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

FirstProgram

```
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.");

        int n1, n2, result;

        n1 = 3;
        n2 = 4;

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

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

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

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

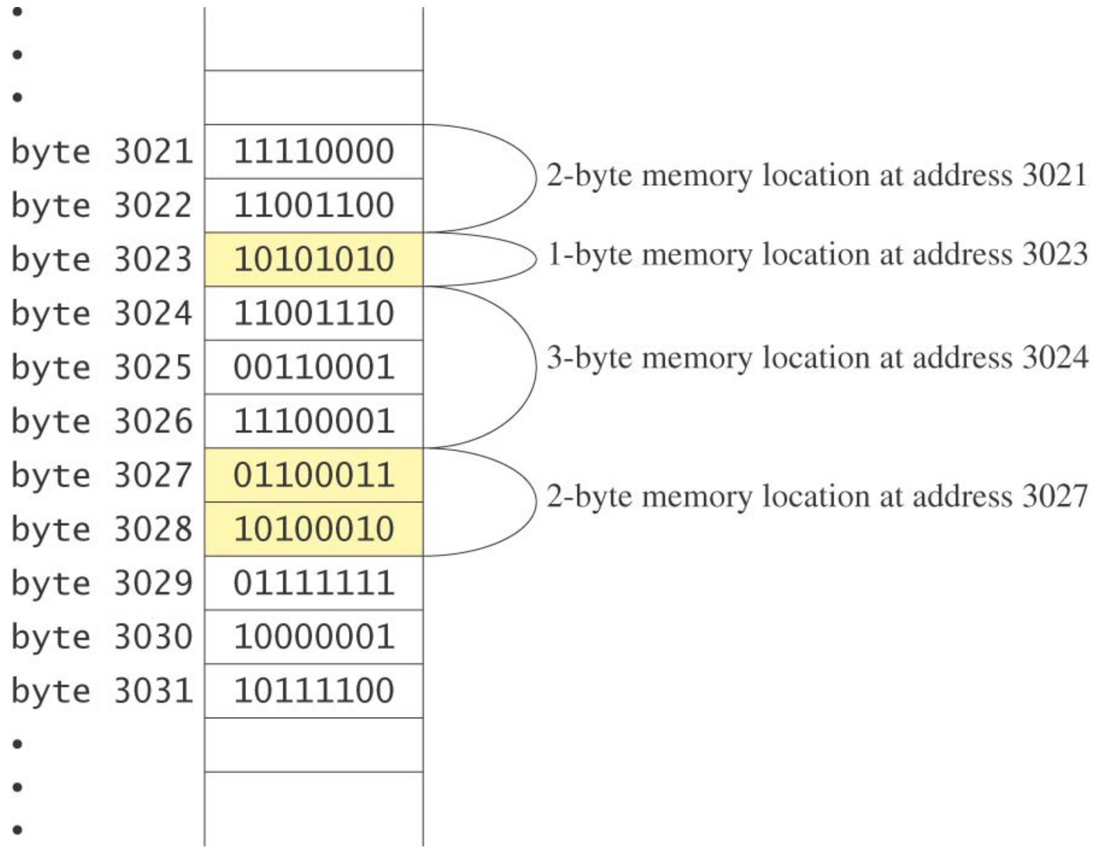
Auxiliary Memory

- 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.

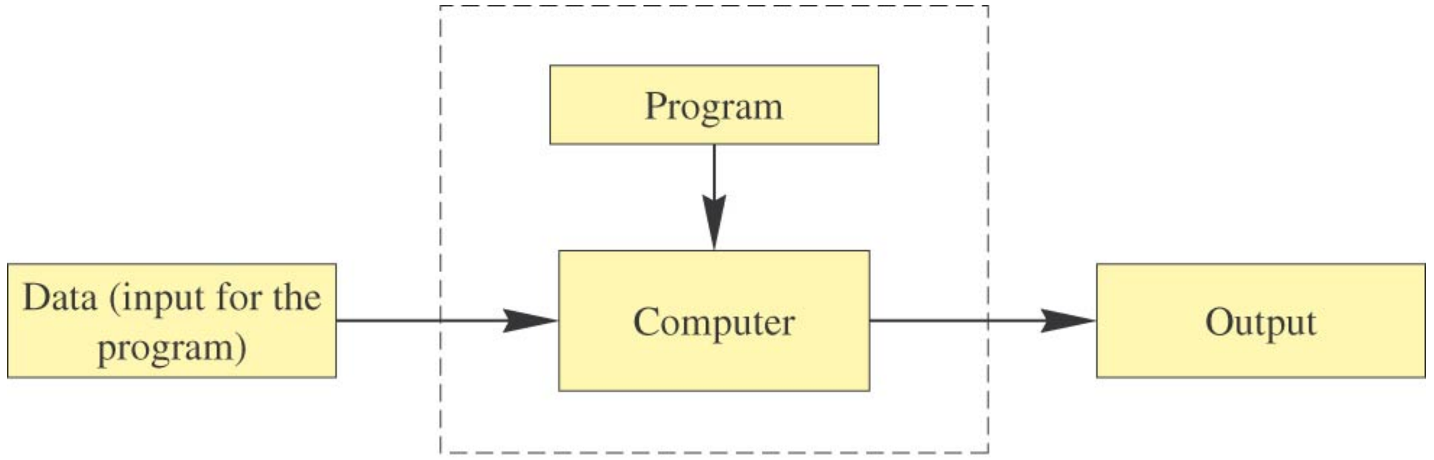
Programs

- 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.

