Introduction to Computers and Java

Chapter 1

*JAVA: An Introduction to Problem Solving & Programming, 6*th Ed. By Walter Savitch
ISBN 0132162709

Objectives

- Overview of
  - computer hardware and software,
  - programs and compilers
  - the Java programming language
- Example program

Hardware and Software

- Computer systems consist of *hardware* and *software.*
  - Hardware includes the *tangible* parts of computer systems.
  - Software includes *programs* - sets of instructions for the computer to follow.
- Familiarity with hardware basics helps us understand software.

Hardware and Memory

- Most modern computers have similar components including
  - Input devices (keyboard, mouse, etc.)
  - Output devices (display screen, printer, etc.)
  - A processor
  - Two kinds of memory (main memory and auxiliary memory).

The Processor

- Also called the *CPU* (central processing unit) or the *chip* (e.g. Pentium processor)
- The processor **processes** a program's instructions.
- It can process only very simple instructions.
- The power of computing comes from speed and program intricacy.

Memory

- Memory holds
  - programs
  - data for the computer to process
  - the results of intermediate processing.
- Two kinds of memory
  - main memory
  - auxiliary memory
- Measured in bits, bytes, megabytes, gigabytes…

Main memory

- Working memory used to store
  - The current program
  - The data the program is using
  - The results of intermediate calculations
- Also called RAM (Random Access Memory)
- Volatile
  - Not permanent
  - Is overwritten when a program stops running

