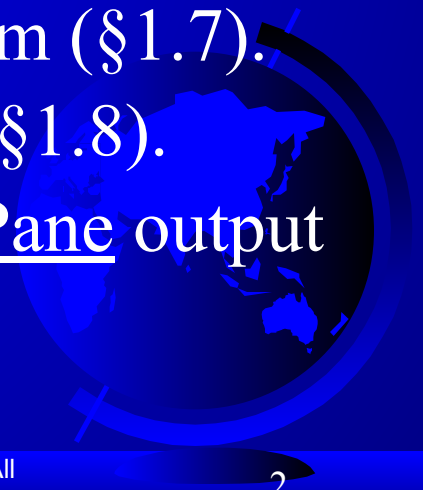
Chapter 1 Introduction to Computers, Programs, and Java

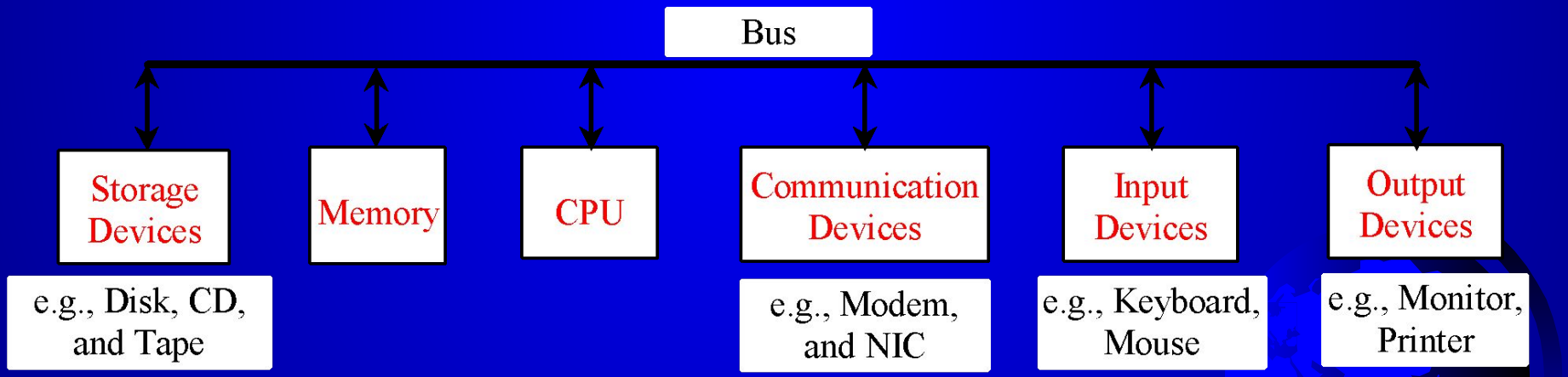
Objectives

- To review computer basics, programs, and operating systems (§§1.2-1.4).
- To explore the relationship between Java and the World Wide Web (§1.5).
- To distinguish the terms API, IDE, and JDK (§1.6).
- To write a simple Java program (§1.7).
- To display output on the console (§1.7).
- To explain the basic syntax of a Java program (§1.7).
- To create, compile, and run Java programs (§1.8).
- (GUI) To display output using the JOptionPane output dialog boxes (§1.9).



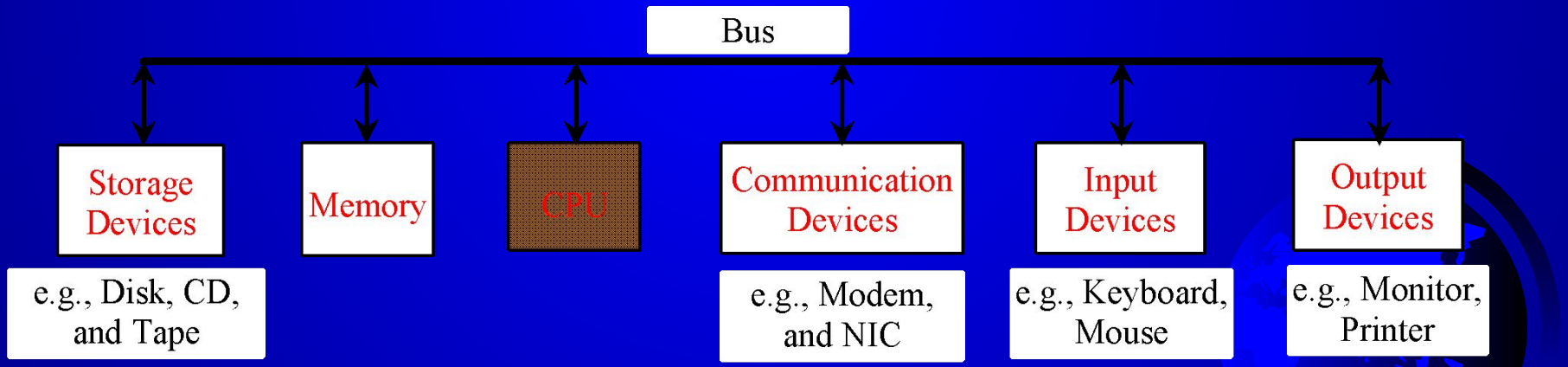
What is a Computer?

A computer consists of a CPU, memory, hard disk, floppy disk, monitor, printer, and communication devices.



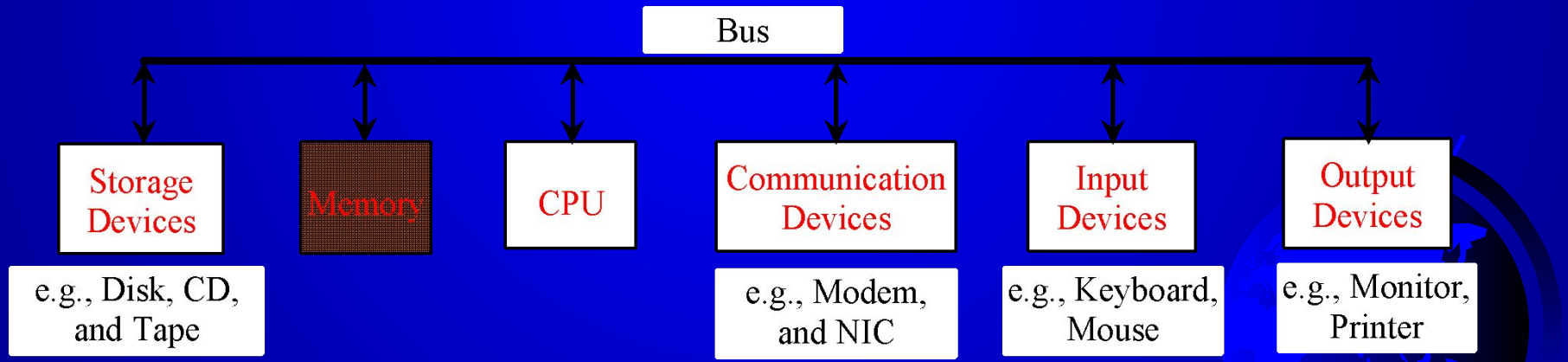
CPU

The central processing unit (CPU) is the brain of a computer. It retrieves instructions from memory and executes them. The CPU speed is measured in megahertz (MHz), with 1 megahertz equaling 1 million pulses per second. The speed of the CPU has been improved continuously. If you buy a PC now, you can get an Intel Pentium 4 Processor at 3 gigahertz (1 gigahertz is 1000 megahertz).



