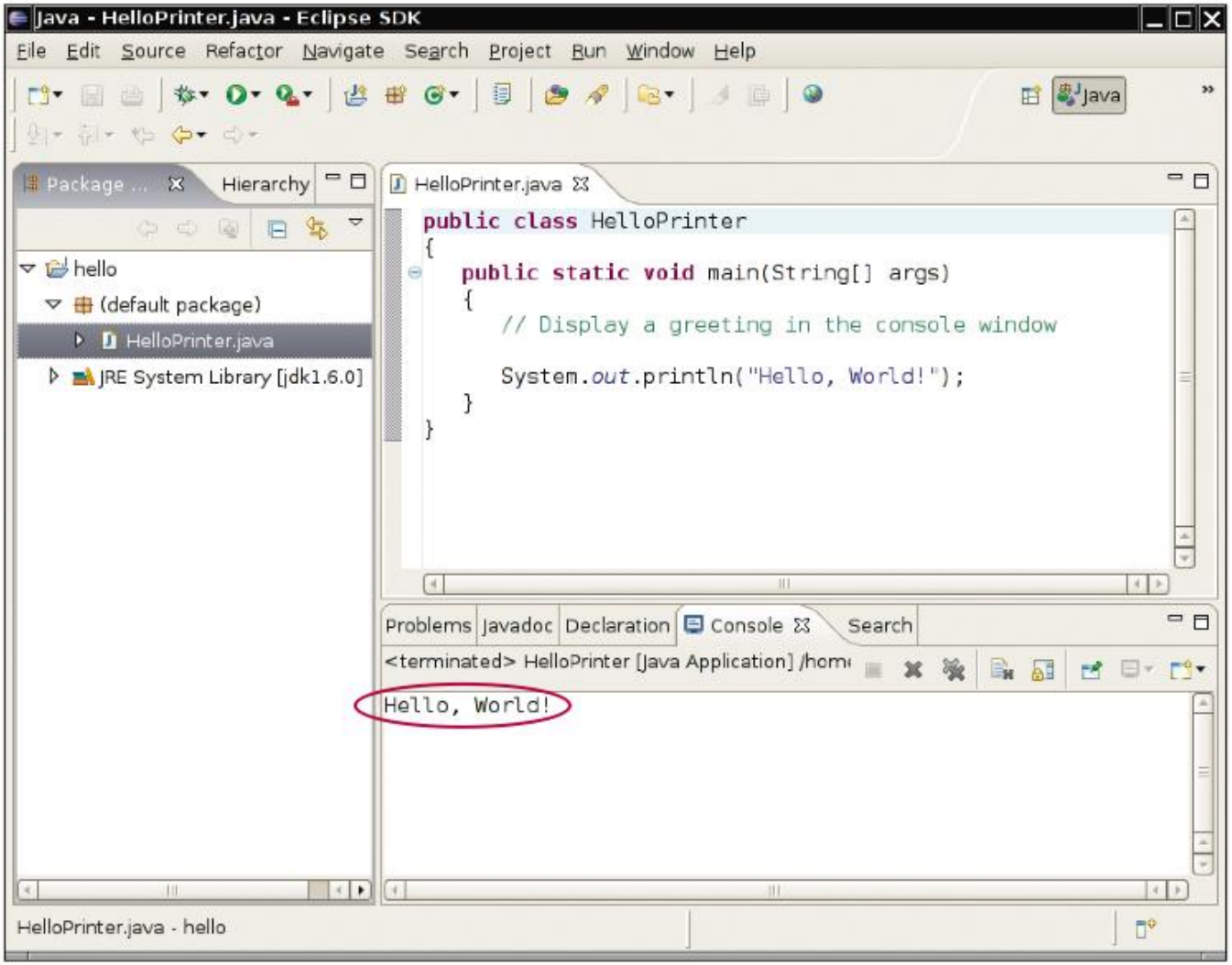


Figure 9 Running the `HelloPrinter` Program in an Integrated Development Environment

