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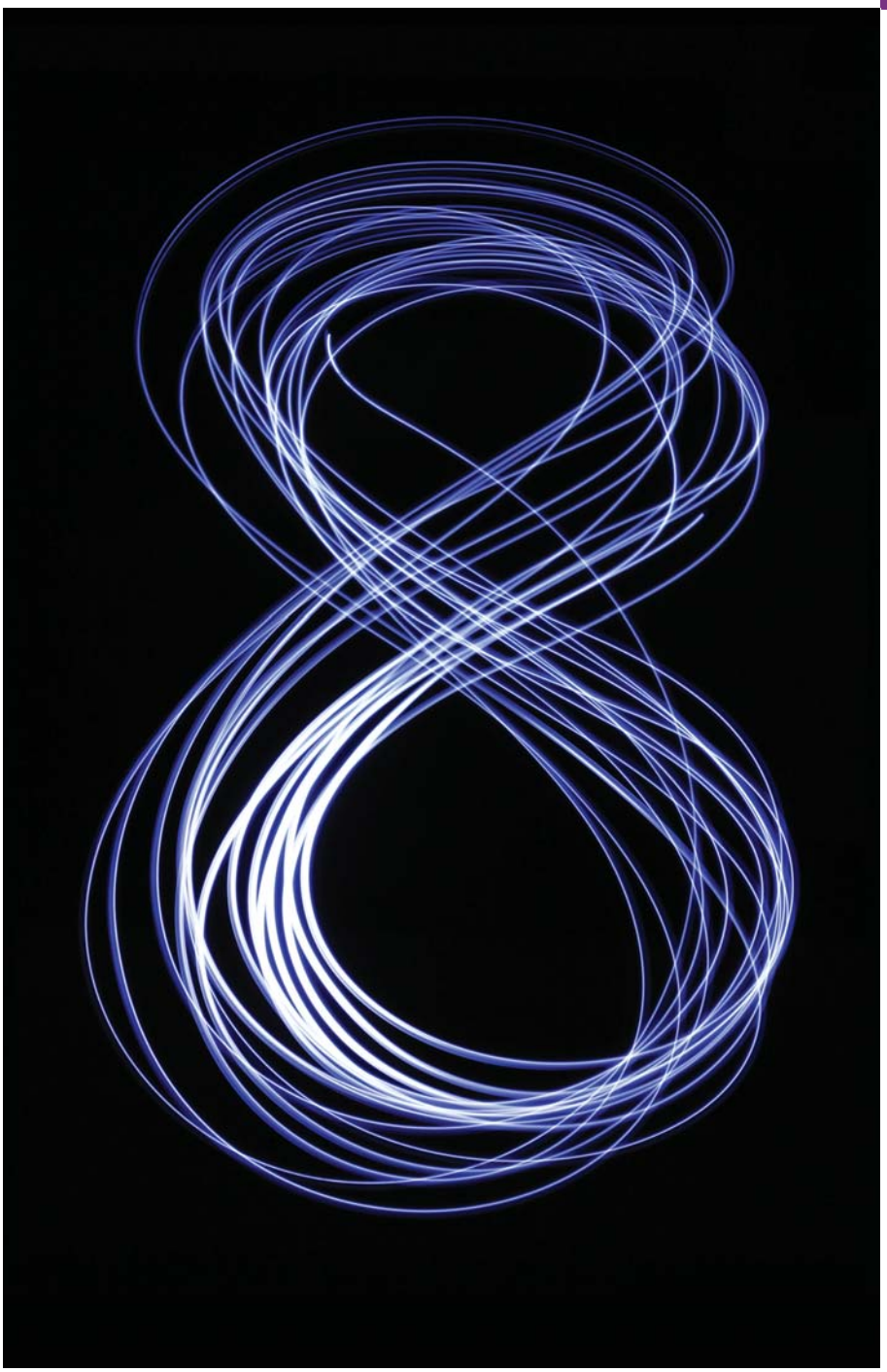
Introduction to Computers, the Internet and Java



Man is still the most extraordinary computer of all.
—John F. Kennedy

Good design is good business.
—Thomas J. Watson, Founder of IBM

Objectives

In this chapter you'll:

- Learn about exciting recent developments in the computer field.
- Learn computer hardware, software and networking basics.
- Understand the data hierarchy.
- Understand the different types of programming languages.
- Understand the importance of Java and other leading programming languages.
- Understand object-oriented programming basics.
- Learn the importance of the Internet and the web.
- Learn a typical Java program-development environment.
- Test-drive a Java application.
- Learn some key recent software technologies.
- See how to keep up-to-date with information technologies.

1.1 Introduction

Welcome to Java—one of the world's most widely used computer programming languages. You're already familiar with the powerful tasks computers perform. Using this textbook, you'll write instructions commanding computers to perform those tasks. **Software** (i.e., the instructions you write) controls **hardware** (i.e., computers).

You'll learn *object-oriented programming*—today's key programming methodology. You'll create and work with many *software objects*.

For many organizations, the preferred language for meeting their enterprise programming needs is Java. Java is also widely used for implementing Internet-based applications and software for devices that communicate over a network.

Forrester Research predicts more than two billion PCs will be in use by 2015.[1] According to Oracle, 97% of enterprise desktops, 89% of PC desktops, three billion devices (Fig. 1.1) and 100% of all Blu-ray Disc™ players run Java, and there are over 9 million Java developers.[2]

According to a study by Gartner, mobile devices will continue to outpace PCs as users' primary computing devices; an estimated 1.96 billion smartphones and 388 million tablets will be shipped in 2015—8.7 times the number of PCs.[3] By 2018, the mobile applications

1. http://www.worldometers.info/computers.
2. http://www.oracle.com/technetwork/articles/java/javaone12review-1863742.html.
3. http://www.gartner.com/newsroom/id/2645115.