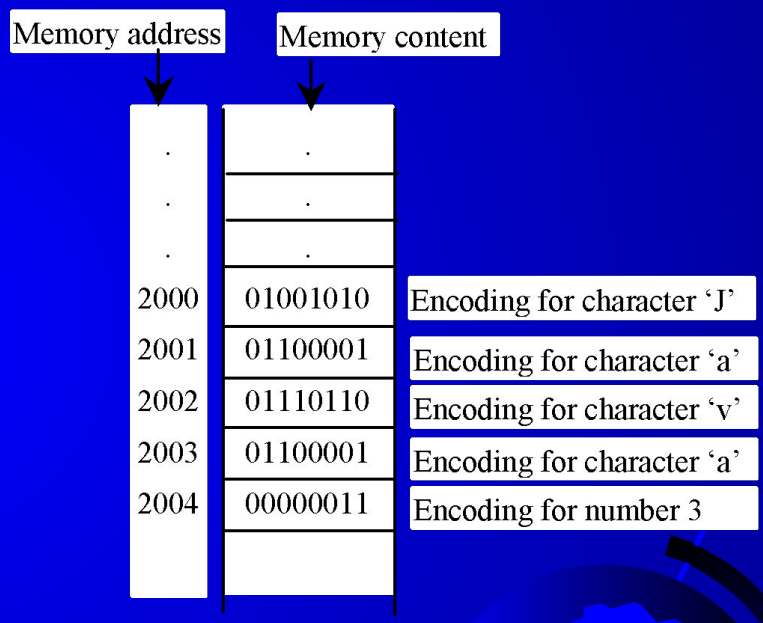
Memory

Memory is to store data and program instructions for CPU to execute. A memory unit is an ordered sequence of bytes, each holds eight bits. A program and its data must be brought to memory before they can be executed. A memory byte is never empty, but its initial content may be meaningless to your program. The current content of a memory byte is lost whenever new information is placed in it.



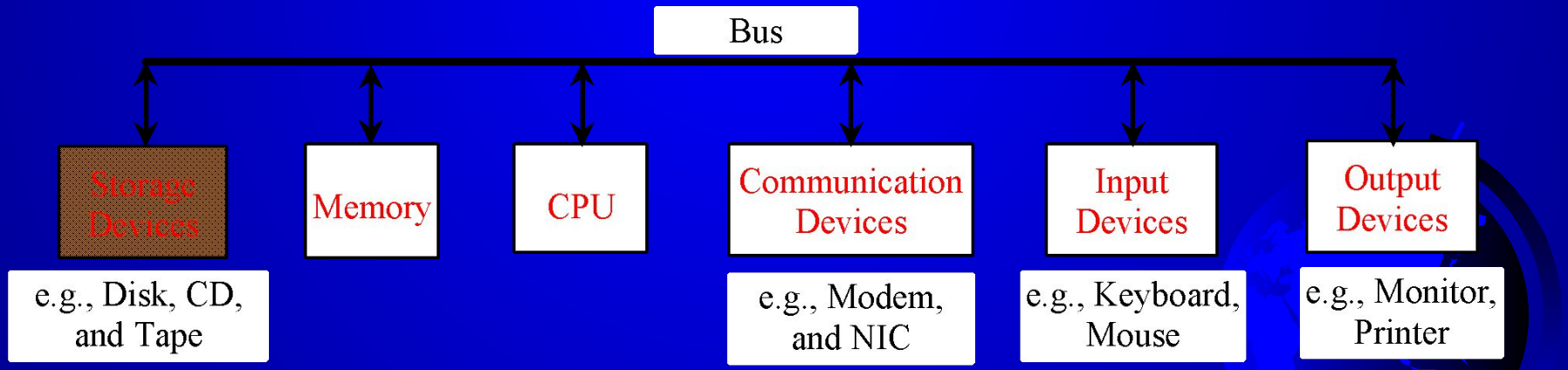
How Data is Stored?

Data of various kinds, such as numbers, characters, and strings, are encoded as a series of bits (zeros and ones). Computers use zeros and ones because digital devices have two stable states, which are referred to as *zero* and *one* by convention. The programmers need not to be concerned about the encoding and decoding of data, which is performed automatically by the system based on the encoding scheme. The encoding scheme varies. For example, character 'J' is represented by 01001010 in one byte. A small number such as three can be stored in a single byte. If computer needs to store a large number that cannot fit into a single byte, it uses a number of adjacent bytes. No two data can share or split a same byte. A byte is the minimum storage unit.



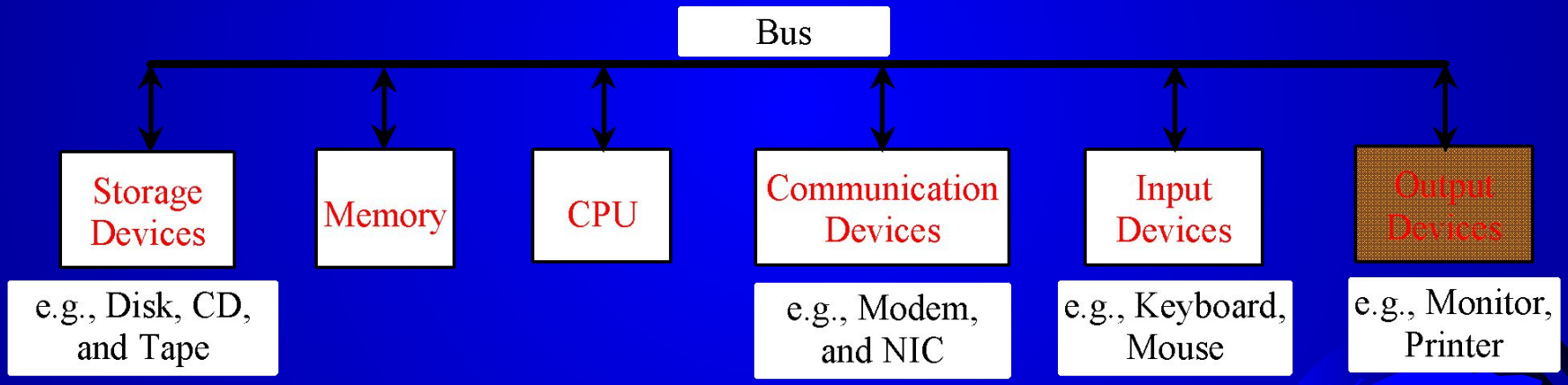
Storage Devices

Memory is volatile, because information is lost when the power is off. Programs and data are permanently stored on storage devices and are moved to memory when the computer actually uses them. There are three main types of storage devices:Disk drives (hard disks and floppy disks), CD drives (CD-R and CD-RW), and Tape drives.



Output Devices: Monitor

The monitor displays information (text and graphics). The resolution and dot pitch determine the quality of the display.