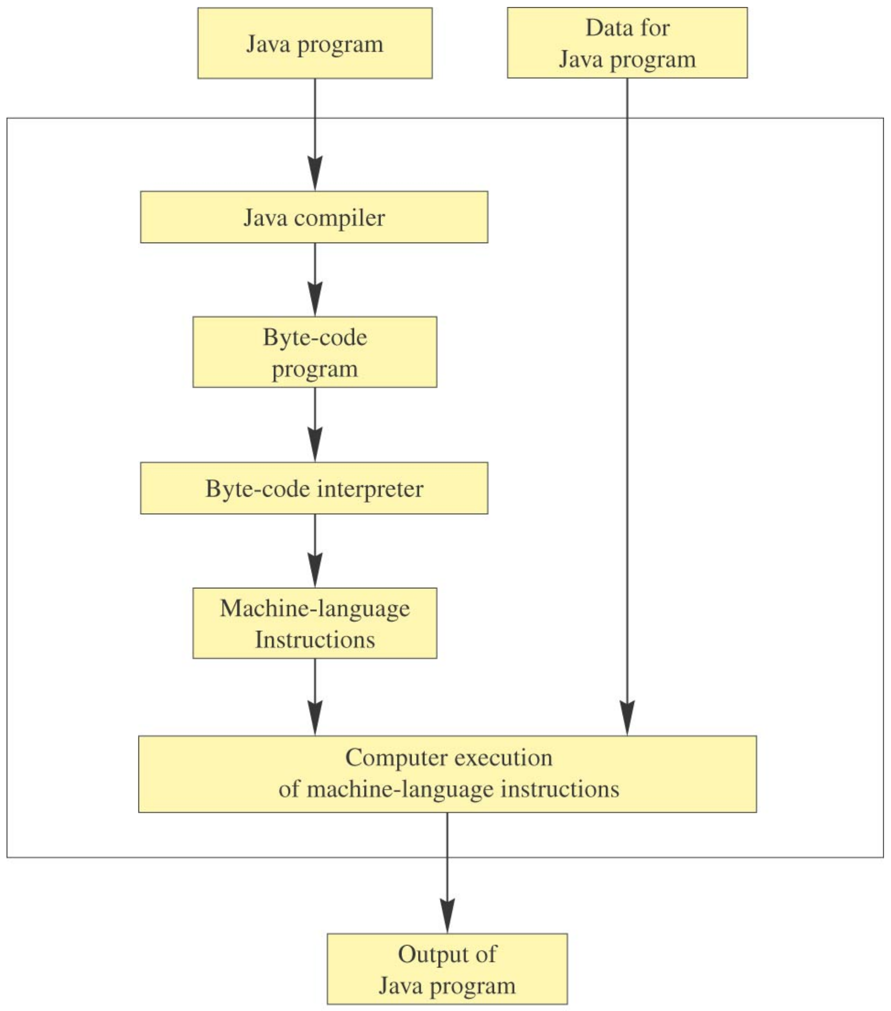
- A byte-code program is easy to translate into machine language for any particular computer.
- A program called an *interpreter* translates each byte-code instruction, executing the resulting machine-language instructions on the particular computer before translating the next byte-code instruction.