Devices		
Airplane systems	ATMs	Automobile infotainment systems
Blu-ray Disc™ players	Cable boxes	Copiers
Credit cards	CT scanners	Desktop computers
e-Readers	Game consoles	GPS navigation systems
Home appliances	Home security systems	Light switches
Lottery terminals	Medical devices	Mobile phones
MRIs	Parking payment stations	Printers
Transportation passes	Robots	Routers
Smart cards	Smart meters	Smartpens
Smartphones	Tablets	Televisions
TV set-top boxes	Thermostats	Vehicle diagnostic systems

Fig. 1.1 | Some devices that use Java.

(apps) market is expected to reach $92 billion.[4] This is creating significant career opportunities for people who program mobile applications, many of which are programmed in Java (see Section 1.6.3).

Java Standard Edition

Java has evolved so rapidly that this tenth edition of *Java How to Program*—based on **Java Standard Edition 7 (Java SE 7)** and **Java Standard Edition 8 (Java SE 8)**—was published just 17 years after the first edition. Java Standard Edition contains the capabilities needed to develop desktop and server applications. The book can be used with *either* Java SE 7 *or* Java SE 8 (released just after this book was published). All of the Java SE 8 features are discussed in modular, easy-to-include-or-omit sections throughout the book.

Prior to Java SE 8, Java supported three programming paradigms—*procedural programming*, *object-oriented programming* and *generic programming*. Java SE 8 adds *functional programming*. In Chapter 17, we'll show how to use functional programming to write programs faster, more concisely, with fewer bugs and that are easier to *parallelize* (i.e., perform multiple calculations simultaneously) to take advantage of today's multi-core hardware architectures to enhance application performance.

Java Enterprise Edition

Java is used in such a broad spectrum of applications that it has two other editions. The **Java Enterprise Edition (Java EE)** is geared toward developing large-scale, distributed networking applications and web-based applications. In the past, most computer applications ran on "standalone" computers (computers that were not networked together). Today's applications can be written with the aim of communicating among the world's computers via the Internet and the web. Later in this book we discuss how to build such web-based applications with Java.

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4. `https://www.abiresearch.com/press/tablets-will-generate-35-of-this-years-25-billion-`.

Java Micro Edition

The **Java Micro Edition (Java ME)**—a subset of Java SE—is geared toward developing applications for resource-constrained embedded devices, such as smartwatches, MP3 players, television set-top boxes, smart meters (for monitoring electric energy usage) and more.

1.2 Hardware and Software

Computers can perform calculations and make logical decisions phenomenally faster than human beings can. Many of today's personal computers can perform billions of calculations in one second—more than a human can perform in a lifetime. *Supercomputers* are already performing *thousands of trillions (quadrillions)* of instructions per second! China's National University of Defense Technology's Tianhe-2 supercomputer can perform over 33 quadrillion calculations per second (33.86 *petaflops*)![5] To put that in perspective, *the Tianhe-2 supercomputer can perform in one second about 3 million calculations for every person on the planet!* And—these supercomputing "upper limits" are growing quickly.

Computers process data under the control of sequences of instructions called **computer programs**. These software programs guide the computer through ordered actions specified by people called computer **programmers**. In this book, you'll learn a key programming methodology that's enhancing programmer productivity, thereby reducing software development costs—*object-oriented programming*.

A computer consists of various devices referred to as hardware (e.g., the keyboard, screen, mouse, hard disks, memory, DVD drives and processing units). Computing costs are *dropping dramatically*, owing to rapid developments in hardware and software technologies. Computers that might have filled large rooms and cost millions of dollars decades ago are now inscribed on silicon chips smaller than a fingernail, costing perhaps a few dollars each. Ironically, silicon is one of the most abundant materials on Earth—it's an ingredient in common sand. Silicon-chip technology has made computing so economical that computers have become a commodity.

1.2.1 Moore's Law

Every year, you probably expect to pay at least a little more for most products and services. The opposite has been the case in the computer and communications fields, especially with regard to the hardware supporting these technologies. For many decades, hardware costs have fallen rapidly.

Every year or two, the capacities of computers have approximately *doubled* inexpensively. This remarkable trend often is called **Moore's Law**, named for the person who identified it in the 1960s, Gordon Moore, co-founder of Intel—the leading manufacturer of the processors in today's computers and embedded systems. Moore's Law and related observations apply especially to the amount of memory that computers have for programs, the amount of secondary storage (such as disk storage) they have to hold programs and data over longer periods of time, and their processor speeds—the speeds at which they *execute* their programs (i.e., do their work).

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5. `http://www.top500.org/`.

Similar growth has occurred in the communications field—costs have plummeted as enormous demand for communications *bandwidth* (i.e., information-carrying capacity) has attracted intense competition. We know of no other fields in which technology improves so quickly and costs fall so rapidly. Such phenomenal improvement is truly fostering the *Information Revolution*.

1.2.2 Computer Organization

Regardless of differences in *physical* appearance, computers can be envisioned as divided into various **logical units** or sections (Fig. 1.2).