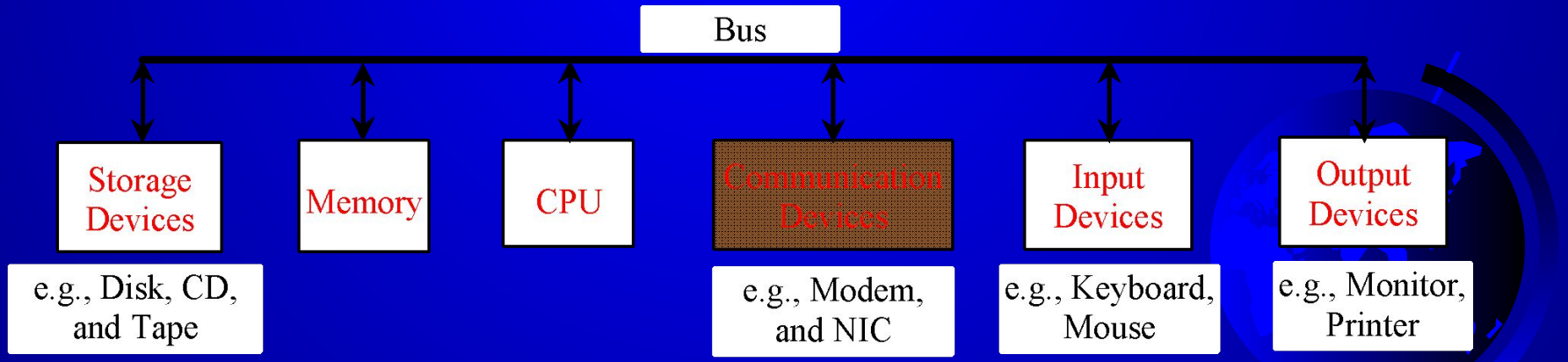
Monitor Resolution and Dot Pitch

resolution The *resolution* specifies the number of pixels per square inch. Pixels (short for "picture elements") are tiny dots that form an image on the screen. The resolution can be set manually. The higher the resolution, the sharper and clearer the image is. However, the image may be very small if you set high resolution on a small screen monitor. PC monitors are usually 15-inch, 17-inch, 19-inch, or 21-inch. For a 15-inch monitor, a comfortable resolution setting would be 640×480 (307,200 pixels).

dot pitch The *dot pitch* is the amount of space between pixels. The smaller the dot pitch, the better the display.

Communication Devices

A *regular modem* uses a phone line and can transfer data in a speed up to 56,000 bps (bits per second). A *DSL* (digital subscriber line) also uses a phone line and can transfer data in a speed 20 times faster than a regular modem. A *cable modem* uses the TV cable line maintained by the cable company. A cable modem is as fast as a DSL. Network interface card (*NIC*) is a device to connect a computer to a local area network (LAN). The LAN is commonly used in business, universities, and government organizations. A typical type of NIC, called *10BaseT*, can transfer data at 10 mbps (million bits per second).



Programs

Computer *programs*, known as *software*, are instructions to the computer.

You tell a computer what to do through programs. Without programs, a computer is an empty machine. Computers do not understand human languages, so you need to use computer languages to communicate with them.

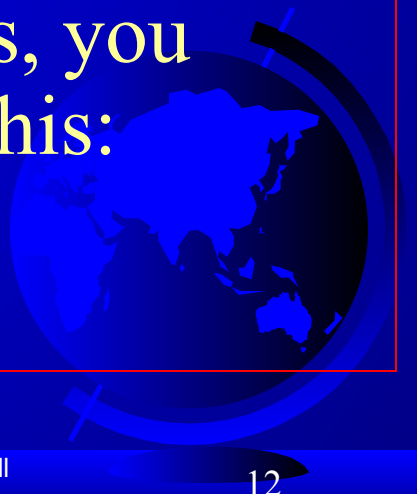
Programs are written using programming languages.

Programming Languages

Machine Language Assembly Language High-Level Language

Machine language is a set of primitive instructions built into every computer. The instructions are in the form of binary code, so you have to enter binary codes for various instructions. Program with native machine language is a tedious process. Moreover the programs are highly difficult to read and modify. For example, to add two numbers, you might write an instruction in binary like this:

```
1101101010011010
```

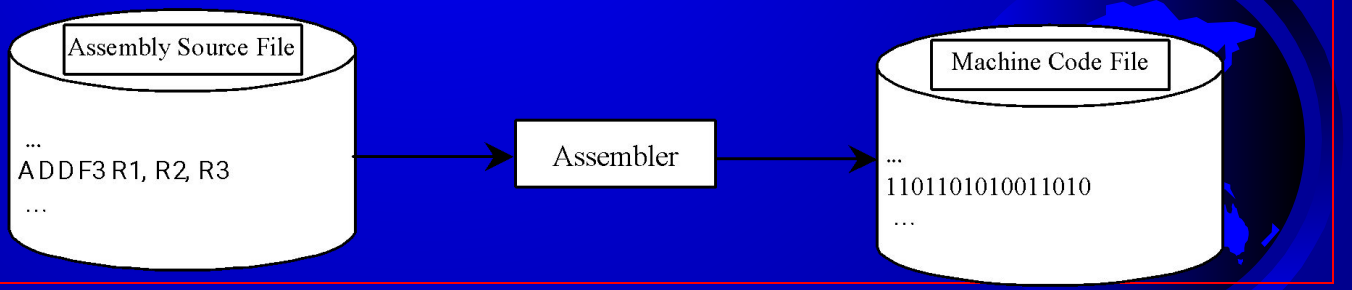


Programming Languages

Machine Language Assembly Language High-Level Language

Assembly languages were developed to make programming easy. Since the computer cannot understand assembly language, however, a program called assembler is used to convert assembly language programs into machine code. For example, to add two numbers, you might write an instruction in assembly code like this:

ADDF3 R1, R2, R3

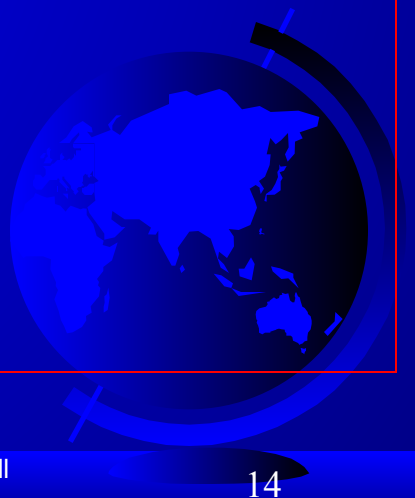


Programming Languages

Machine Language Assembly Language High-Level Language

The high-level languages are English-like and easy to learn and program. For example, the following is a high-level language statement that computes the area of a circle with radius 5:

```
area = 5 * 5 * 3.1415;
```