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

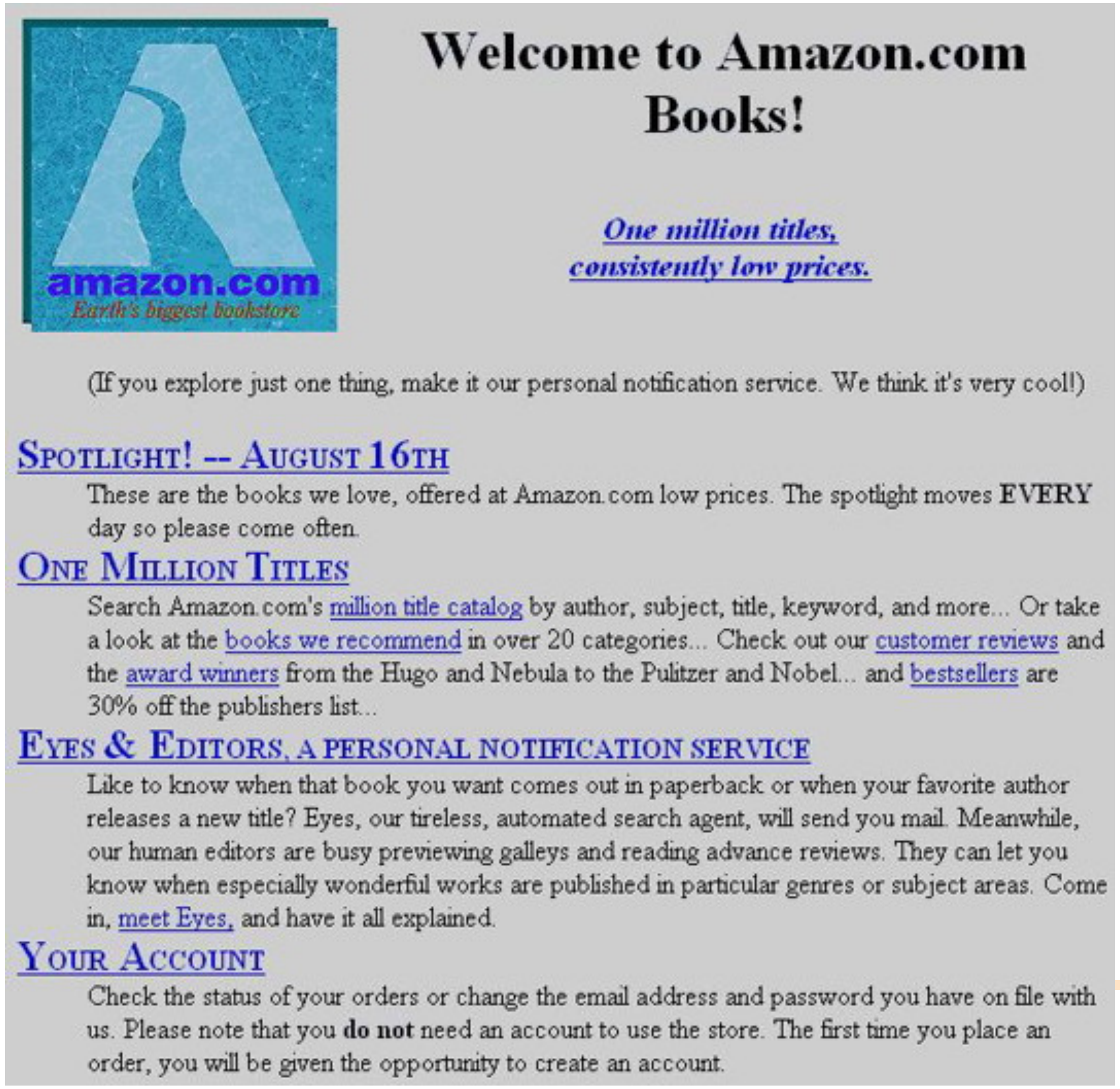
- In 1991, James Gosling and Sun Microsystems began designing a language for home appliances (toasters, TVs, etc.).
  - Challenging, because home appliances are controlled by many different chips (processors)
  - Programs were translated first into an intermediate language common to all appliance processors.

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.

