

Introduction to Computers and Java

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Objectives

- Overview computer hardware and software
- Introduce program design and object-oriented programming
- Overview the Java programming language
- Applets and graphics basics

Outline

- Computer Basics
- Designing Programs
- A Sip of Java

Computer Basics: Outline

Hardware and Memory

Programs

Programming Languages and Compilers

Java Byte-Code

(optional) Graphics Supplement



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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.
 - processor
 - two kinds of memory
 - main memory and auxiliary memory

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

Main memory

- **working memory** used to store
 - the current program
 - the data the program is using
 - the results of intermediate calculations
- usually measured in megabytes
 - e.g. 256 megabytes of RAM
 - RAM is short for **random access memory**
 - a **byte** is a quantity of memory

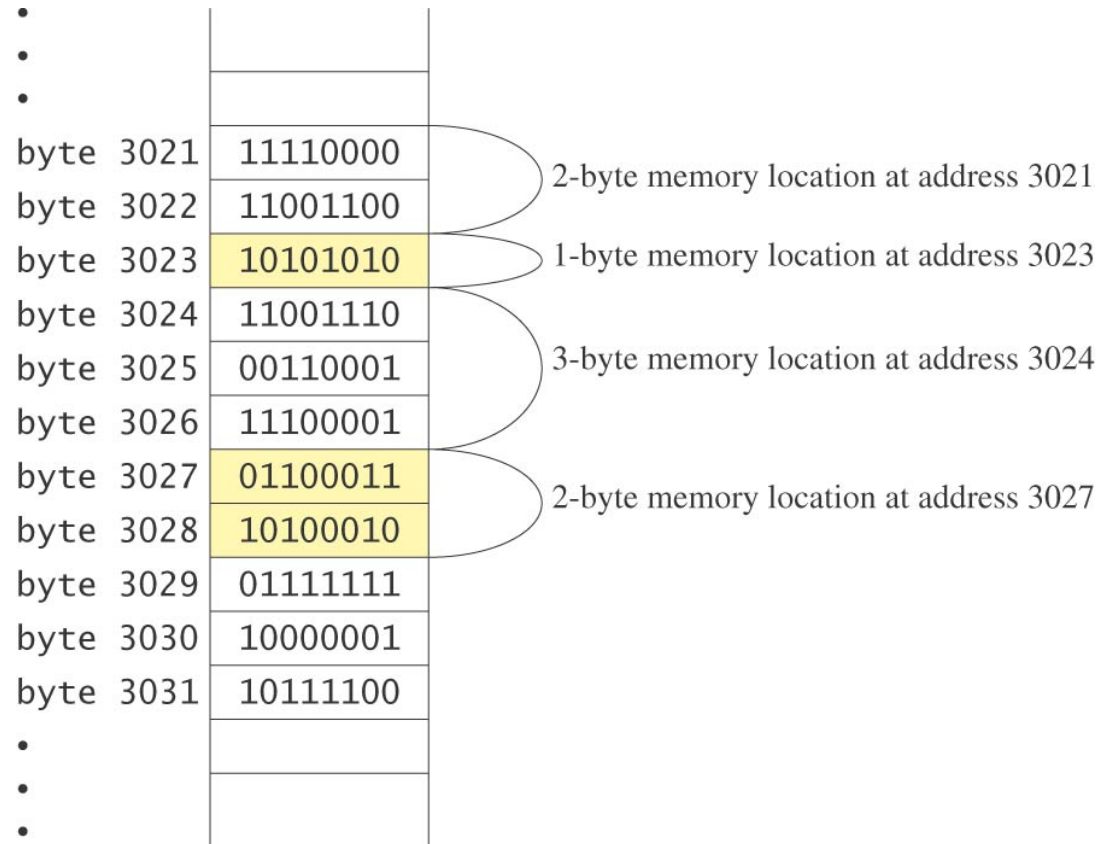
Auxiliary Memory

- also called **secondary memory**
- disk drives, diskettes, CDs, DVDs, etc.
- more or less permanent (nonvolatile)
- usually measured in gigabytes
 - e.g. 50 gigabyte hard drive

Bits, Bytes, and Addresses

- A *bit* is a 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*.