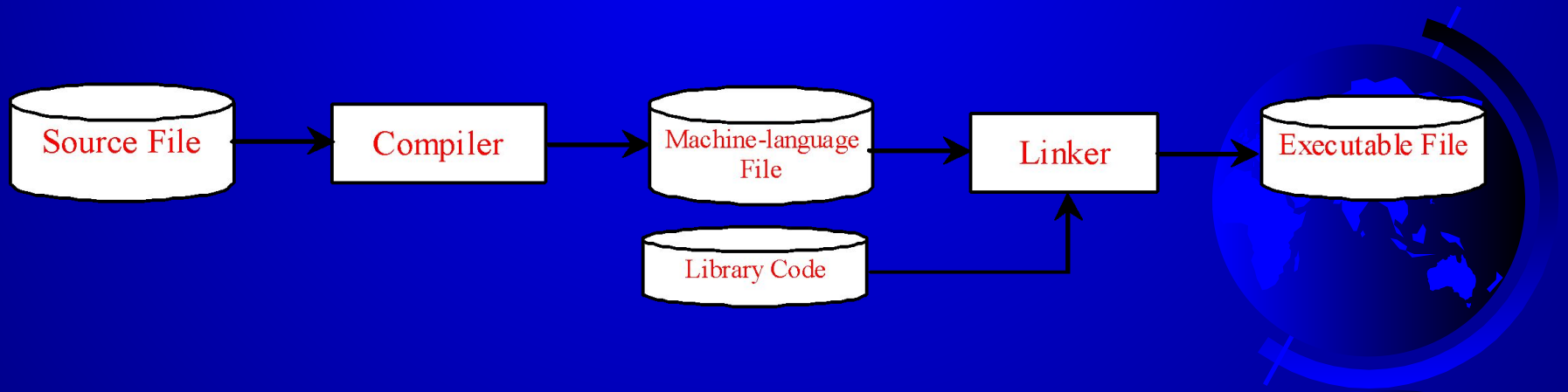


Popular High-Level Languages

- COBOL (COmmon Business Oriented Language)
- FORTRAN (FORmula TRANslation)
- BASIC (Beginner All-purpose Symbolic Instructional Code)
- Pascal (named for Blaise Pascal)
- Ada (named for Ada Lovelace)
- C (whose developer designed B first)
- Visual Basic (Basic-like visual language developed by Microsoft)
- Delphi (Pascal-like visual language developed by Borland)
- C++ (an object-oriented language, based on C)
- C# (a Java-like language developed by Microsoft)
- Java (We use it in the book)

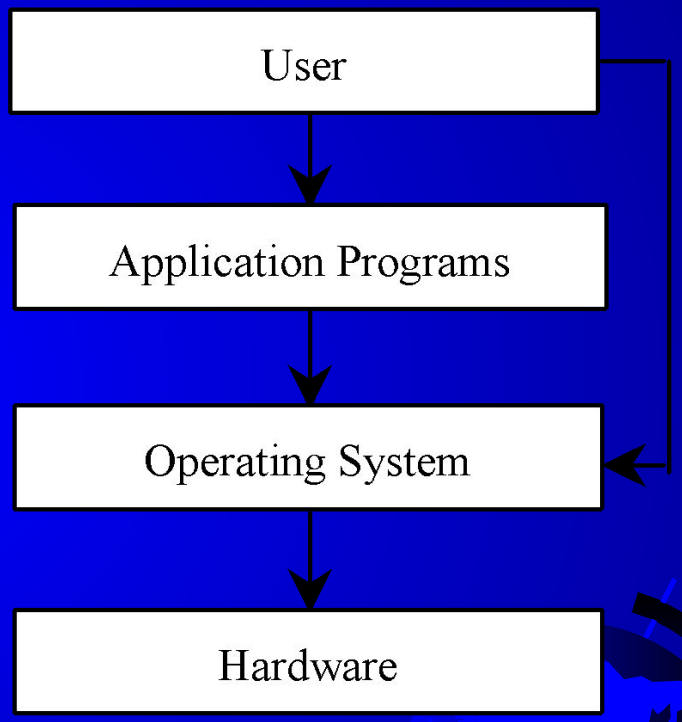
Compiling Source Code

A program written in a high-level language is called a s*ource program*. Since a computer cannot understand a source program. Program called a *compiler* is used to translate the source program into a machine language program called an *object program*. The object program is often then linked with other supporting library code before the object can be executed on the machine.



Operating Systems

The *operating system* (OS) is a program that manages and controls a computer's activities. You are probably using Windows 98, NT, 2000, XP, or ME. Windows is currently the most popular PC operating system. Application programs such as an Internet browser and a word processor cannot run without an operating system.



Why Java?

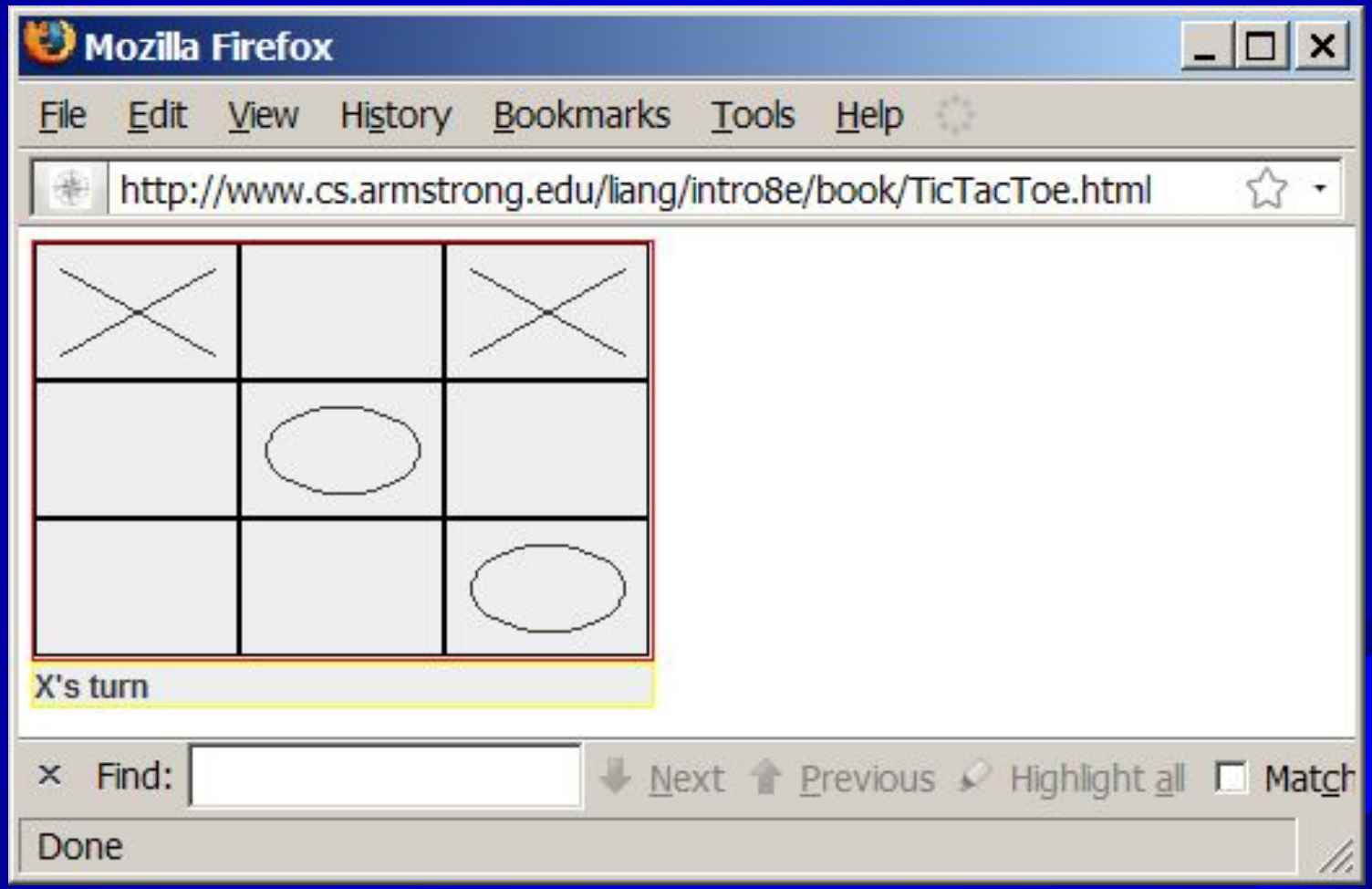
The answer is that Java enables users to develop and deploy applications on the Internet for servers, desktop computers, and small hand-held devices. The future of computing is being profoundly influenced by the Internet, and Java promises to remain a big part of that future. Java is the Internet programming language.