Logical unit	Description
Input unit	This "receiving" section obtains information (data and computer programs) from **input devices** and places it at the disposal of the other units for processing. Most user input is entered into computers through keyboards, touch screens and mouse devices. Other forms of input include receiving voice commands, scanning images and barcodes, reading from secondary storage devices (such as hard drives, DVD drives, Blu-ray Disc™ drives and USB flash drives—also called "thumb drives" or "memory sticks"), receiving video from a webcam and having your computer receive information from the Internet (such as when you stream videos from YouTube® or download e-books from Amazon). Newer forms of input include position data from a GPS device, and motion and orientation information from an *accelerometer* (a device that responds to up/down, left/right and forward/backward acceleration) in a smartphone or game controller (such as Microsoft® Kinect® and Xbox®, Wii™ Remote and Sony® PlayStation® Move).
Output unit	This "shipping" section takes information the computer has processed and places it on various **output devices** to make it available for use outside the computer. Most information that's output from computers today is displayed on screens (including touch screens), printed on paper ("going green" discourages this), played as audio or video on PCs and media players (such as Apple's iPods) and giant screens in sports stadiums, transmitted over the Internet or used to control other devices, such as robots and "intelligent" appliances. Information is also commonly output to secondary storage devices, such as hard drives, DVD drives and USB flash drives. A popular recent form of output is smartphone vibration.
Memory unit	This rapid-access, relatively low-capacity "warehouse" section retains information that has been entered through the input unit, making it immediately available for processing when needed. The memory unit also retains processed information until it can be placed on output devices by the output unit. Information in the memory unit is *volatile*—it's typically lost when the computer's power is turned off. The memory unit is often called either **memory**, **primary memory** or **RAM** (Random Access Memory). Main memories on desktop and notebook computers contain as much as 128 GB of RAM. GB stands for gigabytes; a gigabyte is approximately one billion bytes. A **byte** is eight bits. A bit is either a `0` or a `1`.

Fig. 1.2 | Logical units of a computer. (Part 1 of 2.)

Logical unit	Description
Arithmetic and logic unit (ALU)	This "manufacturing" section performs *calculations*, such as addition, subtraction, multiplication and division. It also contains the *decision* mechanisms that allow the computer, for example, to compare two items from the memory unit to determine whether they're equal. In today's systems, the ALU is implemented as part of the next logical unit, the CPU.
Central processing unit (CPU)	This "administrative" section coordinates and supervises the operation of the other sections. The CPU tells the input unit when information should be read into the memory unit, tells the ALU when information from the memory unit should be used in calculations and tells the output unit when to send information from the memory unit to certain output devices. Many of today's computers have multiple CPUs and, hence, can perform many operations simultaneously. A **multi-core processor** implements multiple processors on a single integrated-circuit chip—a *dual-core processor* has two CPUs and a *quad-core processor* has four CPUs. Today's desktop computers have processors that can execute billions of instructions per second.
Secondary storage unit	This is the long-term, high-capacity "warehousing" section. Programs or data not actively being used by the other units normally are placed on secondary storage devices (e.g., your *hard drive*) until they're again needed, possibly hours, days, months or even years later. Information on secondary storage devices is *persistent*—it's preserved even when the computer's power is turned off. Secondary storage information takes much longer to access than information in primary memory, but its cost per unit is much less. Examples of secondary storage devices include hard drives, DVD drives and USB flash drives, some of which can hold over 2 TB (TB stands for terabytes; a terabyte is approximately one trillion bytes). Typical hard drives on desktop and notebook computers hold up to 2 TB, and some desktop hard drives can hold up to 4 TB.

Fig. 1.2 | Logical units of a computer. (Part 2 of 2.)

1.3 Data Hierarchy

Data items processed by computers form a **data hierarchy** that becomes larger and more complex in structure as we progress from the simplest data items (called "bits") to richer ones, such as characters and fields. Figure 1.3 illustrates a portion of the data hierarchy.

Bits

The smallest data item in a computer can assume the value `0` or the value `1`. It's called a **bit** (short for "binary digit"—a digit that can assume one of *two* values). Remarkably, the impressive functions performed by computers involve only the simplest manipulations of `0`s and `1`s—*examining a bit's value*, *setting a bit's value* and *reversing a bit's value* (from `1` to `0` or from `0` to `1`).

Characters

It's tedious for people to work with data in the low-level form of bits. Instead, they prefer to work with *decimal digits* (0–9), *letters* (A–Z and a–z), and *special symbols* (e.g., $, @, %,

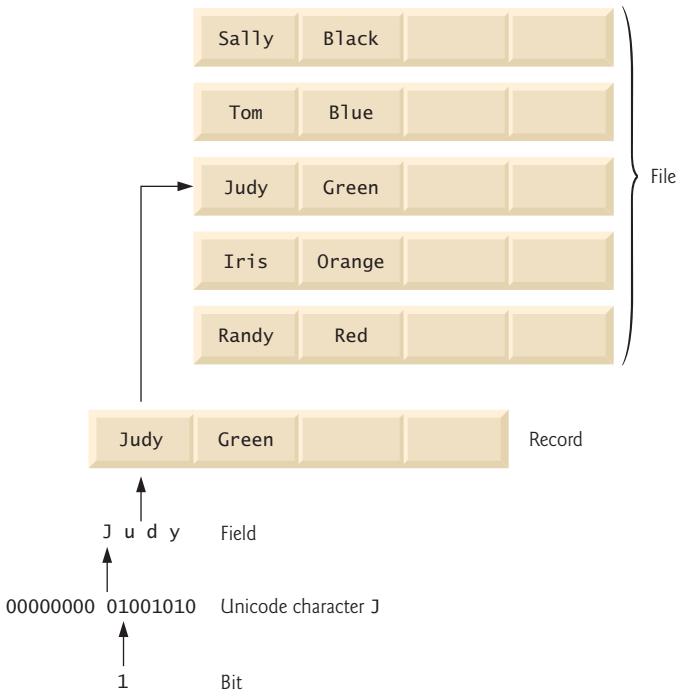

Fig. 1.3 | Data hierarchy.

