Introduction

Advanced Programming

ICOM 4015

Lecture 1

Reading: Java Concepts Chapter 1

Lecture Goals

- To understand the activity of programming
- 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

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**

Important Characteristics of a Computer

- **Can store large amount of data**
  - Instructions to be executed (programs)
  - Data to operate with
- **Can execute very simple instructions from a predetermined set of possible instructions**
  - Access particular data in memory (read)
  - Store data in memory (write)
  - Operate with data in CPU
    - Perform logical/arithmetic operations
  - Make data available to an external source
  - Get data from an external source
- **Executes instructions fast – millions per second…**
- **Instructions must be provided in native language (machine language)**

Machine Instructions

- **Need to be coded following a very specific format (machine language)**
  - Very detailed
  - Each instruction performs a simple task
- **General categories of machine instructions:**
  - Control instructions – tell the computer what to do next
  - Data handling instructions – operate on data stored, or to be stored, in the computer's memory
    - Alter data
    - Compute new data
    - Write data to memory
    - Read data from memory
    - Write data to an external device (output)
    - Read data from an external device (input)

Instruction Execution

- **Instruction is read from memory**
- **Instruction is placed in special register in CPU**
- **Signals are initiated to activate required computer components to perform a particular task**
  - These correspond to the purpose of the instruction
- **Instructions are execute sequentially (except in parallel architectures)**
  - Only one instruction at a time
  - When an instruction is finished, the next instruction in the sequence is executed
    - Except in the case of control instructions that may alter the sequence of instructions to execute.

Machine Code

- **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 instructions are encoded as numbers:

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


Continued…

Machine Code

- **Compiler translates high-level language to machine code**

Self Check

1. What is the code for the Java virtual machine instruction "Load the contents of memory location 100"?
2. Does a person who uses a computer for office work ever run a compiler?

Answers

1. 21 100
2. No–a compiler is intended for programmers, to translate high-level programming instructions into machine code.

Programming Languages

- **Machine/Virtual Machine**

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

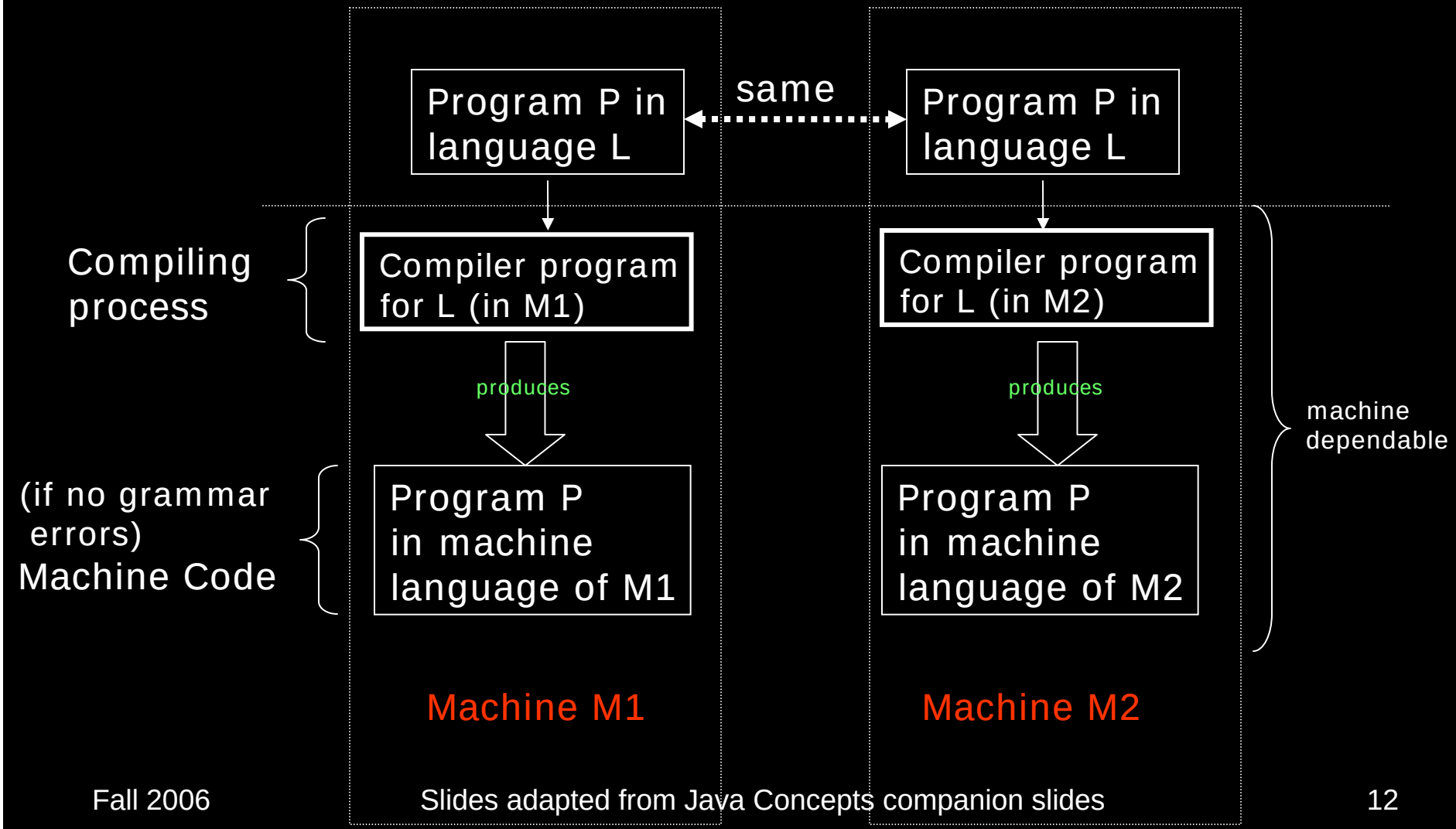
- **Assembler**

```
iload intRate
bipush 100
if_icmpgt intError
```