Addresses



Display 1.1
Main Memory

Storing Data

- Data of all kinds (numbers, letters, strings of characters, audio, video, even programs) are encoded and stored using 1s and 0s.
- When more than a single byte is needed, several adjacent bytes are used.
 - The address of the first byte is the address of the unit of bytes.

Files

- Large groups of bytes in auxiliary memory are called *files*
- Files have names
- Files 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

0 and 1

- Machines with only 2 stable states are easy to make, but programming using only 0s and 1s is difficult.
- Fortunately, the conversion of numbers, letters, strings of characters, audio, video, and programs is done automatically.

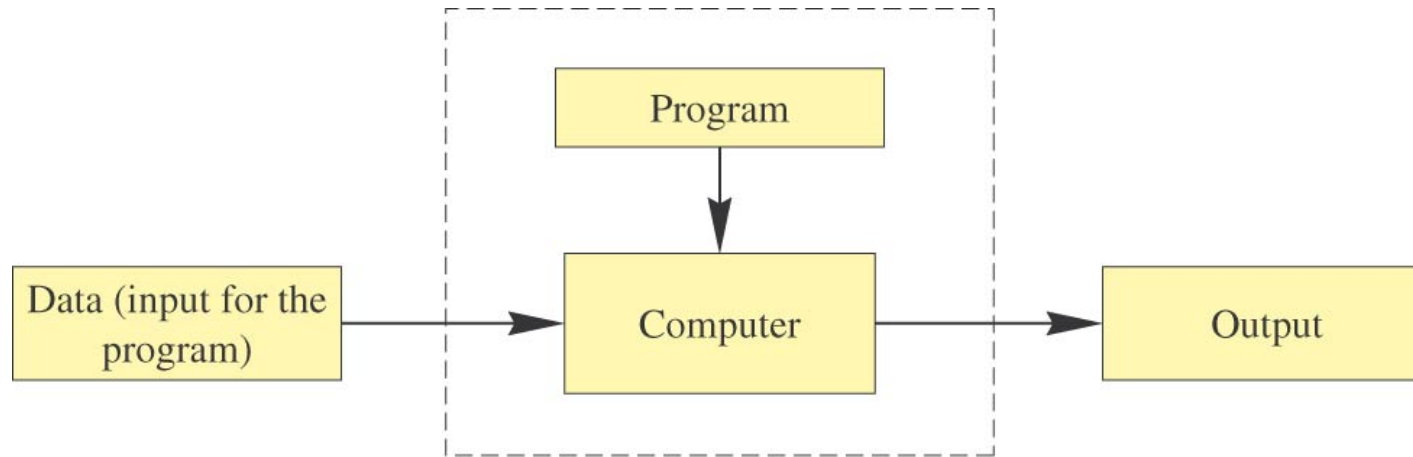
Programs

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

Input and Output

- Normally, a computer received two kinds of input:
 - the program
 - the *data* needed by the program.
- The output is the result(s) produced by following the instructions in the program.

Running a Program



Display 1.2

Running a Program

- Sometimes the computer and the program are considered to be one unit.
 - Programmers typically find this view to be more convenient.

The Operating System

- The *operating system* is a supervisory program that oversees the operation of the computer.
- The operating system retrieves and starts program for you.
- Well-known operating systems include DOS, Microsoft Windows, Apple's Mac OS X, Linux, or UNIX.

Programming Languages

- *High-level languages* are relatively intuitive to write and to understand.
 - Java, Pascal, FORTRAN, C, C++, C#, BASIC, Visual Basic, etc.
- 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*.

Compilers, cont.

- Most high-level languages need a different compiler for each type of computer and for each operating system.
- Most compilers are very large programs that are expensive to produce.

Java Byte-Code

- The Java compiler does **not** translate a Java program into assembly language or machine language for a particular computer.
- Instead, it translates a Java program into *byte-code*
 - Byte-code is the machine language for a hypothetical computer (or interpreter) called the *Java Virtual Machine*

Java Byte-Code, cont.