- Java is a general purpose programming language.
- Java is the Internet programming language.

Java, Web, and Beyond

- Java can be used to develop Web applications.
- Java Applets
- Java Web Applications
- Java can also be used to develop applications for hand-held devices such as Palm and cell phones

Examples of Java's Versatility (Applets)



PDA and Cell Phone

Java's History

- James Gosling and Sun Microsystems
- Oak
- Java, May 20, 1995, Sun World
- HotJava
  - The first Java-enabled Web browser
- Early History Website:

http://java.sun.com/features/1998/05/birthday.html

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Characteristics of Java

- Java Is Simple
- Java Is Object-Oriented
- Java Is Distributed
- Java Is Interpreted
- Java Is Robust
- Java Is Secure
- Java Is Architecture-Neutral
- Java Is Portable
- Java's Performance
- Java Is Multithreaded
- Java Is Dynamic

www.cs.armstrong.edu/liang/intro8e/JavaCharacteristics.pdf

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Java is partially modeled on C++, but greatly simplified and improved. Some people refer to Java as "C++--" because it is like C++ but with more functionality and fewer negative aspects.

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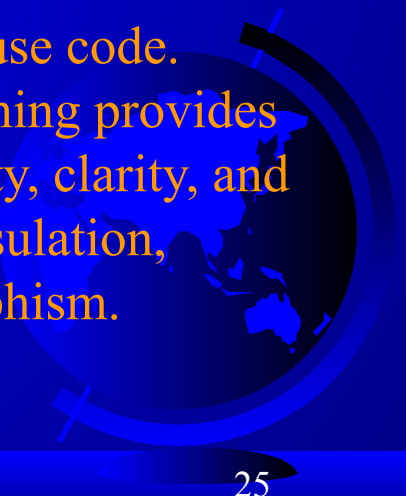
Java is inherently object-oriented. Although many object-oriented languages began strictly as procedural languages, Java was designed from the start to be object-oriented. Object-oriented programming (OOP) is a popular programming approach that is replacing traditional procedural programming techniques.

One of the central issues in software development is how to reuse code. Object-oriented programming provides great flexibility, modularity, clarity, and reusability through encapsulation, inheritance, and polymorphism.



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Distributed computing involves several computers working together on a network. Java is designed to make distributed computing easy. Since networking capability is inherently integrated into Java, writing network programs is like sending and receiving data to and from a file.

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You need an interpreter to run Java programs. The programs are compiled into the Java Virtual Machine code called bytecode. The bytecode is machine-independent and can run on any machine that has a Java interpreter, which is part of the Java Virtual Machine (JVM).

Companion Website

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Java compilers can detect many problems that would first show up at execution time in other languages.

Java has eliminated certain types of error-prone programming constructs found in other languages.

Java has a runtime exception-handling feature to provide programming support for robustness.

Companion Website

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Java implements several security mechanisms to protect your system against harm caused by stray programs.

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Write once, run anywhere

With a Java Virtual Machine (JVM), you can write one program that will run on any platform.

Companion Website

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Because Java is architecture neutral, Java programs are portable. They can be run on any platform without being recompiled.

Companion Website

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Java's performance Because Java is architecture neutral, Java programs are portable. They can be run on any platform without being recompiled.

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Multithread programming is smoothly integrated in Java, whereas in other languages you have to call procedures specific to the operating system to enable multithreading.

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- Java Is Dynamic

Java was designed to adapt to an evolving environment. New code can be loaded on the fly without recompilation. There is no need for developers to create, and for users to install, major new software versions. New features can be incorporated transparently as needed.

JDK Versions

- JDK 1.02 (1995)
- JDK 1.1 (1996)
- JDK 1.2 (1998)
- JDK 1.3 (2000)
- JDK 1.4 (2002)
- JDK 1.5 (2004) a. k. a. JDK 5 or Java 5
- JDK 1.6 (2006) a. k. a. JDK 6 or Java 6
- JDK 1.7 (possibly 2010) a. k. a. JDK 7 or Java 7

JDK Editions

- Java Standard Edition (J2SE)
  - J2SE can be used to develop client-side standalone applications or applets.
- Java Enterprise Edition (J2EE)
  - J2EE can be used to develop server-side applications such as Java servlets and Java ServerPages.
- Java Micro Edition (J2ME).
  - J2ME can be used to develop applications for mobile devices such as cell phones.

This book uses J2SE to introduce Java programming.

Popular Java IDEs

- NetBeans Open Source by Sun
- Eclipse Open Source by IBM

A Simple Java Program

Listing 1.1

```
//This program prints Welcome to Java!
public class Welcome {
  public static void main(String[] args) {
    System.out.println("Welcome to Java!");
  }
}
```

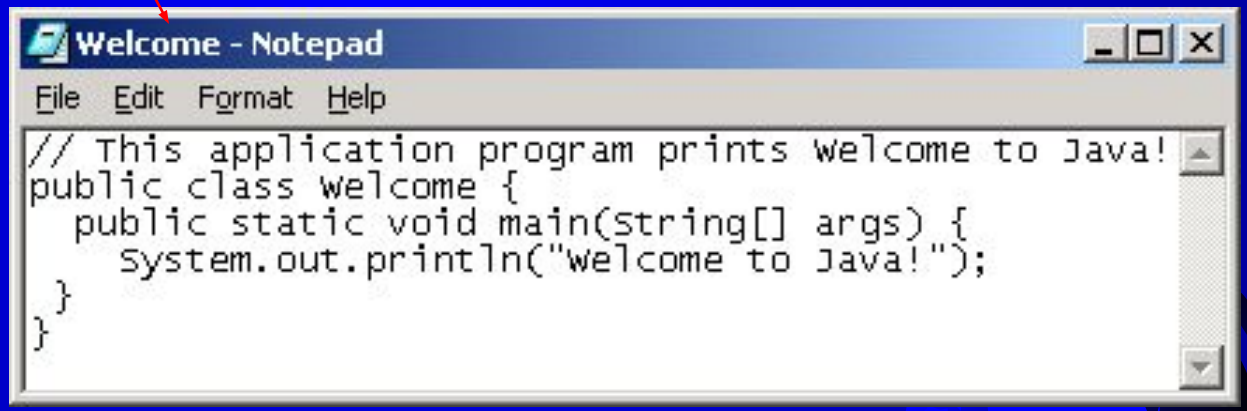
Welcome

Run

IMPORTANT NOTE: (1) To enable the buttons, you must download the entire slide file *slide.zip* and unzip the files into a directory (e.g., c:\slide) . (2) You must have installed JDK and set JDK's bin directory in your environment path (e.g., c:\Program Files\java\jdk1.6.0_14\bin in your environment path.

