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





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

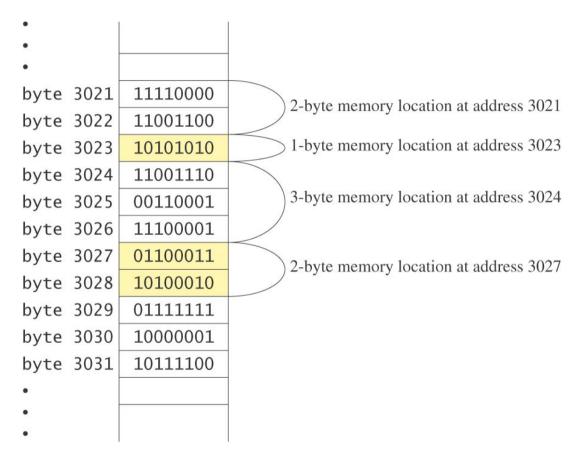


Bits, Bytes, and Addresses

- 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.

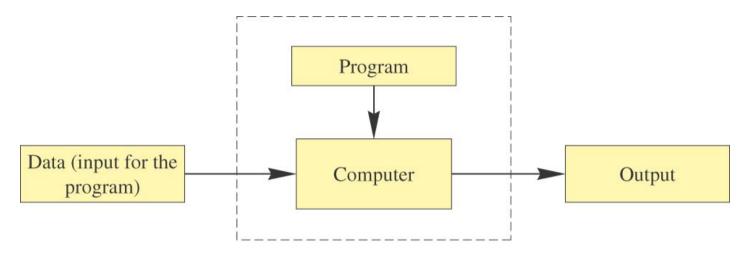


Input and Output

- 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 highlevel 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 assemblylanguage 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 bytecode
 - 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

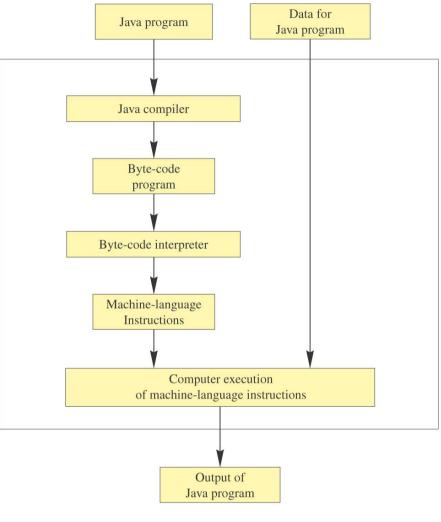
- Use the compiler to translate the Java program into byte-code (done using the compile command).
- Use the byte-code interpreter for your computer to translate each byte-code instruction into machine language and to run the resulting machine-language instructions (done using the run command).



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 <u>sample program</u> 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 bytecode 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





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 it's 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.



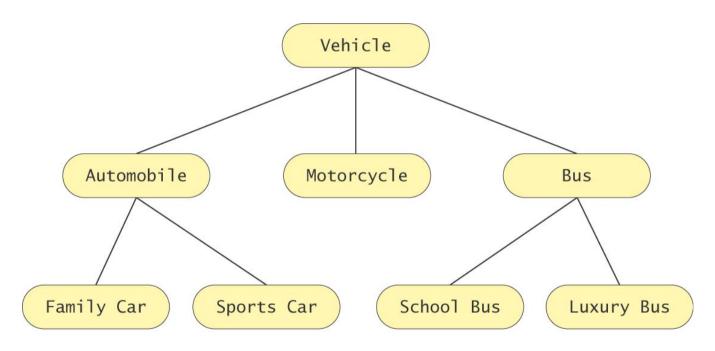
Introduction to Polymorphism

- 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 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 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
- 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.