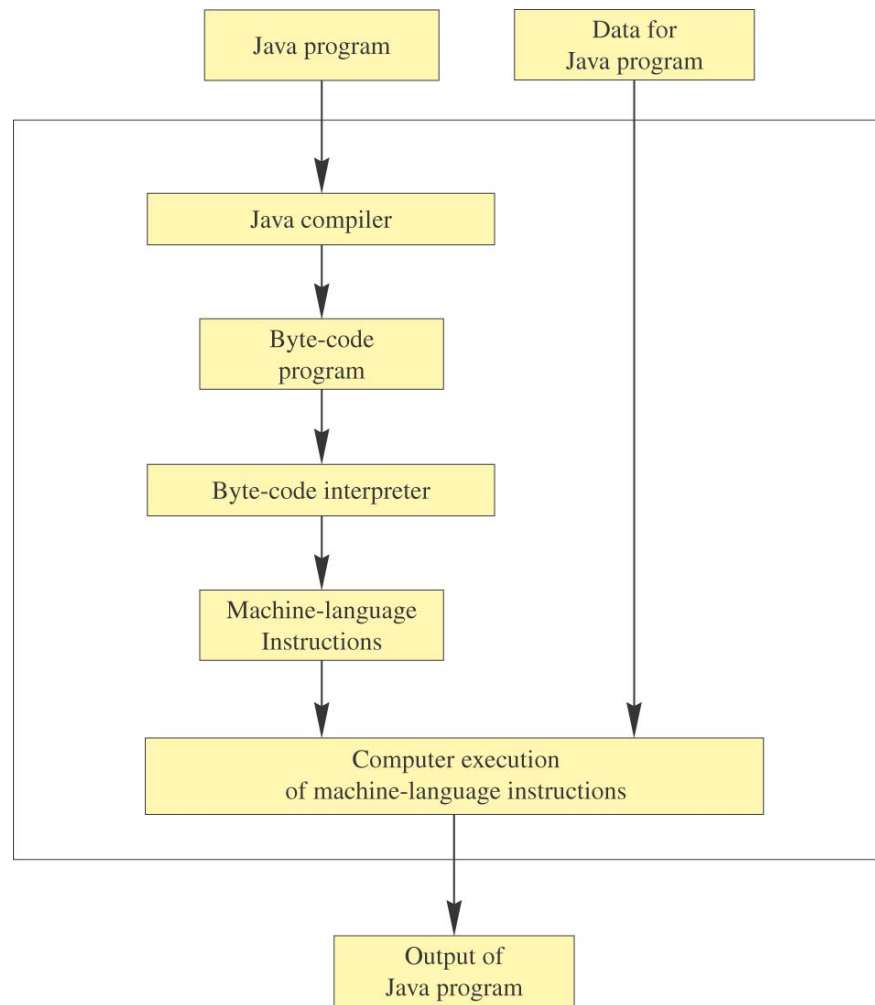
- A byte-code program is easy to translate into machine language for any particular computer.
- A program called an *interpreter* translates each byte-code instruction, executing the resulting machine-language instructions on the particular computer before translating the next byte-code instruction.

Compiling, Interpreting, Running

- Use the compiler to translate the Java program into byte-code (done using the *compile command*).
- Use the byte-code interpreter for your computer to translate each byte-code instruction into machine language and to run the resulting machine-language instructions (done using the *run command*).

Portability

- After compiling a Java program into byte-code, that **byte-code can be used on any computer with a byte-code interpreter** and without a need to recompile.
- Byte-code can be sent over the Internet and used anywhere in the world.
- This makes Java suitable for Internet applications.



Display 1.3

Compiling and Running a Java Program

Class Loader

- A Java program typically consists of several pieces called *classes*.
- Each class may have a separate author and each is compiled (translated into byte-code) separately.
- A *class loader* (called a *linker* in other programming languages) automatically connects the classes together.