&, *, (,), –, +, ", :, ? and /). Digits, letters and special symbols are known as **characters**. The computer's **character set** is the set of all the characters used to write programs and represent data items. Computers process only 1s and 0s, so a computer's character set represents every character as a pattern of 1s and 0s. Java uses **Unicode®** characters that are composed of one, two or four bytes (8, 16 or 32 bits). Unicode contains characters for many of the world's languages. See Appendix H for more information on Unicode. See Appendix B for more information on the **ASCII (American Standard Code for Information Interchange)** character set—the popular subset of Unicode that represents uppercase and lowercase letters, digits and some common special characters.

Fields

Just as characters are composed of bits, **fields** are composed of characters or bytes. A field is a group of characters or bytes that conveys meaning. For example, a field consisting of uppercase and lowercase letters can be used to represent a person's name, and a field consisting of decimal digits could represent a person's age.

Records

Several related fields can be used to compose a **record** (implemented as a `class` in Java). In a payroll system, for example, the record for an employee might consist of the following fields (possible types for these fields are shown in parentheses):

- Employee identification number (a whole number)
- Name (a string of characters)
- Address (a string of characters)
- Hourly pay rate (a number with a decimal point)
- Year-to-date earnings (a number with a decimal point)
- Amount of taxes withheld (a number with a decimal point)

Thus, a record is a group of related fields. In the preceding example, all the fields belong to the *same* employee. A company might have many employees and a payroll record for each.

Files

A **file** is a group of related records. [*Note:* More generally, a file contains arbitrary data in arbitrary formats. In some operating systems, a file is viewed simply as a *sequence of bytes*—any organization of the bytes in a file, such as organizing the data into records, is a view created by the application programmer. You'll see how to do that in Chapter 15.] It's not unusual for an organization to have many files, some containing billions, or even trillions, of characters of information.

Database

A **database** is a collection of data organized for easy access and manipulation. The most popular model is the *relational database*, in which data is stored in simple *tables*. A table includes *records* and *fields*. For example, a table of students might include first name, last name, major, year, student ID number and grade point average fields. The data for each student is a record, and the individual pieces of information in each record are the fields. You can *search*, *sort* and otherwise manipulate the data based on its relationship to multiple tables or databases. For example, a university might use data from the student database in combination with data from databases of courses, on-campus housing, meal plans, etc. We discuss databases in Chapter 24.

Big Data

The amount of data being produced worldwide is enormous and growing quickly. According to IBM, approximately 2.5 quintillion bytes (2.5 *exabytes*) of data are created daily and 90% of the world's data was created in just the past two years![6] According to a Digital Universe study, the global data supply reached 2.8 *zettabytes* (equal to 2.8 trillion gigabytes) in 2012.[7] Figure 1.4 shows some common byte measurements. **Big data** applications deal with such massive amounts of data and this field is growing quickly, creating lots of opportunity for software developers. According to a study by Gartner Group, over 4 million IT jobs globally will support big data by by 2015.[8]

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6. `http://www-01.ibm.com/software/data/bigdata/`.
7. `http://www.guardian.co.uk/news/datablog/2012/dec/19/big-data-study-digital-universe-global-volume`.
8. `http://tech.fortune.cnn.com/2013/09/04/big-data-employment-boom/`.

Unit	Bytes	Which is approximately
1 kilobyte (KB)	1024 bytes	10^3 (1024 bytes exactly)
1 megabyte (MB)	1024 kilobytes	10^6 (1,000,000 bytes)
1 gigabyte (GB)	1024 megabytes	10^9 (1,000,000,000 bytes)
1 terabyte (TB)	1024 gigabytes	10^{12} (1,000,000,000,000 bytes)
1 petabyte (PB)	1024 terabytes	10^{15} (1,000,000,000,000,000 bytes)
1 exabyte (EB)	1024 petabytes	10^{18} (1,000,000,000,000,000,000 bytes)
1 zettabyte (ZB)	1024 exabytes	10^{21} (1,000,000,000,000,000,000,000 bytes)

Fig. 1.4 | Byte measurements.

1.4 Machine Languages, Assembly Languages and High-Level Languages

Programmers write instructions in various programming languages, some directly understandable by computers and others requiring intermediate *translation* steps. Hundreds of such languages are in use today. These may be divided into three general types:

1. Machine languages
2. Assembly languages
3. High-level languages

Machine Languages

Any computer can directly understand only its own **machine language**, defined by its hardware design. Machine languages generally consist of strings of numbers (ultimately reduced to 1s and 0s) that instruct computers to perform their most elementary operations one at a time. Machine languages are *machine dependent* (a particular machine language can be used on only one type of computer). Such languages are cumbersome for humans. For example, here's a section of an early machine-language payroll program that adds overtime pay to base pay and stores the result in gross pay:

```
+1300042774
+1400593419
+1200274027
```

Assembly Languages and Assemblers

Programming in machine language was simply too slow and tedious for most programmers. Instead of using the strings of numbers that computers could directly understand, programmers began using English-like abbreviations to represent elementary operations. These abbreviations formed the basis of **assembly languages**. *Translator programs* called **assemblers** were developed to convert early assembly-language programs to machine language at computer speeds. The following section of an assembly-language payroll program also adds overtime pay to base pay and stores the result in gross pay:

```
load   basepay
add    overpay
store  grosspay
```

Although such code is clearer to humans, it's incomprehensible to computers until translated to machine language.