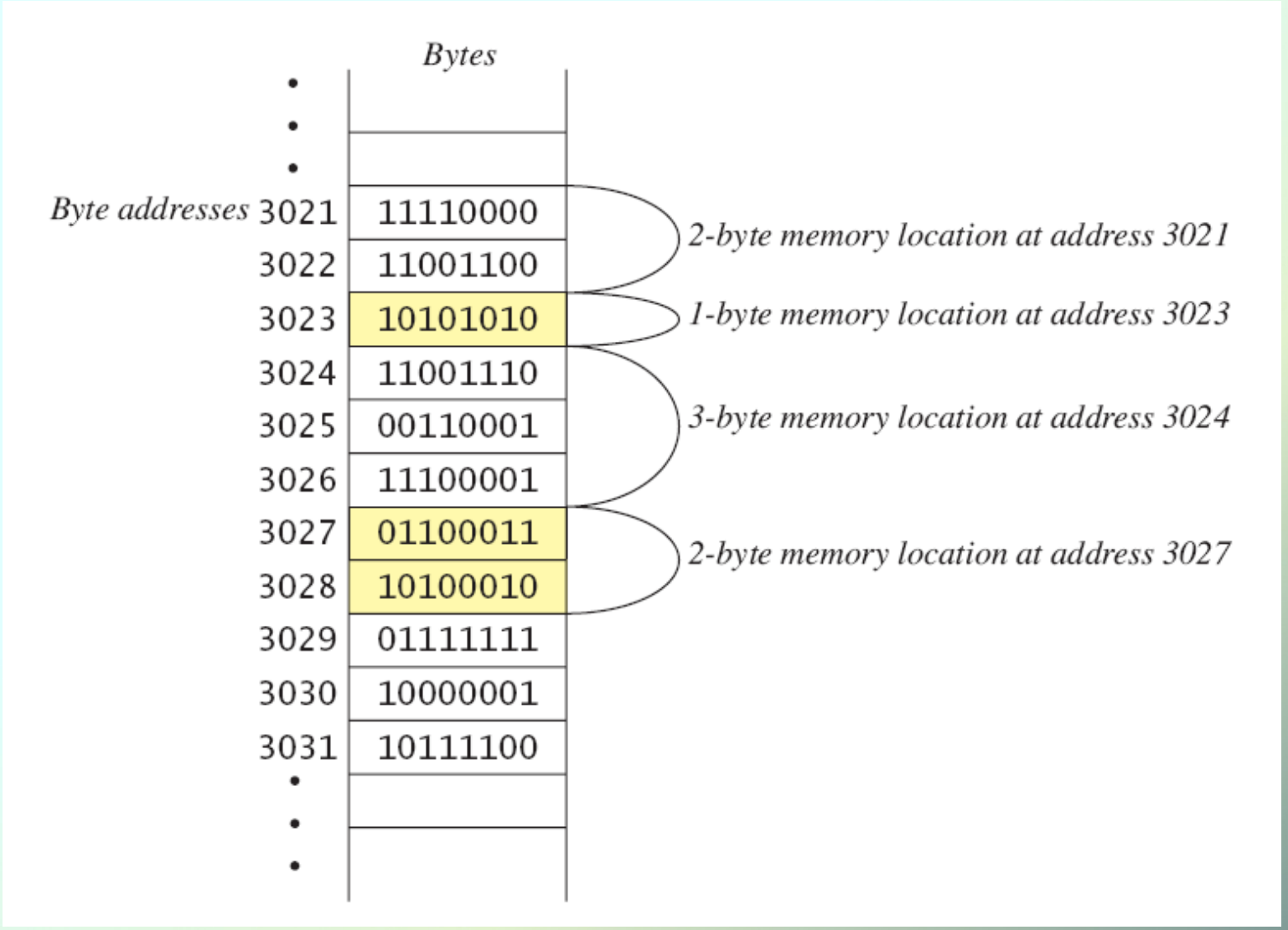
Auxiliary Memory

- Also called *secondary memory*
- Used to store:
  - Program source code
  - Data files
- Disk drives, CDs, DVDs, flash drives, etc.
- More or less permanent (nonvolatile)

Bits, Bytes, and Addresses

- Bits and bytes are quantities of memory
- A *bit* is a single digit with a value of either 0 or 1.
- A *byte* consists of 8 bits.
- Each byte in main memory resides at a numbered location called its *address.*

Main Memory



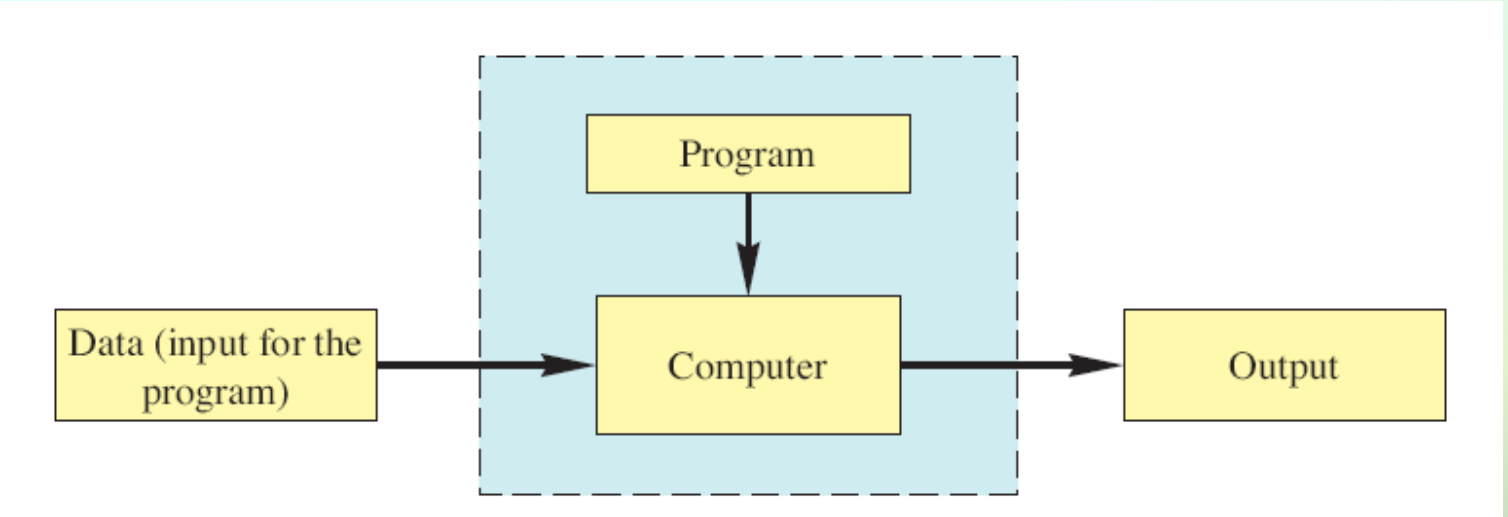
Files

- Large groups of bytes in auxiliary memory are called *files.*
- Files have names and are organized into groups called *directories* or *folders.*
- Java programs are stored in files.
- Programs files are copied from auxiliary memory to main memory in order to be run.