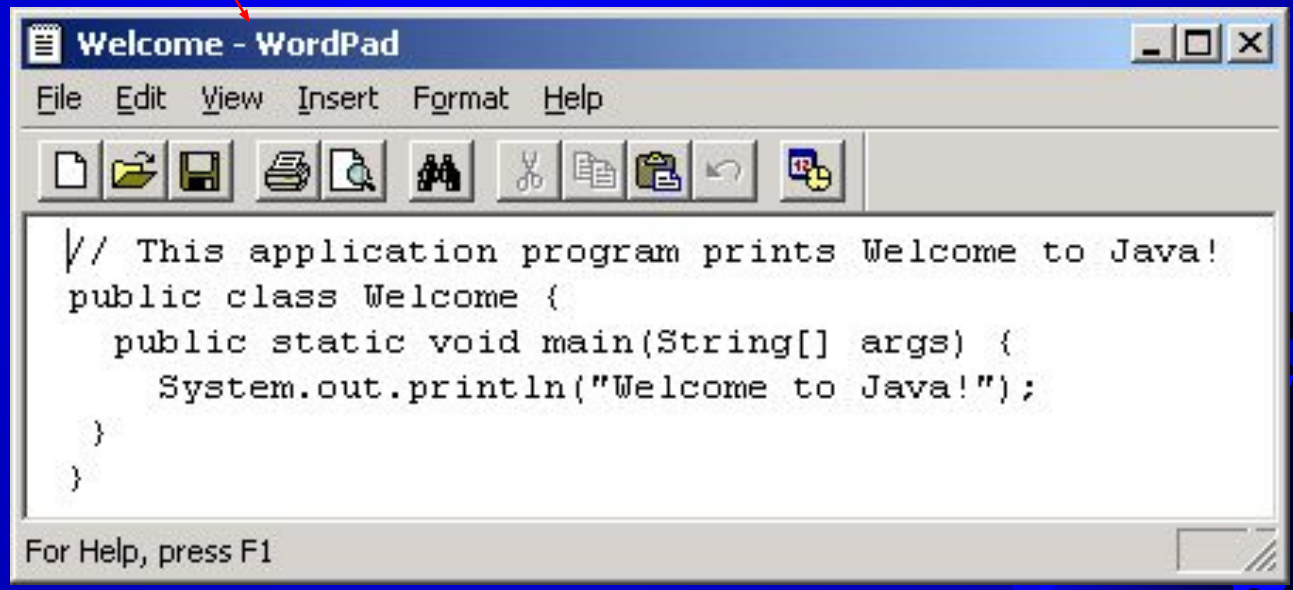
Creating and Editing Using NotePad

To use NotePad, type
notepad Welcome.java
from the DOS prompt.

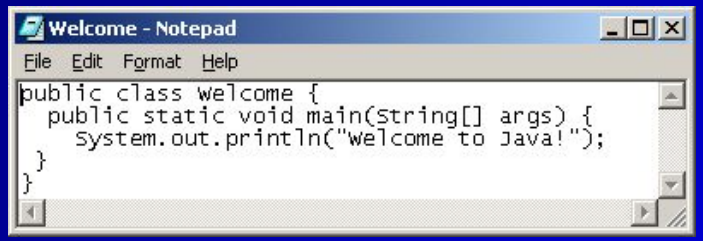


Creating and Editing Using WordPad

To use WordPad, type
write Welcome.java
from the DOS prompt.



Creating, Compiling, and Running Programs



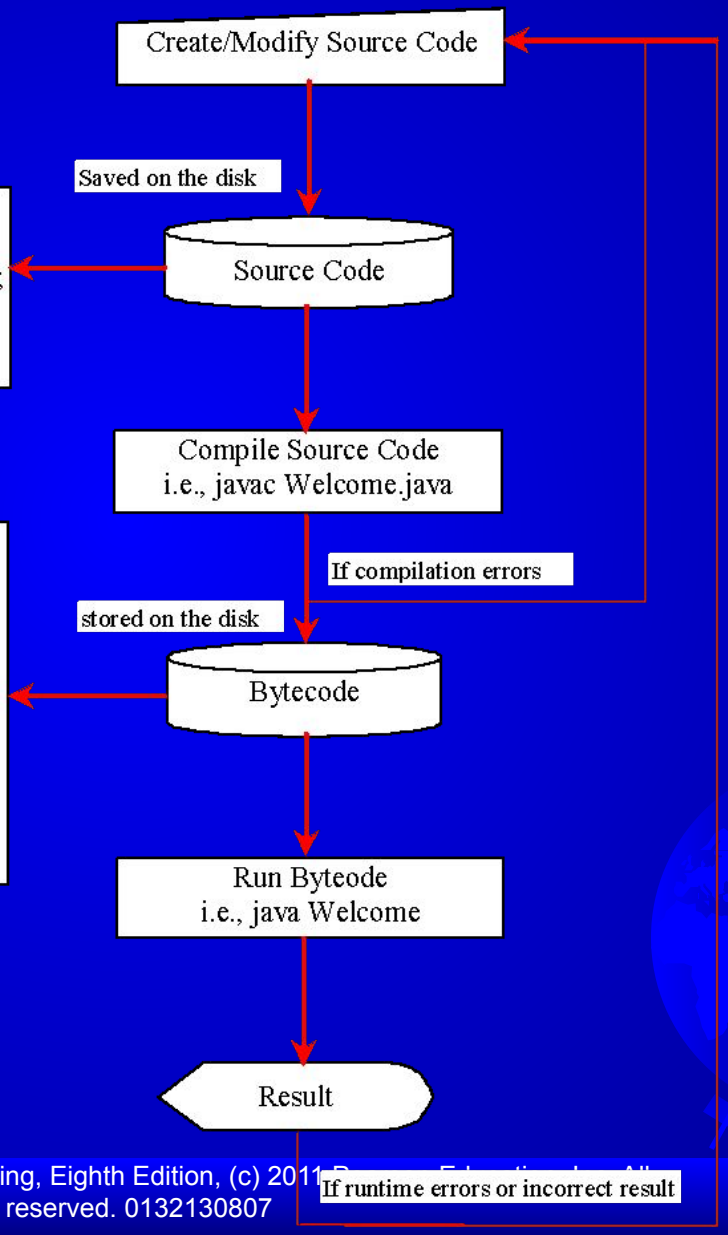
Source code (developed by the programmer)

```
public class Welcome {
  public static void main(String[] args) {
    System.out.println("Welcome to Java!");
  }
}
```