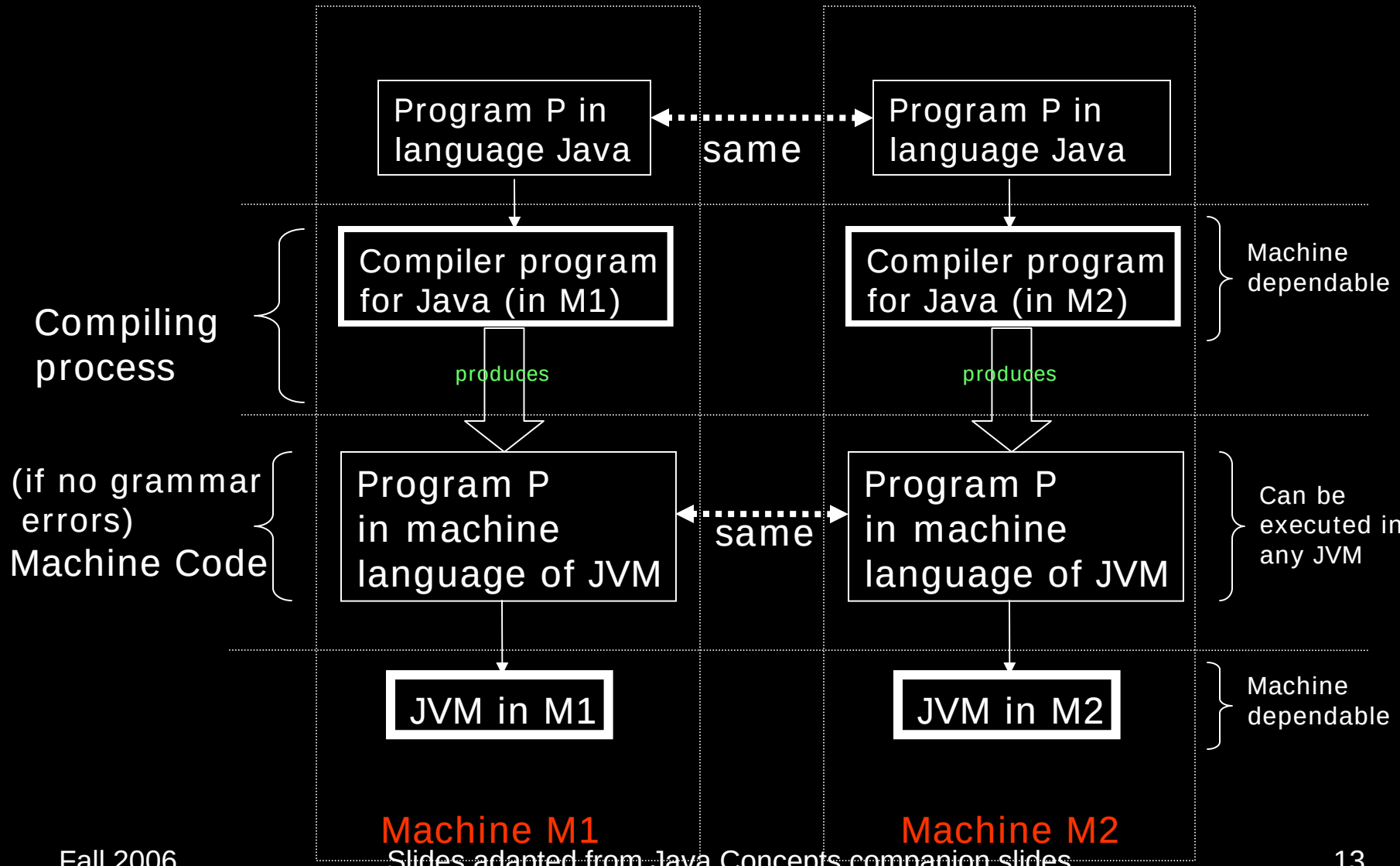
- **High-level language**

```
if (intRate > 100) . . .
```