Programs

- A *program* is a set of instructions for a computer to follow.
- We use programs almost daily (email, word processors, video games, etc.).
- Following the instructions is called *running* or *executing* the program.

Running a Program



- Program files are copied into main memory when a program is run
- The OS (Operating System – Windows, Linux, MAC OS) loads and starts a program

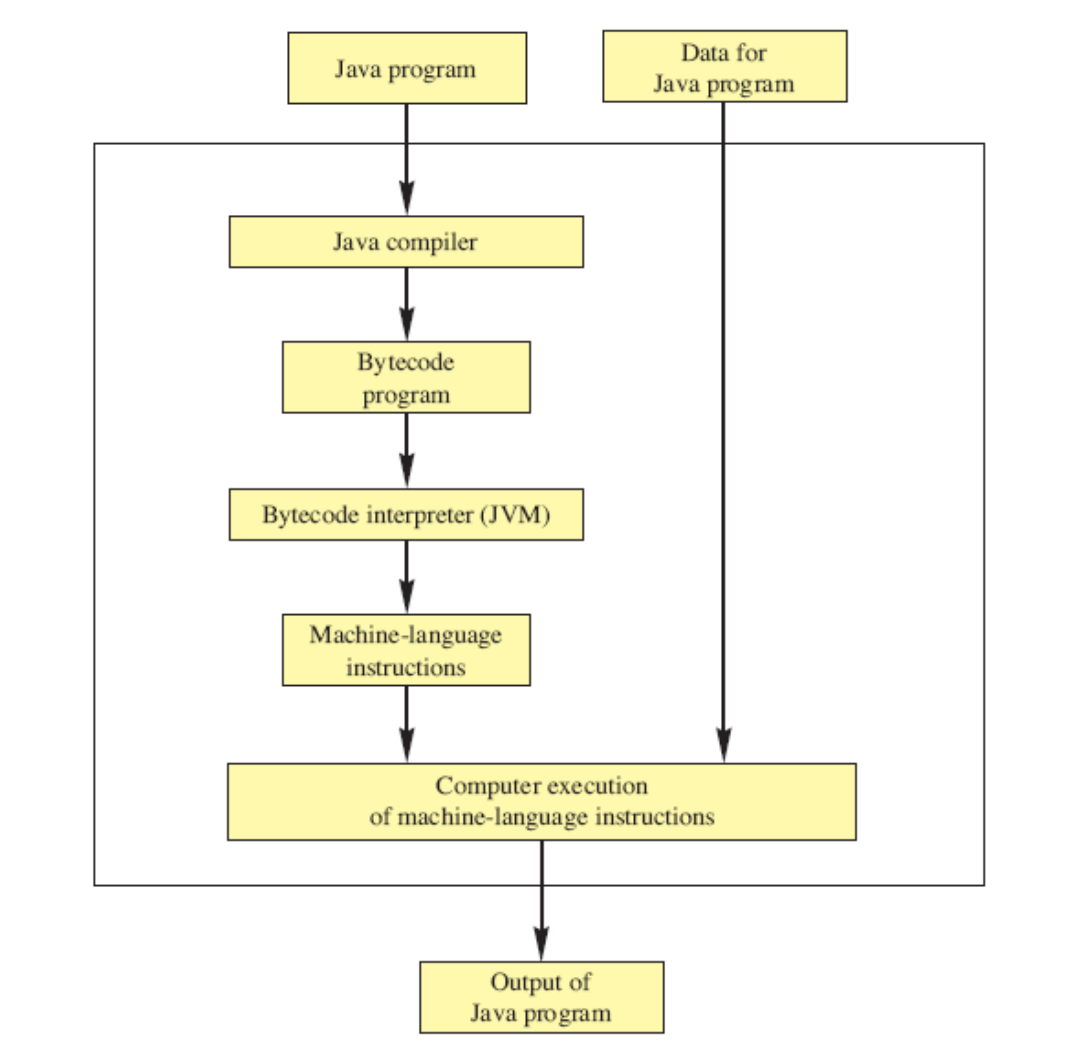
Programming Languages

- *High-level languages* are relatively easy to use
  - Java, C#, C++, Visual Basic, Python, Ruby.
- Unfortunately, computer hardware does not understand high-level languages.
  - Therefore, a high-level language program must be translated into a *low-level language.*

Compilers

- A *compiler* translates a program from a high-level language to a low-level language the computer can run.
- You *compile* a program by running the compiler on the high-level-language version of the program called the *source program.*
- Compilers produce *machine*- or *assembly-language* programs called *object programs.*
- The Java compiler produces byte-code, which is interpreted when a program is executed.