Byte code (generated by the compiler for JVM to read and interpret, not for you to understand)

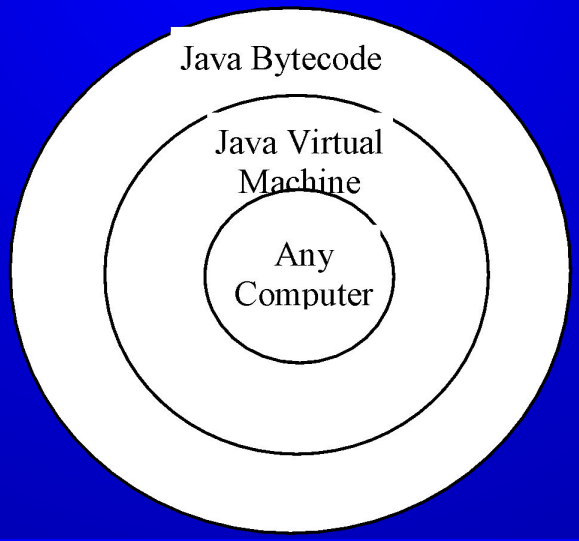
```
...
Method Welcome()
  0 aload_0
  ...

Method void main(java.lang.String[])
  0 getstatic #2 ...
  3 ldc #3 <String " Welcome to
Java!" >
  5 invokevirtual #4 ...
```



Compiling Java Source Code

You can port a source program to any machine with appropriate compilers. The source program must be recompiled, however, because the object program can only run on a specific machine. Nowadays computers are networked to work together. Java was designed to run object programs on any platform. With Java, you write the program once, and compile the source program into a special type of object code, known as *bytecode*. The bytecode can then run on any computer with a Java Virtual Machine, as shown below. Java Virtual Machine is a software that interprets Java bytecode.



animation

Trace a Program Execution

Enter main method

```
//This program prints Welcome to Java!
public class Welcome {
  public static void main(String[] args) {
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  }
}
```

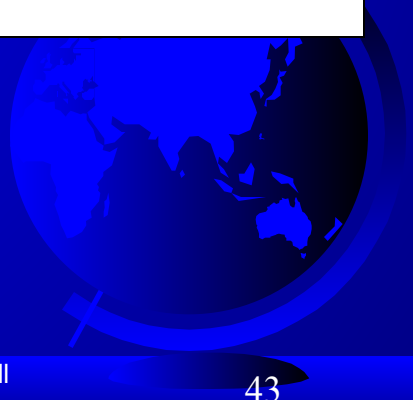

animation

Trace a Program Execution

Execute statement

```
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  }
}
```

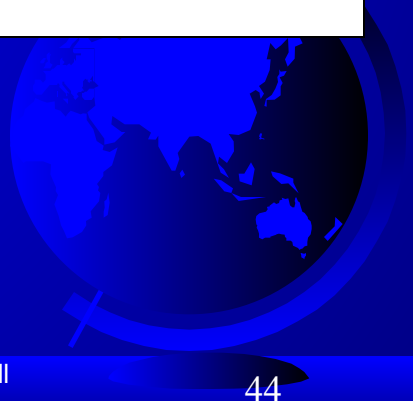

Trace a Program Execution

```
//This program prints Welcome to Java!
public class Welcome {
  public static void main(String[] args) {
    System.out.println("Welcome to Java!");
  }
}
```

print a message to the console

Two More Simple Examples

Welcome1 Run

ComputeExpression Run

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Supplements on the Companion Website

- See Supplement I.B for installing and configuring JDK
- See Supplement I.C for compiling and running Java from the command window for details

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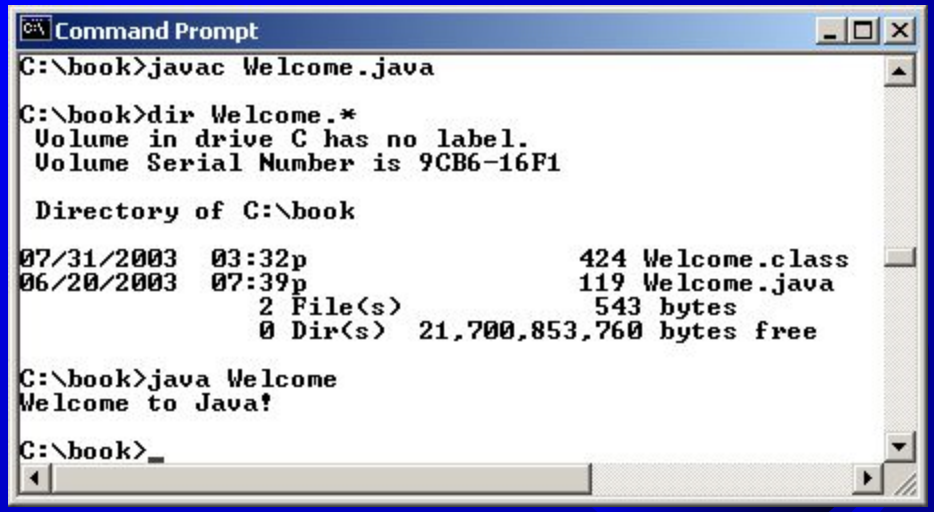
Compiling and Running Java from the Command Window

- Set path to JDK bin directory
  - set path=c:\Program Files\java\jdk1.6.0\bin
- Set classpath to include the current directory
  - set classpath=.
- Compile
  - javac Welcome.java
- Run
  - java Welcome