High-Level Languages and Compilers

With the advent of assembly languages, computer usage increased rapidly, but programmers still had to use numerous instructions to accomplish even the simplest tasks. To speed the programming process, **high-level languages** were developed in which single statements could be written to accomplish substantial tasks. Translator programs called **compilers** convert high-level language programs into machine language. High-level languages allow you to write instructions that look almost like everyday English and contain commonly used mathematical notations. A payroll program written in a high-level language might contain a *single* statement such as

```
grossPay = basePay + overTimePay
```

From the programmer's standpoint, high-level languages are preferable to machine and assembly languages. Java is one of the most widely used high-level programming languages.

Interpreters

Compiling a large high-level language program into machine language can take considerable computer time. *Interpreter* programs, developed to execute high-level language programs directly, avoid the delay of compilation, although they run slower than compiled programs. We'll say more about interpreters in Section 1.9, where you'll learn that Java uses a clever performance-tuned mixture of compilation and interpretation to run programs.

1.5 Introduction to Object Technology

Today, as demands for new and more powerful software are soaring, building software quickly, correctly and economically remains an elusive goal. *Objects*, or more precisely, the *classes* objects come from, are essentially *reusable* software components. There are date objects, time objects, audio objects, video objects, automobile objects, people objects, etc. Almost any *noun* can be reasonably represented as a software object in terms of *attributes* (e.g., name, color and size) and *behaviors* (e.g., calculating, moving and communicating). Software-development groups can use a modular, object-oriented design-and-implementation approach to be much more productive than with earlier popular techniques like "structured programming"—object-oriented programs are often easier to understand, correct and modify.

1.5.1 The Automobile as an Object

To help you understand objects and their contents, let's begin with a simple analogy. Suppose you want to *drive a car and make it go faster by pressing its accelerator pedal*. What must happen before you can do this? Well, before you can drive a car, someone has to *design* it. A car typically begins as engineering drawings, similar to the *blueprints* that describe the design of a house. These drawings include the design for an accelerator pedal. The pedal *hides* from the driver the complex mechanisms that actually make the car go faster, just as the brake pedal "hides" the mechanisms that slow the car, and the steering wheel "hides" the mechanisms that turn the car. This enables people with little or no knowledge of how engines, braking and steering mechanisms work to drive a car easily.

Just as you cannot cook meals in the kitchen of a blueprint, you cannot drive a car's engineering drawings. Before you can drive a car, it must be *built* from the engineering drawings that describe it. A completed car has an *actual* accelerator pedal to make it go faster, but even that's not enough—the car won't accelerate on its own (hopefully!), so the driver must *press* the pedal to accelerate the car.

1.5.2 Methods and Classes

Let's use our car example to introduce some key object-oriented programming concepts. Performing a task in a program requires a **method**. The method houses the program statements that actually perform its tasks. The method hides these statements from its user, just as the accelerator pedal of a car hides from the driver the mechanisms of making the car go faster. In Java, we create a program unit called a **class** to house the set of methods that perform the class's tasks. For example, a class that represents a bank account might contain one method to *deposit* money to an account, another to *withdraw* money from an account and a third to *inquire* what the account's current balance is. A class is similar in concept to a car's engineering drawings, which house the design of an accelerator pedal, steering wheel, and so on.

1.5.3 Instantiation

Just as someone has to *build a car* from its engineering drawings before you can actually drive a car, you must *build an object* of a class before a program can perform the tasks that the class's methods define. The process of doing this is called *instantiation*. An object is then referred to as an **instance** of its class.

1.5.4 Reuse

Just as a car's engineering drawings can be *reused* many times to build many cars, you can *reuse* a class many times to build many objects. Reuse of existing classes when building new classes and programs saves time and effort. Reuse also helps you build more reliable and effective systems, because existing classes and components often have undergone extensive *testing*, *debugging* and *performance* tuning. Just as the notion of *interchangeable parts* was crucial to the Industrial Revolution, reusable classes are crucial to the software revolution that has been spurred by object technology.

Software Engineering Observation 1.1

Use a building-block approach to creating your programs. Avoid reinventing the wheel—use existing high-quality pieces wherever possible. This software reuse *is a key benefit of object-oriented programming.*

1.5.5 Messages and Method Calls

When you drive a car, pressing its gas pedal sends a *message* to the car to perform a task—that is, to go faster. Similarly, you *send messages to an object*. Each message is implemented as a **method call** that tells a method of the object to perform its task. For example, a program might call a bank-account object's *deposit* method to increase the account's balance.

1.5.6 Attributes and Instance Variables

A car, besides having capabilities to accomplish tasks, also has *attributes*, such as its color, its number of doors, the amount of gas in its tank, its current speed and its record of total

miles driven (i.e., its odometer reading). Like its capabilities, the car's attributes are represented as part of its design in its engineering diagrams (which, for example, include an odometer and a fuel gauge). As you drive an actual car, these attributes are carried along with the car. Every car maintains its *own* attributes. For example, each car knows how much gas is in its own gas tank, but *not* how much is in the tanks of *other* cars.

An object, similarly, has attributes that it carries along as it's used in a program. These attributes are specified as part of the object's class. For example, a bank-account object has a *balance attribute* that represents the amount of money in the account. Each bank-account object knows the balance in the account it represents, but *not* the balances of the *other* accounts in the bank. Attributes are specified by the class's **instance variables**.