Compiling and Running a Program



A First Java Application

- Create a directory for this course
  - `mkdir java1`
  - `cd java1`
- Create a directory for examples from the book
  - `mkdir savitch`
  - `cd savitch`
- Create a subdirectory for chapter1
  - `mkdir ch01`
  - `cd ch01`

A First Java Application

Click the “Savitch Src” link on the course webpage:

http://www.sfs.uni-tuebingen.de/~saile/ws15-16/java

- Download ch01/FirstProgam.java to **`java1/savitch/ch01`**

A First Java Application

- DrJava is an IDE (integrated development environment): combines text editor with commands to compile and run java programs
- Start drjava and open FirstProgram.java
- Compile and run the program

```
Hello out there.
I will add two numbers for you.
Enter two whole numbers on a line:
12 30
The sum of those two numbers is
42
```

Sample screen output

Some Terminology

- *programmer:* person who writes programs
- *user:* person who interacts with the program
- *package:* library of classes that have been defined already.
  - `import java.util.Scanner;`
- *argument(s)*: item(s) inside parenthesis
- *variable:* place to store data
- *statement:* instruction – ends with ;
- *syntax:* grammar rules for a programming language

Printing to the Screen

```
System.out.println("Whatever you want to print");
```

- `System.out` is an object for sending output to the screen.
- `println` is a method to print whatever is in parentheses to the screen.
- The object performs an action when you *invoke* or *call* one of its methods

```
objectName.methodName(argumentsTheMethodNeeds);
```

Compiling Programs or Classes

- A Java program consists of one or more classes, which must be compiled before running the program.
- Each class should be in a separate file.
- The name of the file should be the same as the name of the class, with the extension **.java**
  - Class FirstProgram is stored in file FirstProgram.java
- The compiler generates a file with the extension **.class** (FirstProgram.class)

Compiling and Running

- A Java program can involve any number of classes.
- The class to run will contain the words

```
public static void main(String[] args)
```

somewhere in the file

Object-Oriented Programming

- Our world consists of *objects* (people, trees, cars, cities, airline reservations, etc.).
- Objects can perform *actions* which affect themselves and other objects in the world.
- Object-oriented programming (*OOP*) treats a program as a collection of objects that interact by means of actions.
- Java is an object-oriented programming language.

OOP Terminology

- Objects, appropriately, are called *objects.*
- Actions are called *methods.*
- Objects of the same kind have the same *type* and belong to the same *class.*
  - Objects of a class have a common set of methods and the same kinds of data
  - but each object can have it's own data values.

Algorithms

- By designing methods, programmers provide actions for objects to perform.
- An *algorithm* describes a means of performing an action.
- Once an algorithm is defined, expressing it in Java (or in another programming language) usually is easy.

Algorithms

- An algorithm is a set of instructions for solving a problem.
- An algorithm must be expressed completely and precisely.
- Algorithms usually are expressed in English or in *pseudocode.*

Reusable Components

- Most programs are created by combining components that exist already.
- Reusing components saves time and money.
- Reused components are likely to be better developed, and more reliable.
- New components should be designed to be reusable by other applications.

Testing and Debugging

- Eliminate errors by avoiding them in the first place.
  - Carefully design classes, algorithms and methods.
  - Carefully code everything into Java.
- Test your program with appropriate test cases (some where the answer is known), discover and fix any errors, then retest.

Errors

- An error in a program is called a *bug.*
- Eliminating errors is called *debugging.*
- Three kinds or errors
  - Syntax errors
  - Runtime errors
  - Logic errors

Syntax Errors

- Grammatical mistakes in a program
  - The grammatical rules for writing a program are very strict
- The compiler catches syntax errors and prints an error message.
- Example: using a period where a program expects a comma

Runtime Errors

- Errors that are detected when your program is running, but not during compilation
- When the computer detects an error, it terminates the program and prints an error message.
- Example: attempting to divide by 0