The Internet in 1995



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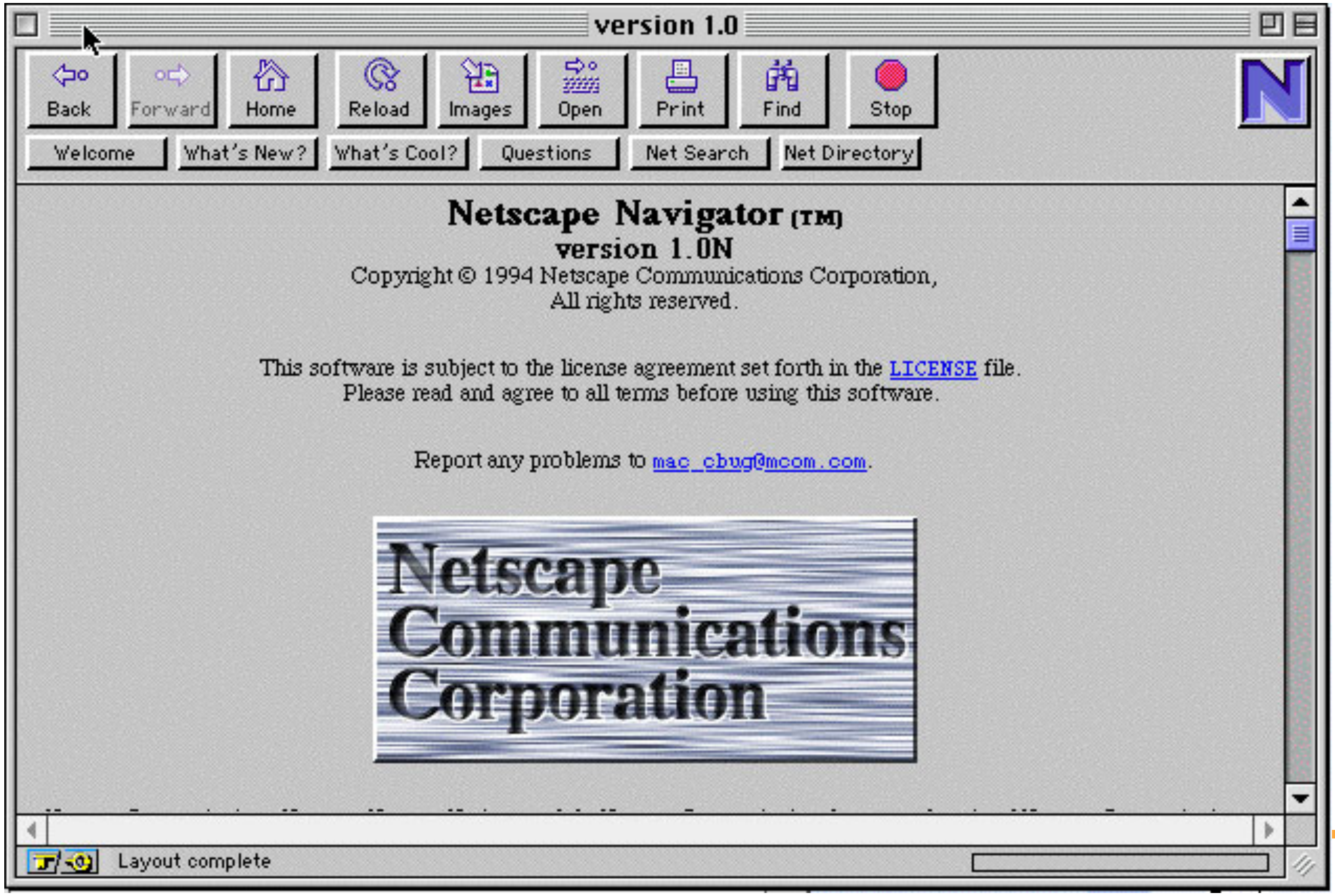
Browsers in 1995



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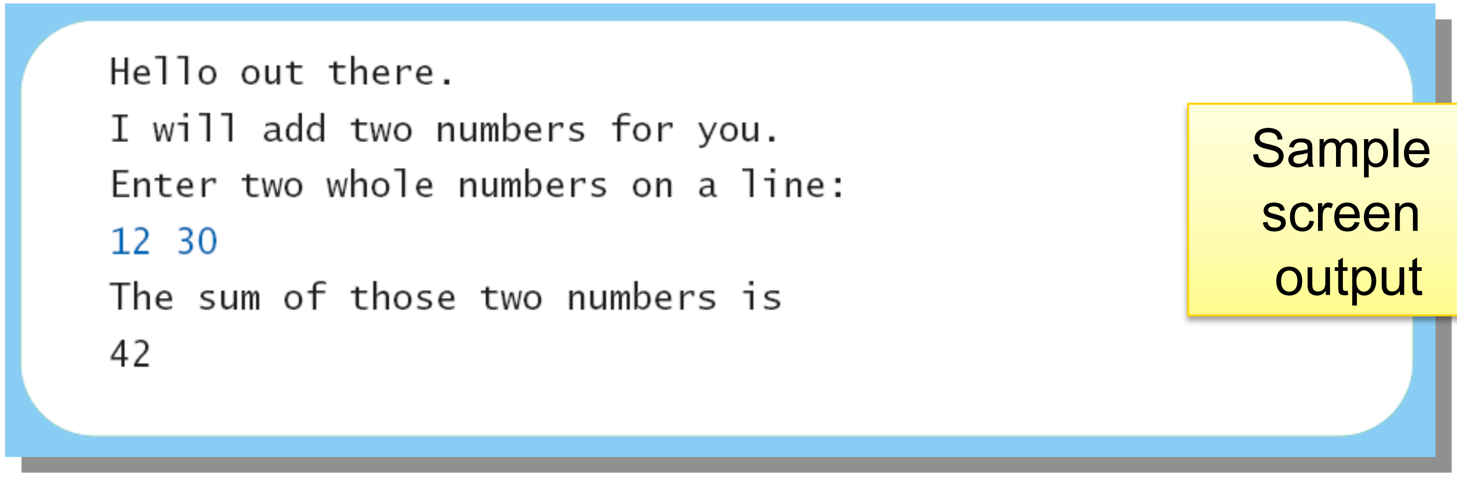
Applications and Applets

- 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

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

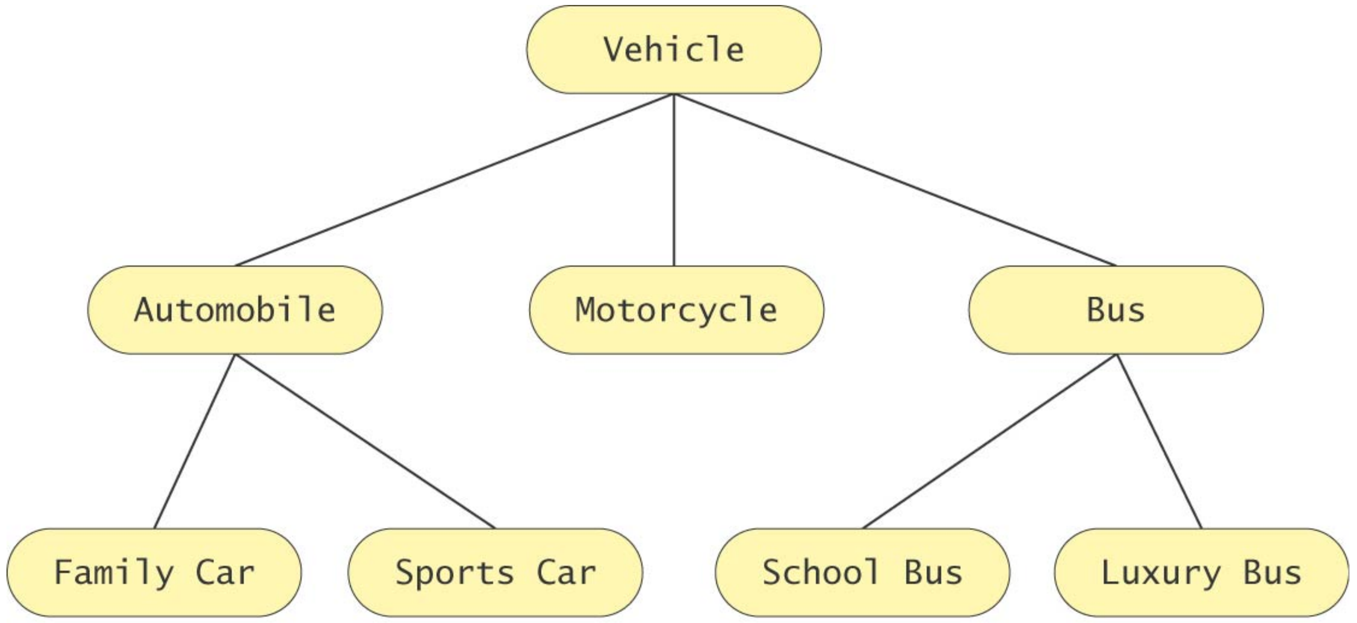
- An automobile consists of several parts and pieces and is capable of doing many useful things.
  - Awareness of the accelerator pedal, the brake pedal, and the steering wheel is important to the driver.
  - Awareness of the fuel injectors, the automatic braking control system, and the power steering 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.



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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

A Sip of Java: Outline

History of the Java Language

Applets

A First Java Program

Compiling a Java Program or Class

Running a Java Program

Objects and Methods

A Sample Graphics Applet