Common Approach with High-Level Language Programs



Approach Followed by Java System



The Java Programming Language

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

Applets on a Web Page

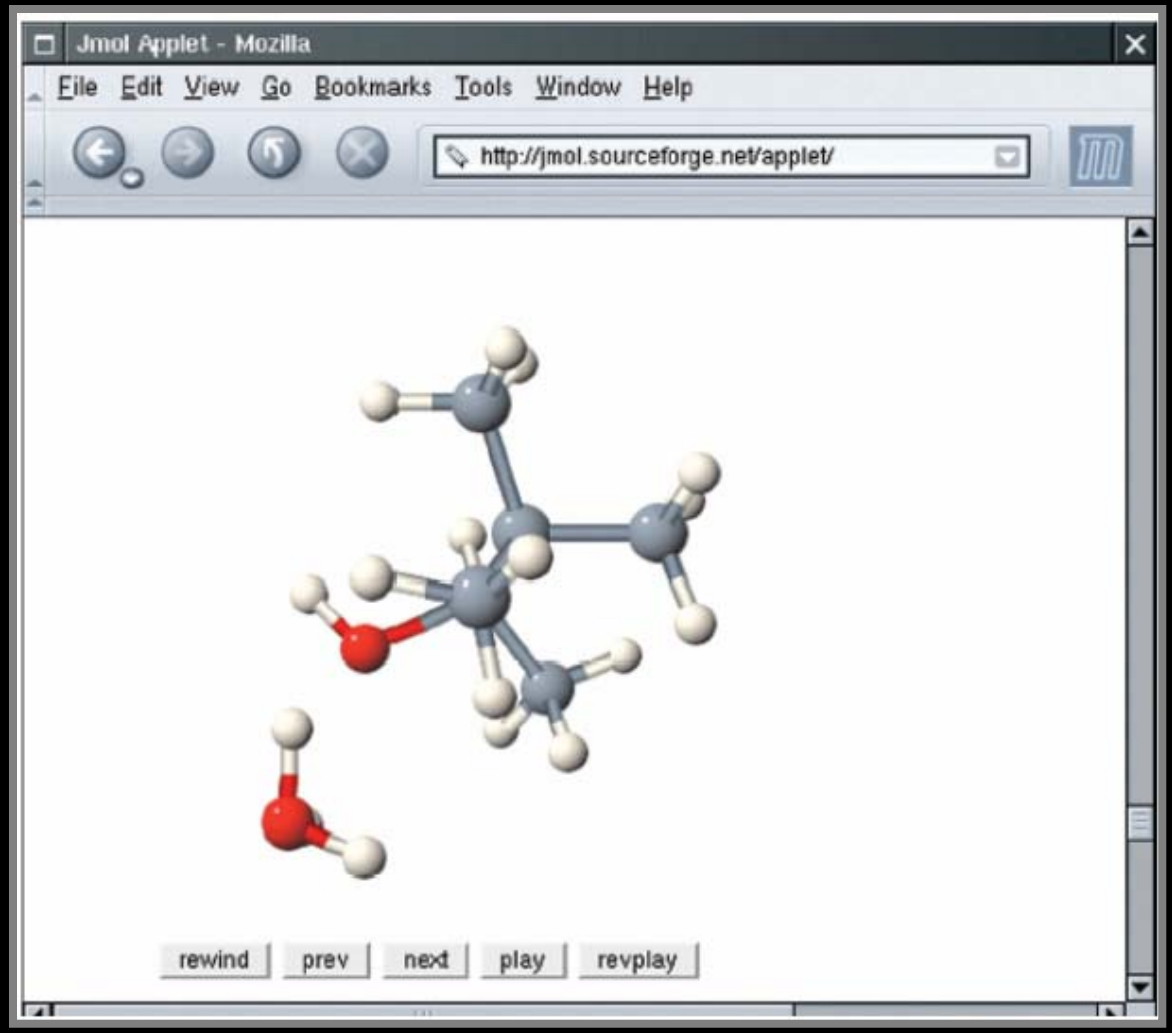


Figure 7:
Applets on a Web Page

Self Check

1. What are the two most important benefits of the Java language?
2. How long does it take to learn the entire Java library?