1.5.7 Encapsulation and Information Hiding

Classes (and their objects) **encapsulate**, i.e., encase, their attributes and methods. A class's (and its object's) attributes and methods are intimately related. Objects may communicate with one another, but they're normally not allowed to know how other objects are implemented—implementation details are *hidden* within the objects themselves. This **information hiding**, as we'll see, is crucial to good software engineering.

1.5.8 Inheritance

A new class of objects can be created conveniently by **inheritance**—the new class (called the **subclass**) starts with the characteristics of an existing class (called the **superclass**), possibly customizing them and adding unique characteristics of its own. In our car analogy, an object of class "convertible" certainly *is an* object of the more *general* class "automobile," but more *specifically*, the roof can be raised or lowered.

1.5.9 Interfaces

Java also supports **interfaces**—collections of related methods that typically enable you to tell objects *what* to do, but not *how* to do it (we'll see an exception to this in Java SE 8). In the car analogy, a "basic-driving-capabilities" interface consisting of a steering wheel, an accelerator pedal and a brake pedal would enable a driver to tell the car *what* to do. Once you know how to use this interface for turning, accelerating and braking, you can drive many types of cars, even though manufacturers may *implement* these systems *differently*.

A class **implements** zero or more interfaces, each of which can have one or more methods, just as a car implements separate interfaces for basic driving functions, controlling the radio, controlling the heating and air conditioning systems, and the like. Just as car manufacturers implement capabilities *differently*, classes may implement an interface's methods *differently*. For example a software system may include a "backup" interface that offers the methods *save* and *restore*. Classes may implement those methods differently, depending on the types of things being backed up, such as programs, text, audios, videos, etc., and the types of devices where these items will be stored.

1.5.10 Object-Oriented Analysis and Design (OOAD)

Soon you'll be writing programs in Java. How will you create the **code** (i.e., the program instructions) for your programs? Perhaps, like many programmers, you'll simply turn on

your computer and start typing. This approach may work for small programs (like the ones we present in the early chapters of the book), but what if you were asked to create a software system to control thousands of automated teller machines for a major bank? Or suppose you were asked to work on a team of 1,000 software developers building the next generation of the U.S. air traffic control system? For projects so large and complex, you should not simply sit down and start writing programs.

To create the best solutions, you should follow a detailed **analysis** process for determining your project's **requirements** (i.e., defining *what* the system is supposed to do) and developing a **design** that satisfies them (i.e., specifying *how* the system should do it). Ideally, you'd go through this process and carefully review the design (and have your design reviewed by other software professionals) before writing any code. If this process involves analyzing and designing your system from an object-oriented point of view, it's called an **object-oriented analysis-and-design (OOAD) process**. Languages like Java are object oriented. Programming in such a language, called **object-oriented programming (OOP)**, allows you to implement an object-oriented design as a working system.

1.5.11 The UML (Unified Modeling Language)

Although many different OOAD processes exist, a single graphical language for communicating the results of *any* OOAD process has come into wide use. The Unified Modeling Language (UML) is now the most widely used graphical scheme for modeling object-oriented systems. We present our first UML diagrams in Chapters 3 and 4, then use them in our deeper treatment of object-oriented programming through Chapter 11. In our *optional* online ATM Software Engineering Case Study in Chapters 33–34 we present a simple subset of the UML's features as we guide you through an object-oriented design experience.

1.6 Operating Systems

Operating systems are software systems that make using computers more convenient for users, application developers and system administrators. They provide services that allow each application to execute safely, efficiently and *concurrently* (i.e., in parallel) with other applications. The software that contains the core components of the operating system is the **kernel**. Popular desktop operating systems include Linux, Windows and Mac OS X. Popular mobile operating systems used in smartphones and tablets include Google's Android, Apple's iOS (for its iPhone, iPad and iPod Touch devices), Windows Phone 8 and BlackBerry OS.

1.6.1 Windows—A Proprietary Operating System

In the mid-1980s, Microsoft developed the **Windows operating system**, consisting of a graphical user interface built on top of DOS—an enormously popular personal-computer operating system that users interacted with by typing commands. Windows borrowed many concepts (such as icons, menus and windows) popularized by early Apple Macintosh operating systems and originally developed by Xerox PARC. Windows 8 is Microsoft's latest operating system—its features include PC and tablet support, a tiles-based user interface, security enhancements, touch-screen and multi-touch support, and more. Windows is a *proprietary* operating system—it's controlled by Microsoft exclusively. It's by far the world's most widely used operating system.

1.6.2 Linux—An Open-Source Operating System

The **Linux** operating system—which is popular in servers, personal computers and embedded systems—is perhaps the greatest success of the *open-source* movement. The **open-source software** development style departs from the *proprietary* development style (used, for example, with Microsoft's Windows and Apple's Mac OS X). With open-source development, individuals and companies—often worldwide—contribute their efforts in developing, maintaining and evolving software. Anyone can use and customize it for their own purposes, typically at no charge. The Java Development Kit and many related Java technologies are now open source.

Some organizations in the open-source community are the *Eclipse Foundation* (the *Eclipse Integrated Development Environment* helps Java programmers conveniently develop software), the *Mozilla Foundation* (creators of the *Firefox web browser*), the *Apache Software Foundation* (creators of the *Apache web server* that *delivers web pages over the Internet* in response to web-browser requests) and *GitHub* and *SourceForge* (which provide the *tools for managing open-source projects*).