A Sip of Java: Outline

History of the Java Language

Applications and Applets

A First Java Application Program

Writing, Compiling, and Running a Java Program

History of Java

- In 1991, **James Gosling** and Sun Microsystems began designing a language for home appliances (toasters, TVs, etc.).
 - Challenging, because home appliances are controlled by many different chips (processors)
 - Programs were translated first into an intermediate language common to all appliance processors.

History of Java

- Then the intermediate language was translated into the machine language for a particular appliance's processor.
- Appliance manufacturers weren't impressed.
- In 1994, Gosling realized that his language would be ideal for a Web browser that could run programs over the Internet.
 - Sun produced the browser known today as [HotJava](#).

Applications and Applets

- Two kinds of java programs: *applications* and *applets*
- Applications
 - Regular programs
 - Meant to be run on your computer
- Applets
 - Little applications
 - Meant to be sent to another location on the internet and run there

A First Java Application

- View [sample program](#) Listing 1.1
 - class FirstProgram

```
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

FirstProgram

```
import java.util.Scanner;

public class FirstProgram
{
    public static void main(String[] args)
    {
        System.out.println("Hello out there.");
        System.out.println("I will add two numbers for you.");
        System.out.println("Enter two whole numbers on a line:");

        int n1, n2;

        Scanner keyboard = new Scanner(System.in);
        n1 = keyboard.nextInt( );
        n2 = keyboard.nextInt( );