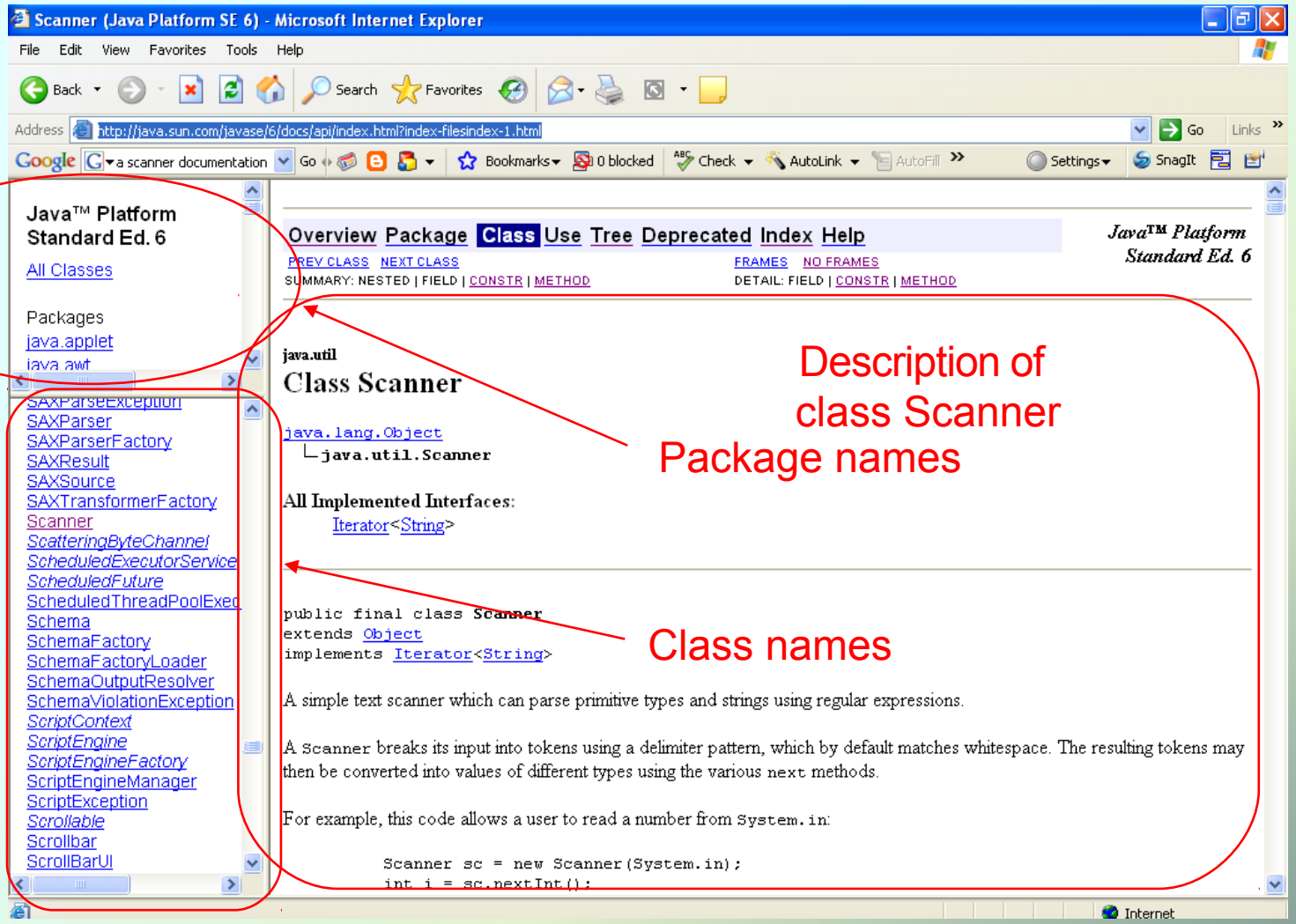
Logic Errors

- Errors that are not detected during compilation or while running, but which cause the program to produce incorrect results
- Examples:
  - using subtraction where addition is required
  - an attempt to calculate a Fahrenheit temperature from a Celsius temperature by multiplying by 9/5 and adding 23 instead of 32

Software Reuse

- Programs not usually created entirely from scratch
- Most contain components which already exist
- Reusable classes are used
  - Design class objects which are general
  - Java provides many classes
  - Note documentation on following slide

Software Reuse



- Follow the link “Java 7 API” on the course website