Rapid improvements to computing and communications, decreasing costs and open-source software have made it easier and more economical to create software-based businesses now than just a few decades ago. Facebook, which was launched from a college dorm room, was built with open-source software.[9]

A variety of issues—such as Microsoft's market power, the relatively small number of user-friendly Linux applications and the diversity of Linux distributions (Red Hat Linux, Ubuntu Linux and many others)—have prevented widespread Linux use on desktop computers. But Linux has become extremely popular on servers and in embedded systems, such as Google's Android-based smartphones.

1.6.3 Android

Android—the fastest-growing mobile and smartphone operating system—is based on the Linux kernel and uses Java. Experienced Java programmers can quickly dive into Android development. One benefit of developing Android apps is the openness of the platform. The operating system is open source and free.

The Android operating system was developed by Android, Inc., which was acquired by Google in 2005. In 2007, the Open Handset Alliance™—which now has 87 company members worldwide (`http://www.openhandsetalliance.com/oha_members.html`)—was formed to develop, maintain and evolve Android, driving innovation in mobile technology and improving the user experience while reducing costs. As of April 2013, more than 1.5 million Android devices (smartphones, tablets, etc.) were being activated *daily*.[10] By October 2013, a Strategy Analytics report showed that Android had 81.3% of the global *smartphone* market share, compared to 13.4% for Apple, 4.1% for Microsoft and 1% for Blackberry.[11] Android devices now include smartphones, tablets, e-readers, robots, jet engines, NASA satellites, game consoles, refrigerators, televisions, cameras, health-care

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9. `http://developers.facebook.com/opensource`.
10. `http://www.technobuffalo.com/2013/04/16/google-daily-android-activations-1-5-million/`.
11. `http://blogs.strategyanalytics.com/WSS/post/2013/10/31/Android-Captures-Record-81-Percent-Share-of-Global-Smartphone-Shipments-in-Q3-2013.aspx`.

devices, smartwatches, automobile in-vehicle infotainment systems (for controlling the radio, GPS, phone calls, thermostat, etc.) and more.[12]

Android smartphones include the functionality of a mobile phone, Internet client (for web browsing and Internet communication), MP3 player, gaming console, digital camera and more. These handheld devices feature full-color *multitouch screens* which allow you to control the device with *gestures* involving one touch or multiple simultaneous touches. You can download apps directly onto your Android device through Google Play and other app marketplaces. At the time of this writing, there were over one million apps in **Google Play**, and the number is growing quickly.[13]

We present an introduction to Android app development in our textbook, *Android How to Program, Second Edition,* and in our professional book, *Android for Programmers: An App-Driven Approach, Second Edition*. After you learn Java, you'll find it straightforward to begin developing and running Android apps. You can place your apps on Google Play (`play.google.com`), and if they're successful, you may even be able to launch a business. Just remember—Facebook, Microsoft and Dell were all launched from college dorm rooms.

1.7 Programming Languages

In this section, we comment briefly on several popular programming languages (Fig. 1.5). In the next section, we introduce Java.

Programming language	Description
Fortran	Fortran (FORmula TRANslator) was developed by IBM Corporation in the mid-1950s for scientific and engineering applications that require complex mathematical computations. It's still widely used, and its latest versions support object-oriented programming.
COBOL	COBOL (COmmon Business Oriented Language) was developed in the late 1950s by computer manufacturers, the U.S. government and industrial computer users based on a language developed by Grace Hopper, a U.S. Navy Rear Admiral and computer scientist who also advocated for the international standardization of programming languages. COBOL is still widely used for commercial applications that require precise and efficient manipulation of large amounts of data. Its latest version supports object-oriented programming.
Pascal	Research in the 1960s resulted in *structured programming*—a disciplined approach to writing programs that are clearer, easier to test and debug and easier to modify than large programs produced with previous techniques. One result of this research was the development in 1971 of the Pascal programming language, which was designed for teaching structured programming and was popular in college courses for several decades.

Fig. 1.5 | Some other programming languages. (Part 1 of 3.)

12. `http://www.businessweek.com/articles/2013-05-29/behind-the-internet-of-things-is-android-and-its-everywhere`.
13. `http://en.wikipedia.org/wiki/Google_Play`.

Programming language	Description
Ada	Ada, based on Pascal, was developed under the sponsorship of the U.S. Department of Defense (DOD) during the 1970s and early 1980s. The DOD wanted a single language that would fill most of its needs. The Ada language was named after Lady Ada Lovelace, daughter of the poet Lord Byron. She's credited with writing the world's first computer program in the early 1800s (for the Analytical Engine mechanical computing device designed by Charles Babbage). Ada also supports object-oriented programming.
Basic	Basic was developed in the 1960s at Dartmouth College to familiarize novices with programming techniques. Many of its latest versions are object oriented.
C	C was developed in the early 1970s by Dennis Ritchie at Bell Laboratories. It initially became widely known as the UNIX operating system's development language. Today, most of the code for general-purpose operating systems is written in C or C++.
C++	C++, which is based on C, was developed by Bjarne Stroustrup in the early 1980s at Bell Laboratories. C++ provides several features that "spruce up" the C language, but more important, it provides capabilities for object-oriented programming.
Objective-C	Objective-C is another object-oriented language based on C. It was developed in the early 1980s and later acquired by NeXT, which in turn was acquired by Apple. It has become the key programming language for the OS X operating system and all iOS-powered devices (such as iPods, iPhones and iPads).
Visual Basic	Microsoft's Visual Basic language was introduced in the early 1990s to simplify the development of Microsoft Windows applications. Its latest versions support object-oriented programming.
Visual C#	Microsoft's three object-oriented primary programming languages are Visual Basic (based on the original Basic), Visual C++ (based on C++) and Visual C# (based on C++ and Java, and developed for integrating the Internet and the web into computer applications).
PHP	PHP, an object-oriented, open-source scripting language supported by a community of users and developers, is used by millions of websites. PHP is platform independent—implementations exist for all major UNIX, Linux, Mac and Windows operating systems. PHP also supports many databases, including the popular open-source MySQL.
Perl	Perl (Practical Extraction and Report Language), one of the most widely used object-oriented scripting languages for web programming, was developed in 1987 by Larry Wall. It features rich text-processing capabilities.
Python	Python, another object-oriented scripting language, was released publicly in 1991. Developed by Guido van Rossum of the National Research Institute for Mathematics and Computer Science in Amsterdam (CWI), Python draws heavily from Modula-3—a systems programming language. Python is "extensible"—it can be extended through classes and programming interfaces.
JavaScript	JavaScript is the most widely used scripting language. It's primarily used to add dynamic behavior to web pages—for example, animations and improved interactivity with the user. It's provided with all major web browsers.