Answers

1. **Safety and portability.**
2. **No one person can learn the entire library–it is too large.**

Becoming Familiar with your Computer

- **Log in**
- **Locate the Java compiler**
- **Understand files and folders**
  - Programs are kept in files
  - File: a collection of items of information that are kept together
  - Files have names, and the rules for legal names differ from one system to another
  - Files are stored in folders or directories; these file containers can be nested

Continued…

Becoming Familiar with your Computer

- **Write a simple program (later)**
- **Save your work**
  - Develop a strategy for keeping backup copies of your work

A Shell Window

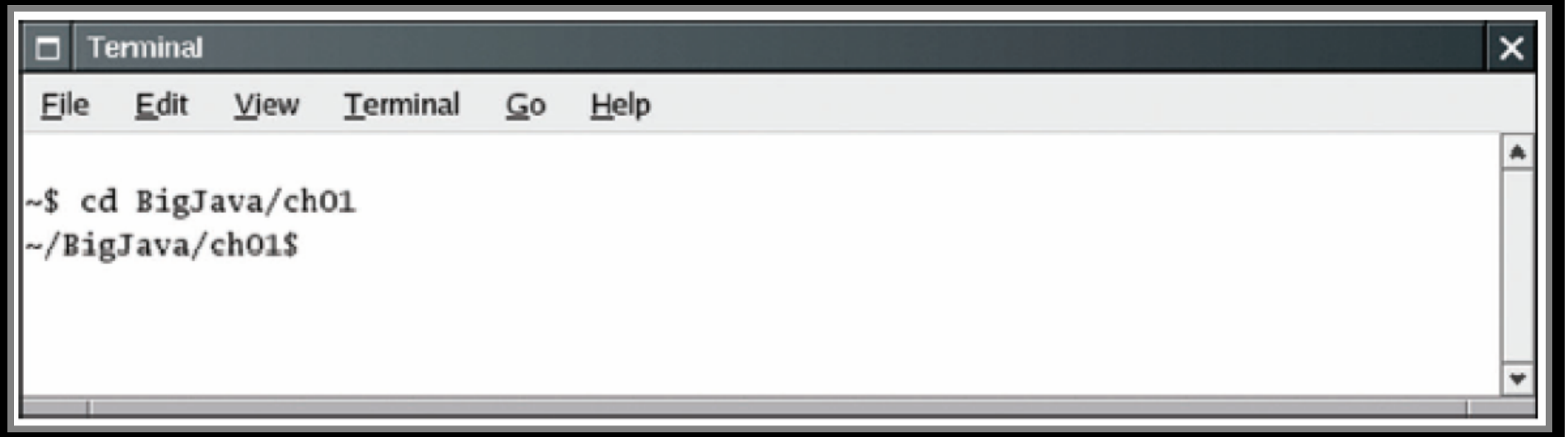


Figure 8:
A Shell Window

An Integrated Development Environment

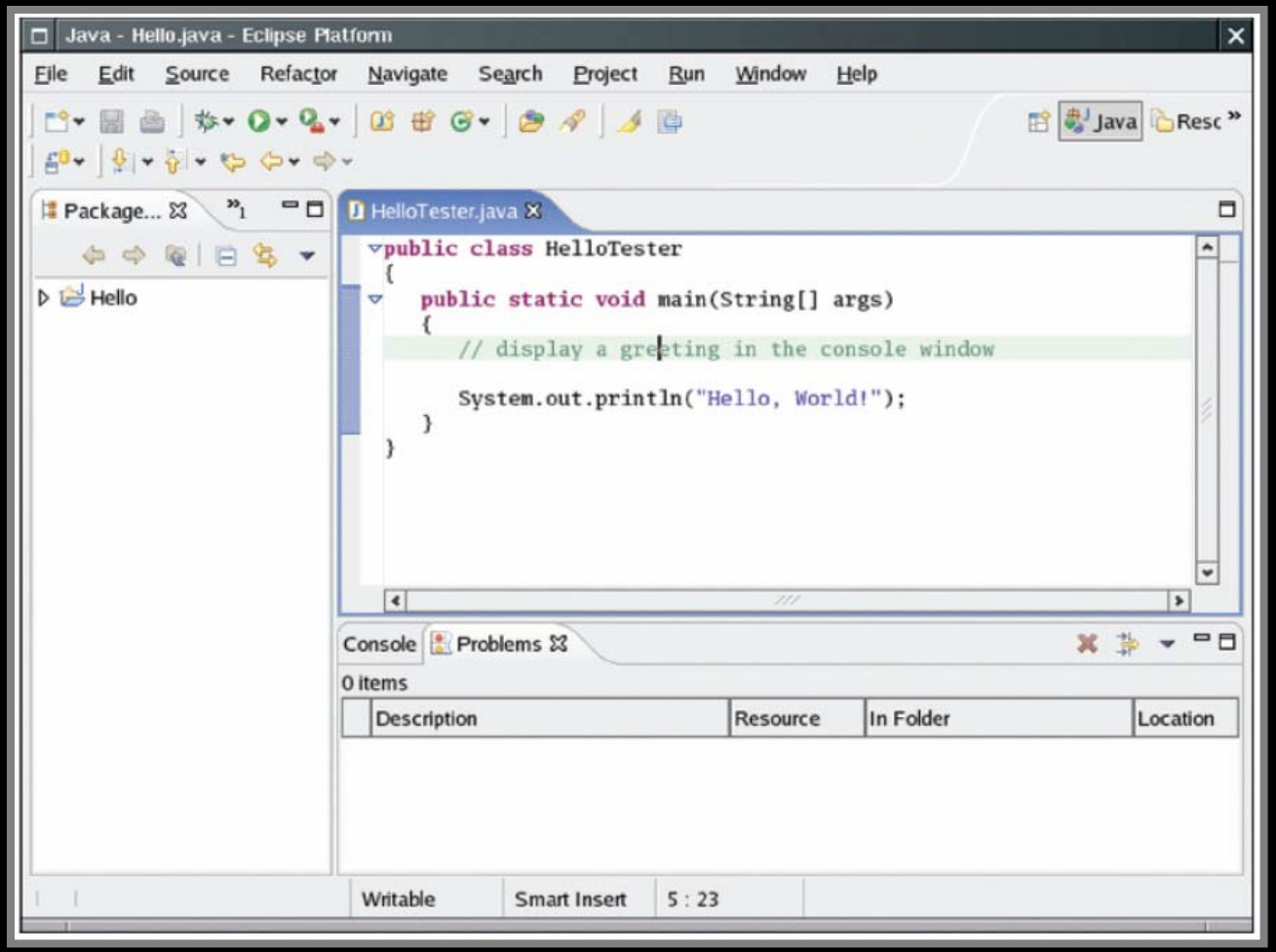


Figure 9: An Integrated Development Environment

Nested Folders

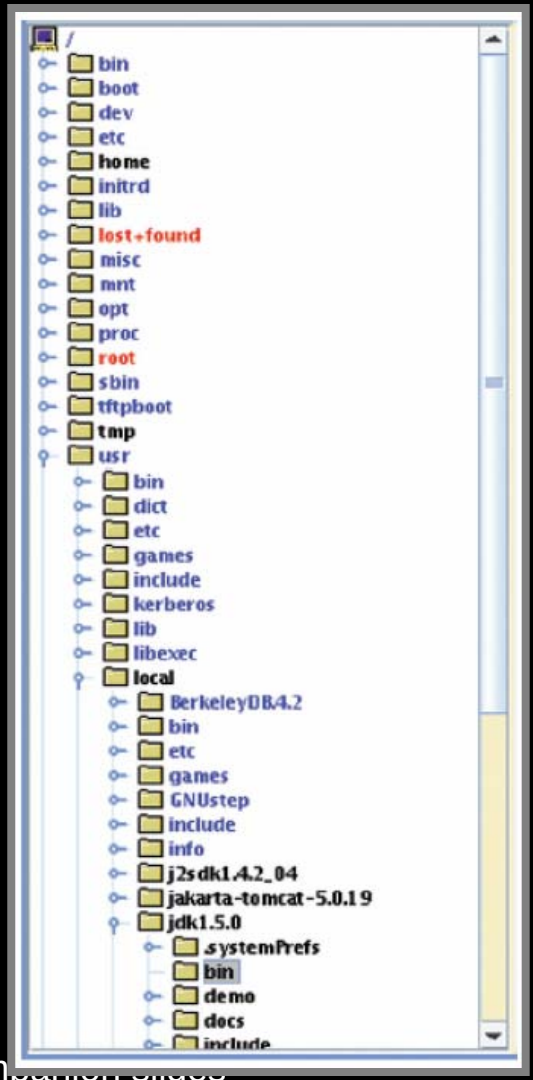


Figure 10:
Nested Folders

Self Check

1. How are programming projects stored on a computer?
2. What do you do to protect yourself from data loss when you work on programming projects?

Answers

1. Programs are stored in files, and files are stored in folders or directories.
2. You back up your files and folders.

File HelloTester.java

```
1: public class HelloTester
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: }
```