Compiling and Running Java from TextPad

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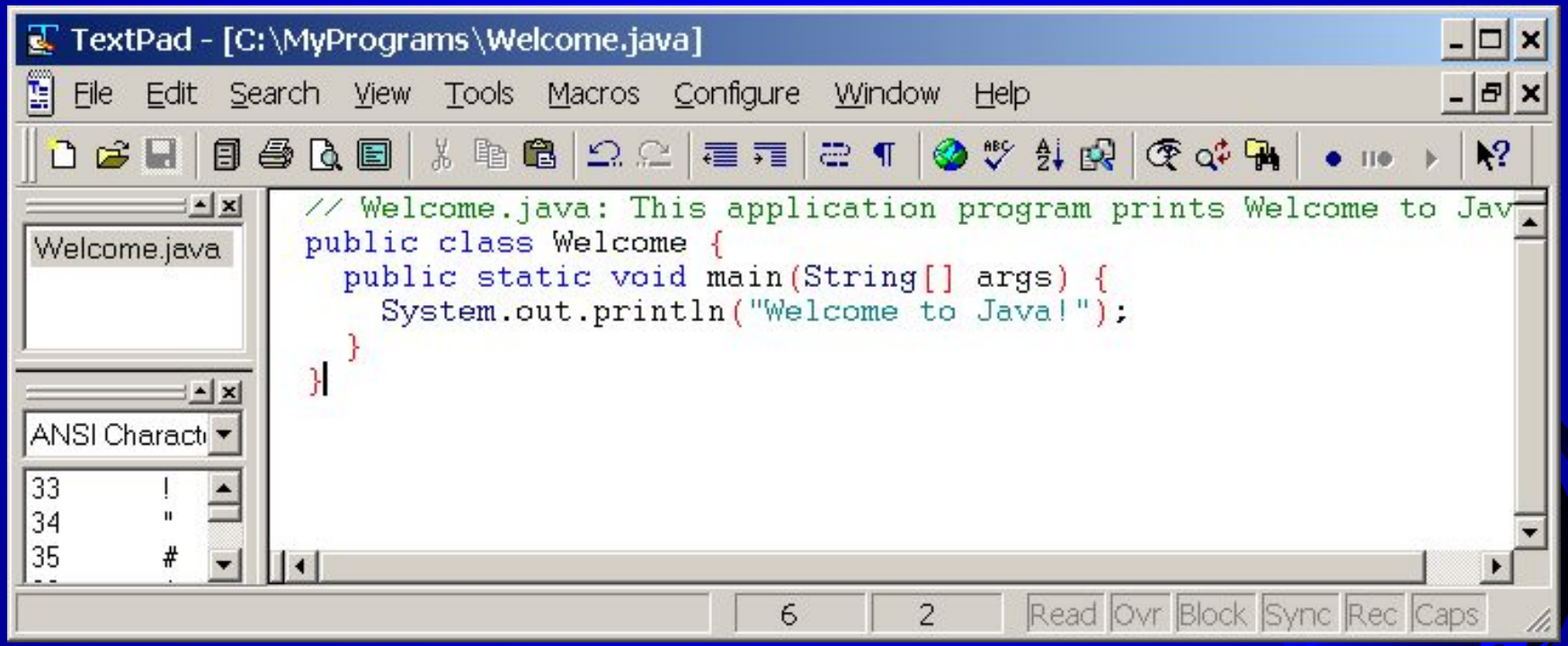
- See Supplement II.A on the Website for details



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Compiling and Running Java from JBuilder

- See Supplement II.H on the Website for details

Companion Website

Compiling and Running Java from NetBeans

- See Supplement I.D on the Website for details

Anatomy of a Java Program

- Comments
- Reserved words
- Modifiers
- Statements
- Blocks
- Classes
- Methods
- The main method

Comments

Three types of comments in Java.

Line comment: A line comment is preceded by two slashes (//) in a line.

Paragraph comment: A paragraph comment is enclosed between /* and */ in one or multiple lines.

javadoc comment: javadoc comments begin with /** and end with */. They are used for documenting classes, data, and methods. They can be extracted into an HTML file using JDK's javadoc command.

Reserved Words

Reserved words or keywords are words that have a specific meaning to the compiler and cannot be used for other purposes in the program. For example, when the compiler sees the word class, it understands that the word after class is the name for the class. Other reserved words in Listing 1.1 are public, static, and void. Their use will be introduced later in the book.

Modifiers

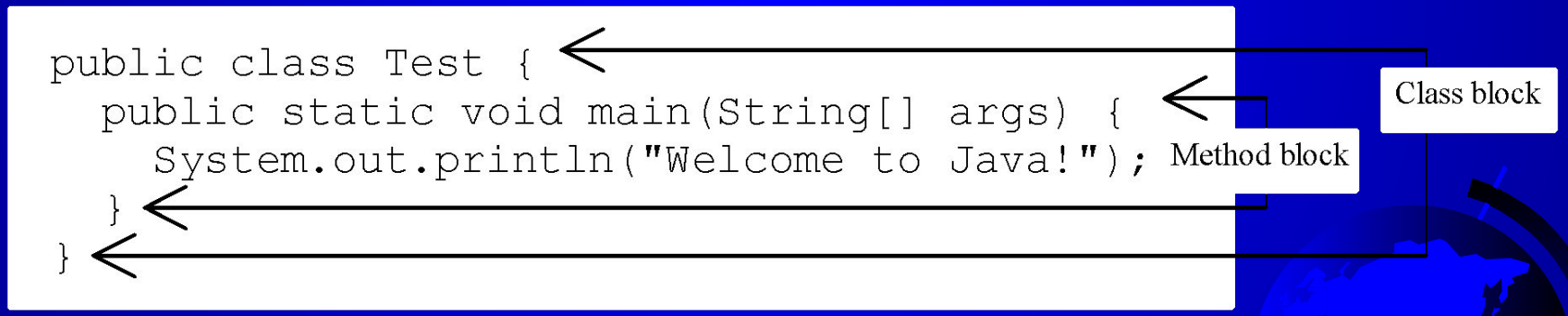
Java uses certain reserved words called modifiers that specify the properties of the data, methods, and classes and how they can be used. Examples of modifiers are public and static. Other modifiers are private, final, abstract, and protected. A public datum, method, or class can be accessed by other programs. A private datum or method cannot be accessed by other programs. Modifiers are discussed in Chapter 6, "Objects and Classes."

Statements

A statement represents an action or a sequence of actions. The statement System.out.println("Welcome to Java!") in the program in Listing 1.1 is a statement to display the greeting "Welcome to Java!" Every statement in Java ends with a semicolon (;).

Blocks

A pair of braces in a program forms a block that groups components of a program.



Classes

The class is the essential Java construct. A class is a template or blueprint for objects. To program in Java, you must understand classes and be able to write and use them. The mystery of the class will continue to be unveiled throughout this book. For now, though, understand that a program is defined by using one or more classes.

Methods

What is System.out.println? It is a method: a collection of statements that performs a sequence of operations to display a message on the console. It can be used even without fully understanding the details of how it works. It is used by invoking a statement with a string argument. The string argument is enclosed within parentheses. In this case, the argument is "Welcome to Java!" You can call the same println method with a different argument to print a different message.

main Method

The main method provides the control of program flow. The Java interpreter executes the application by invoking the main method.

The main method looks like this:

```
public static void main(String[] args) {
  // Statements;
}
```

Displaying Text in a Message Dialog Box

you can use the showMessageDialog method in the JOptionPane class. JOptionPane is one of the many predefined classes in the Java system, which can be reused rather than "reinventing the wheel."

WelcomeInMessageDialogBox

Run

IMPORTANT NOTE: To enable the buttons, you must download the entire slide file *slide.zip* and unzip the files into a directory (e.g., c:\slide) .

The showMessageDialog Method

```
JOptionPane.showMessageDialog(null,
  "Welcome to Java!",
  "Display Message",
  JOptionPane.INFORMATION_MESSAGE);
```

Two Ways to Invoke the Method

There are several ways to use the showMessageDialog method. For the time being, all you need to know are two ways to invoke it.

One is to use a statement as shown in the example:

```
JOptionPane.showMessageDialog(null, x,
  y, JOptionPane.INFORMATION_MESSAGE);
```

where x is a string for the text to be displayed, and y is a string for the title of the message dialog box.

The other is to use a statement like this:

```
JOptionPane.showMessageDialog(null, x);
```

where x is a string for the text to be displayed.