From Source Code to Running Program

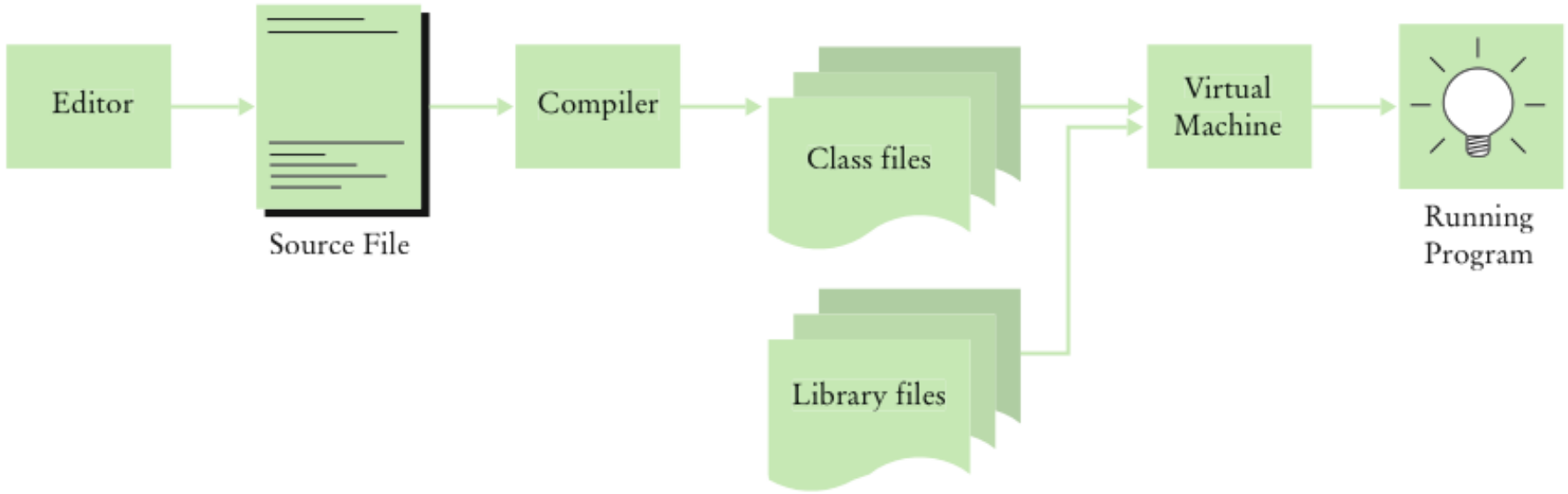


Figure 10 From Source Code to Running Program

Self Check 1.13

Can you use a word processor for writing Java programs?

Answer: Yes, but you must remember to save your file as "plain text".

Self Check 1.14

What do you expect to see when you load a class file into your text editor?

Answer: A sequence of random characters, some funny looking. Class files contain virtual machine instructions that are encoded as binary numbers.

Errors

- **Compile-time error:** A violation of the programming language rules that is detected by the compiler
  - *Example*:

```
System.ou.println("Hello, World!);
```

  - *Syntax error*
- **Run-time error:** Causes the program to take an action that the programmer did not intend
  - *Examples:*

```
System.out.println("Hello, Word!");
System.out.println(1/0);
```

  - *Logic error*

Error Management Strategy

- Learn about common errors and how to avoid them
- Use defensive programming strategies to minimize the likelihood and impact of errors
- Apply testing and debugging strategies to flush out those errors that remain

Self Check 1.15

Suppose you omit the `//` characters from the `HelloPrinter.java` program but not the remainder of the comment. Will you get a compile-time error or a run-time error?

Answer: A compile-time error. The compiler will not know what to do with the word `Display`.

Self Check 1.16

When you used your computer, you may have experienced a program that “crashed” (quit spontaneously) or “hung” (failed to respond to your input). Is that behavior a compile-time error or a run-time error?

Answer: It is a run-time error. After all, the program had been compiled in order for you to run it.

Self Check 1.17

Why can't you test a program for run-time errors when it has compiler errors?

Answer: When a program has compiler errors, no class file is produced, and there is nothing to run.

Algorithms

- **Algorithm:** A sequence of steps that is:
  - *unambiguous*
  - *executable*
  - *terminating*
- Algorithm for deciding which car to buy, based on total costs:

```
For each car, compute the total cost as follows:
   annual fuel consumed = annual miles driven / fuel efficiency
   annual fuel cost = price per gallon x annual fuel consumed
   operating cost = 10 x annual fuel cost
   total cost = purchase price + operating cost
If total cost1 < total cost2
   Choose car1
Else
   Choose car2
```

Pseudocode

- **Pseudocode:** An informal description of an algorithm:
  - *Describe how a value is set or changed:*

    total cost = purchase price + operating cost

  - *Describe decisions and repetitions:*

    For each car
    operating cost = 10 x annual fuel cost
    total cost = purchase price + operating cost

    Use indentation to indicate which statements should be selected or repeated

  - *Indicate results:*

    Choose car1

Program Development Process

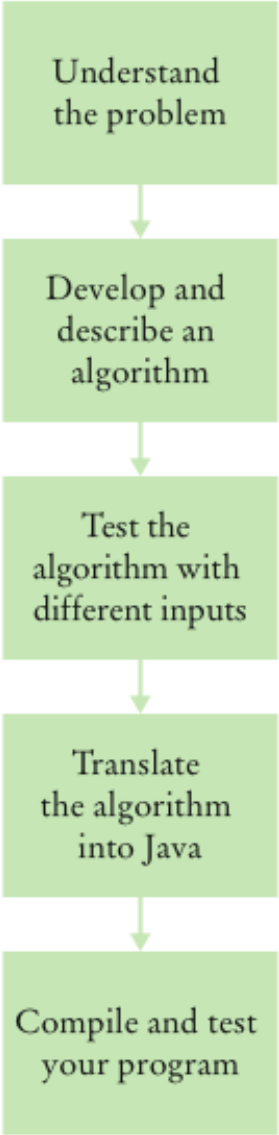


Figure 12
The Program Development Process

Self Check 1.18

Investment Problem: You put $10,000 into a bank account that earns 5 percent interest per year. How many years does it take for the account balance to be double the original?

Algorithm:

Start with a year value of 0 and a balance of $10,000.
Repeat the following steps while the balance is less than $20,000.
  Add 1 to the year value.
  Multiply the balance value by 1.05 (a 5 percent increase).

Suppose the interest rate was 20 percent. How long would it take for the investment to double?

Answer: 4 years:

```
0 10,000
1 12,000
2 14,400
3 17,280
4 20,736
```

Self Check 1.19

Suppose your cell phone carrier charges you $29.95 for up to 300 minutes of calls, and $0.45 for each additional minute, plus 12.5 percent taxes and fees. Give an algorithm to compute the monthly charge for a given number of minutes.

Answer:

Is the number of minutes at most 300?

a. If so, the answer is $29.95 × 1.125 = $33.70.

b. If not,

1. Compute the difference: (number of minutes) – 300.
2. Multiply that difference by 0.45.
3. Add $29.95.
4. Multiply the total by 1.125. That is the answer.