Output

```
Hello, World!
```

`HelloTester` in a Console Window

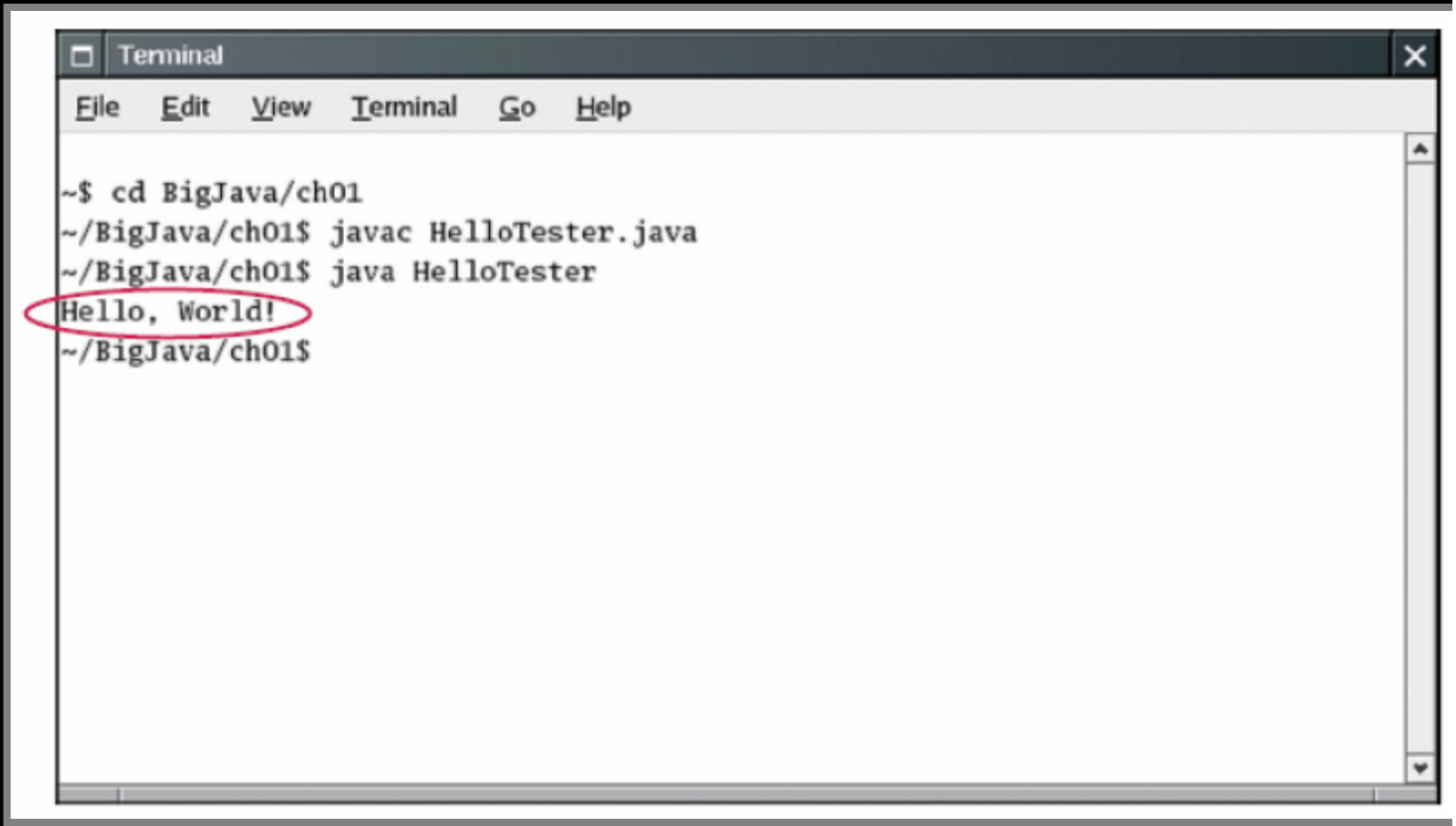


Figure 11:
Running the `HelloTester` Program in a Console Window

HelloTester in an IDE

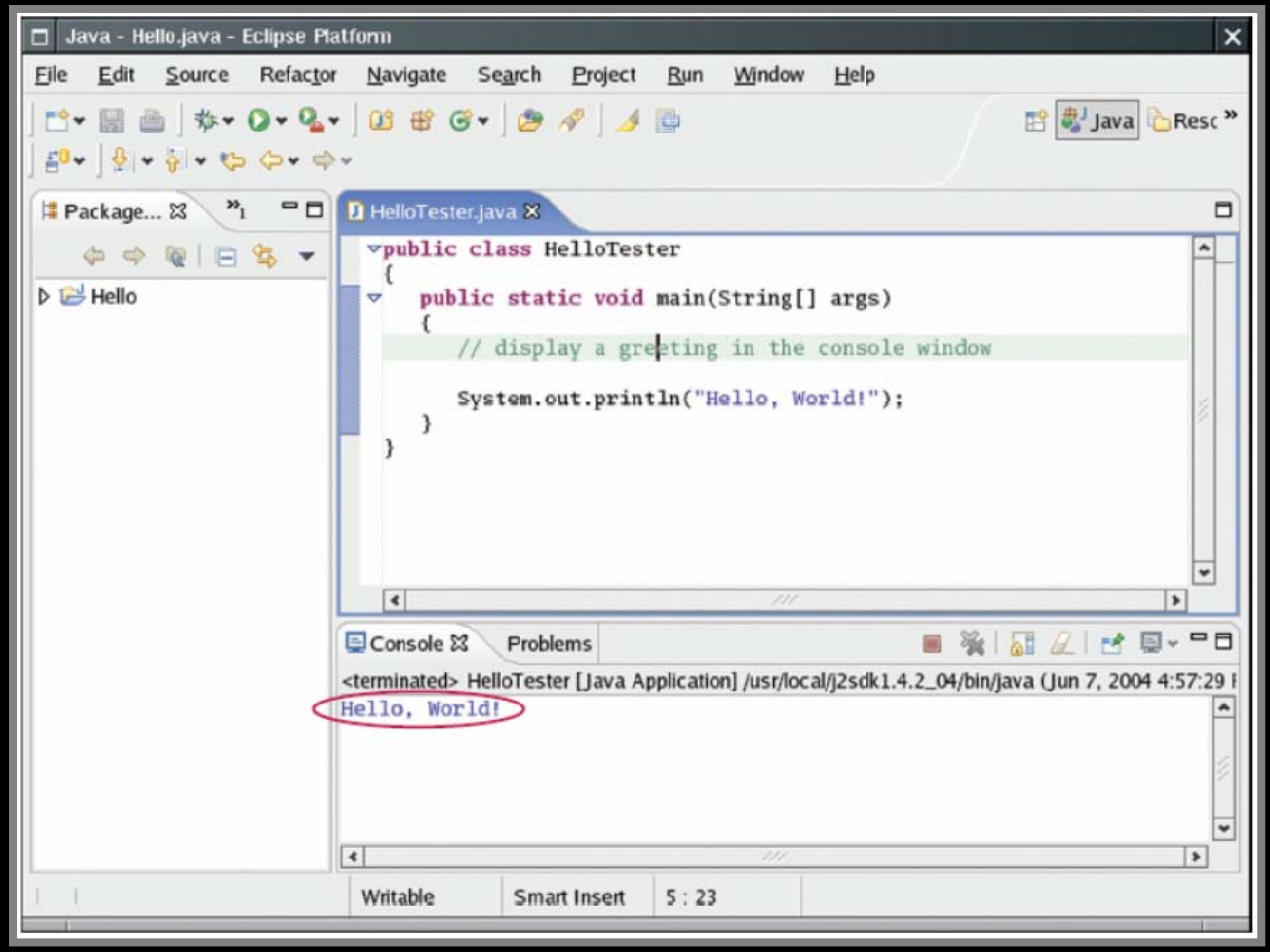


Figure 12:
Running the `HelloTester` Program in an Integrated Development Environment

A Simple Program

- `public class ClassName`
- `public static void main(String[] args)`
- `// comment`
- Method call

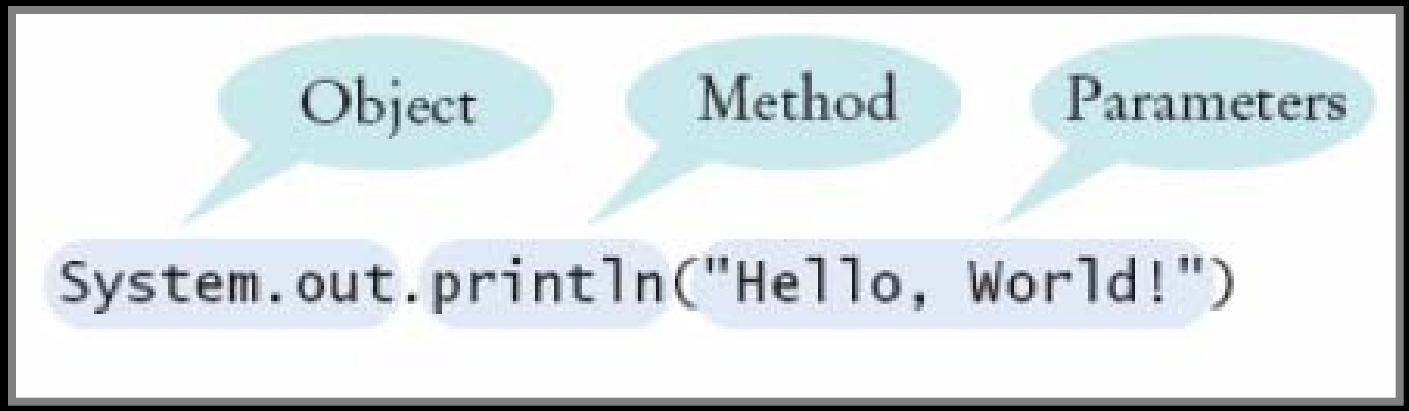


Figure 13:
Calling a Method

`System` Class
`System.out` Object
`println` Method

Syntax 1.1: Method Call

object`.`*methodName*`(`*parameters*`)`

Example:

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

Purpose:

To invoke a method of an object and supply any additional parameters

Self Check

1. How would you modify the HelloTester program to print the words `"Hello,"` and `"World!"` on two lines?
2. Would the program continue to work if you omitted the line starting with `//`?
3. What does the following set of statements print?

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

Answers

1.
```
System.out.println("Hello,");
System.out.println("World");
```

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

3. The printout is `My lucky number is12`. It would be a good idea to add a space after the is.

Errors

- **Syntax errors**

```
System.ouch.print(". . .");
System.out.print("Hello);
```

- **Detected by the compiler**
- **Logic errors**

```
System.out.print("Hell");
```

- **Detected (hopefully) through testing**

Self Check

1. Suppose you omit the // characters from the HelloTester.java program but not the remainder of the comment. Will you get a compile-time error or a run-time error?
2. How can you find logic errors in a program?

Answers

1. A compile-time error. The compiler will not know what to do with the word display.
2. You need to run the program and observe its behavior.