        System.out.println("The sum of those two numbers is");
        System.out.println(n1 + n2);
    }
}
```

Some Terminology

- The person who writes a program is called the *programmer*.
- The person who interacts with the program is called the *user*.
- A *package* is a library of classes that have been defined already.
 - `import java.util.Scanner;`

Some Terminology

- The item(s) inside parentheses are called *argument(s)* and provide the information needed by methods.
- A *variable* is something that can store data.
- An instruction to the computer is called a *statement*; it ends with a semicolon.
- The grammar rules for a programming language are called the *syntax* of the 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.

Printing to the Screen

- The object performs an action when you *invoke* or *call* one of its methods

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

Compiling a Java Program or Class

- A Java program consists of one or more **classes**, which **must be compiled before running the program**
- You need not compile classes that accompany Java (e.g. **System and Scanner**)
- **Each class should be in a separate file**
- **The name of the file should be the same as the name of the class**

Compiling and Running

- Use an *IDE* (integrated development environment) which combines a text editor with commands for compiling and running Java programs
- When a Java program is compiled, the byte-code version of the program has the same name, but the ending is changed from `.java` to `.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

Designing Programs: Outline

Object-Oriented Programming

Encapsulation

Polymorphism

Inheritance

Algorithms

Components

Testing and Debugging



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Programming

- Programming is a **creative** process
- Programming can be learned by **discovering** the techniques used by experienced programmers
- These **techniques are applicable to almost every programming language**, including Java

Object-Oriented Programming

- Our world consists of *objects* (people, trees, cars, cities, airline reservations, etc.).
- Objects can perform *actions* which effect 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.

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 within a class have a *common set of methods* and the *same kinds of data*
 - but each object can have its *own data values*.

OOP Design Principles

- OOP adheres to three primary design principles:
 - encapsulation
 - polymorphism
 - inheritance

Introduction to Encapsulation

- The data and methods associated with any particular class are encapsulated (“put together in a capsule”), but **only part of the contents is made accessible**.
 - Encapsulation provides a means of using the class, but it omits the details of **how the class works**.
 - Encapsulation often is called *information hiding*.

Accessibility Example

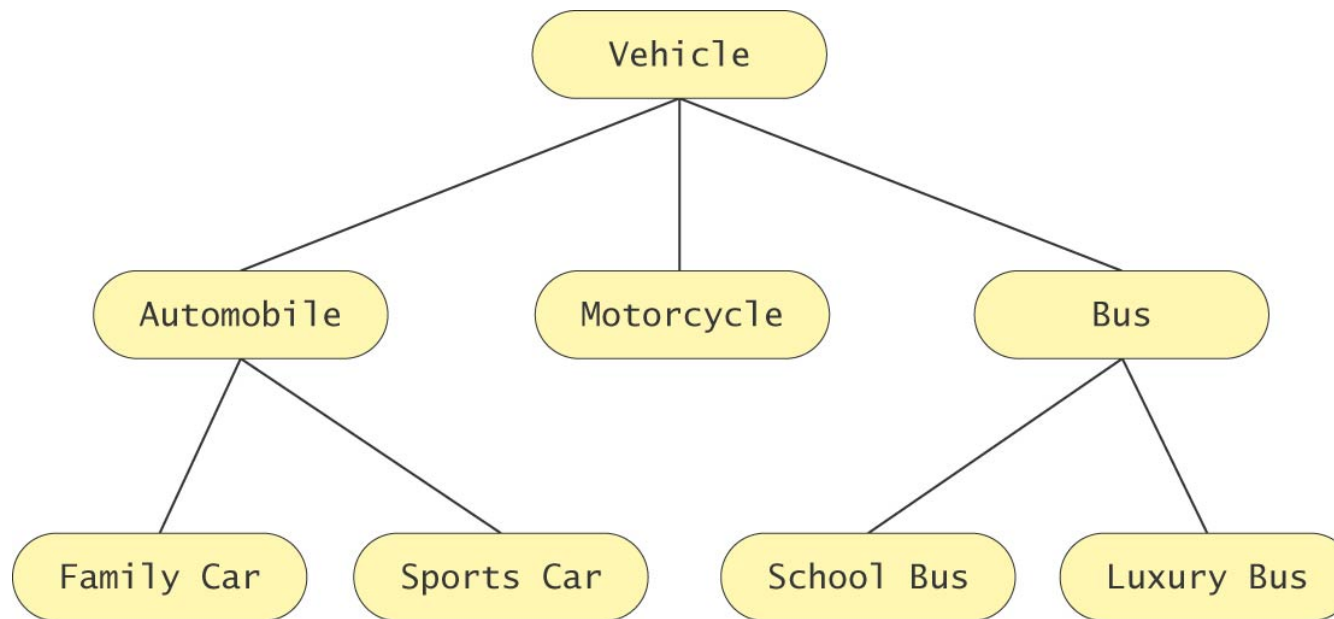
- An **automobile** consists of several parts and pieces and is capable of doing many useful things.
 - Awareness of the accelerator pedal, the brake pedal, and the steering wheel is important to the driver.
 - Awareness of the fuel injectors, the automatic braking control system, and the power steering pump is not important to the driver.

Introduction to Polymorphism

- from the Greek meaning “many forms”
- The same program instruction adapts to mean different things in different contexts.
 - A **method name**, used as an instruction, produces results that depend on the class of the object that used the method.
 - everyday analogy: “take time to recreate” causes different people to do different activities
- more about polymorphism in Chapter 7

Introduction to Inheritance

- Classes can be organized using inheritance.



Display 1.4

An Inheritance Hierarchy

Introduction to Inheritance, cont.

- A class at lower levels inherits all the characteristics of classes above it in the hierarchy.
- At each level, classifications become more specialized by adding other characteristics.
- Higher classes are more inclusive; lower classes are less inclusive.

Inheritance in Java

- used to organize classes
- “Inherited” characteristics do not need to be repeated
- New characteristics are added
- more about inheritance in Chapter 7

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, cont.

- 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 pseudo code.

Example: Total Cost of All Items

- Write the number 0 on the whiteboard
- For each item on the list
 - add the cost of the item to the number on the whiteboard
 - replace the number on the whiteboard with the result of this addition
- Announce that the answer is the number written on the whiteboard

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.

Making Components Reusable

- Specify exactly how objects of the class interact with other objects.
- Design a class so that objects are general, rather than unique to a particular application.

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 of 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
- example: an attempt to calculate a Fahrenheit temperature from a Celsius temperature by multiplying by $9/5$ and adding 23 instead of 32

Summary

- You have completed an overview of computer hardware and software.
- You have been introduced to program design and object-oriented programming.
- You have completed an overview of the Java programming language.
- You have been introduced to applets and graphics basics.