The Compilation Process

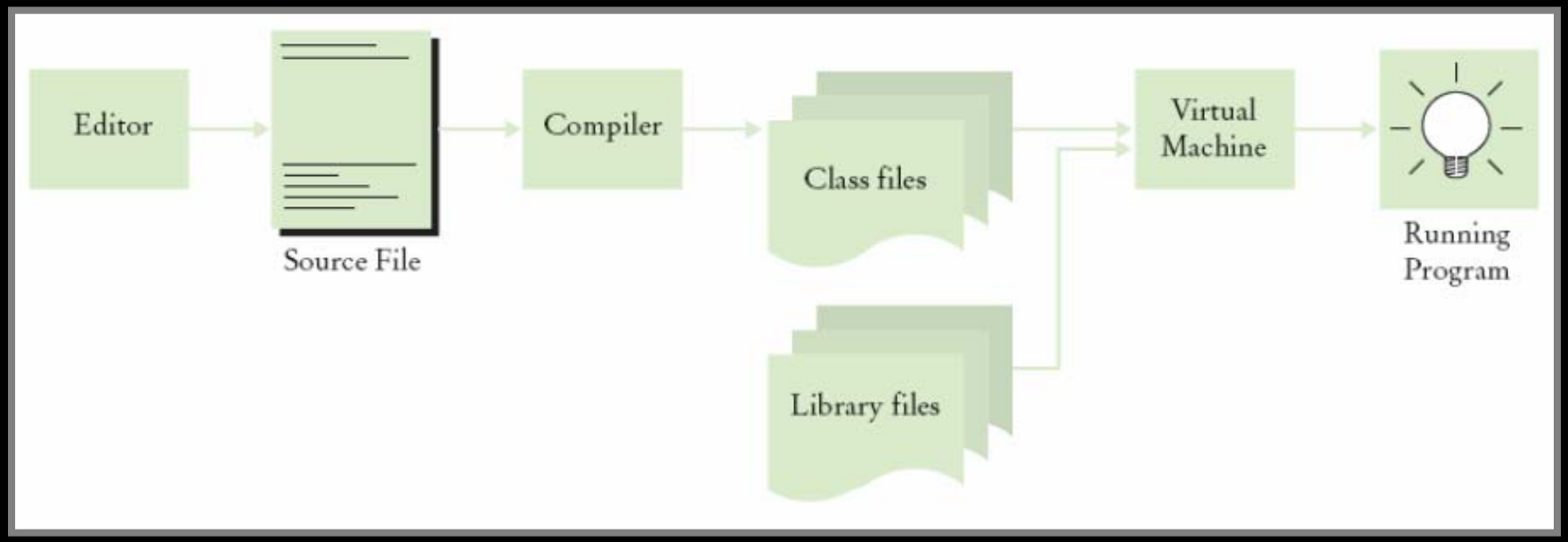


Figure 14:
From Source Code to Running Program

The Edit—Compile—Loop Test

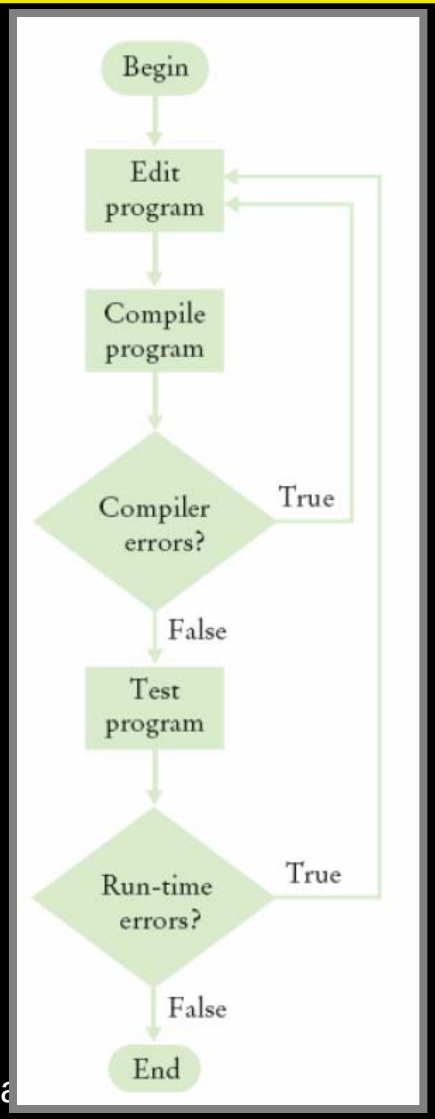


Figure 15:
The Edit—Compile—Loop Test

Self Check

1. What do you expect to see when you load a class file into your text editor?
2. Why can't you test a program for run-time errors when it has compiler errors?

Answers

1. A sequence of random characters, some funny-looking. Class files contain virtual machine instructions that are encoded as binary numbers.
2. When a program has compiler errors, no class file is produced, and there is nothing to run.