Fig. 1.5 | Some other programming languages. (Part 2 of 3.)

Programming language	Description
Ruby on Rails	Ruby, created in the mid-1990s, is an open-source, object-oriented programming language with a simple syntax that's similar to Python. Ruby on Rails combines the scripting language Ruby with the Rails web application framework developed by 37Signals. Their book, *Getting Real* (`gettingreal.37signals.com/toc.php`), is a must read for web developers. Many Ruby on Rails developers have reported productivity gains over other languages when developing database-intensive web applications.

Fig. 1.5 | Some other programming languages. (Part 3 of 3.)

1.8 Java

The microprocessor revolution's most important contribution to date is that it enabled the development of personal computers. Microprocessors have had a profound impact in intelligent consumer-electronic devices. Recognizing this, Sun Microsystems in 1991 funded an internal corporate research project led by James Gosling, which resulted in a C++-based object-oriented programming language that Sun called Java.

A key goal of Java is to be able to write programs that will run on a great variety of computer systems and computer-controlled devices. This is sometimes called "write once, run anywhere."

The web exploded in popularity in 1993, and Sun saw the potential of using Java to add *dynamic content*, such as interactivity and animations, to web pages. Java drew the attention of the business community because of the phenomenal interest in the web. Java is now used to develop large-scale enterprise applications, to enhance the functionality of web servers (the computers that provide the content we see in our web browsers), to provide applications for consumer devices (cell phones, smartphones, television set-top boxes and more) and for many other purposes. Java is also the key language for developing Android smartphone and tablet apps. Sun Microsystems was acquired by Oracle in 2010.

Java Class Libraries

You can create each class and method you need to form your Java programs. However, most Java programmers take advantage of the rich collections of existing classes and methods in the **Java class libraries**, also known as the **Java APIs (Application Programming Interfaces)**.

Performance Tip 1.1

Using Java API classes and methods instead of writing your own versions can improve program performance, because they're carefully written to perform efficiently. This also shortens program development time.

1.9 A Typical Java Development Environment

We now explain the steps to create and execute a Java application. Normally there are five phases—edit, compile, load, verify and execute. We discuss them in the context of the Java

SE 8 Development Kit (JDK). See the *Before You Begin* section *for information on downloading and installing the JDK on Windows, Linux and OS X.*

Phase 1: Creating a Program

Phase 1 consists of editing a file with an *editor program*, normally known simply as an *editor* (Fig. 1.6). Using the editor, you type a Java program (typically referred to as **source code**), make any necessary corrections and save it on a secondary storage device, such as your hard drive. Java source code files are given a name ending with the **`.java` extension**, indicating that the file contains Java source code.

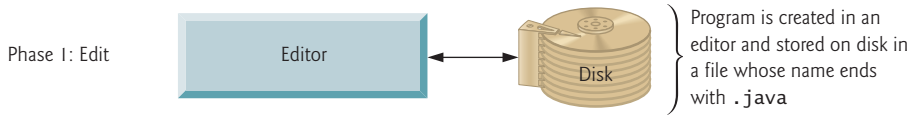

Fig. 1.6 | Typical Java development environment—editing phase.

Two editors widely used on Linux systems are `vi` and `emacs`. Windows provides **Notepad**. OS X provides **TextEdit**. Many freeware and shareware editors are also available online, including Notepad++ (`notepad-plus-plus.org`), EditPlus (`www.editplus.com`), TextPad (`www.textpad.com`) and jEdit (`www.jedit.org`).

Integrated development environments (IDEs) provide tools that support the software development process, such as editors, debuggers for locating **logic errors** (errors that cause programs to execute incorrectly) and more. There are many popular Java IDEs, including:

- Eclipse (`www.eclipse.org`)
- NetBeans (`www.netbeans.org`)
- IntelliJ IDEA (`www.jetbrains.com`)

On the book's website at

```
www.deitel.com/books/jhtp10
```

we provide Dive-Into® videos that show you how to executes this book's Java applications and how to develop new Java applications with Eclipse, NetBeans and IntelliJ IDEA.

Phase 2: Compiling a Java Program into Bytecodes

In Phase 2, you use the command **`javac`** (the **Java compiler**) to **compile** a program (Fig. 1.7). For example, to compile a program called `Welcome.java`, you'd type

```
javac Welcome.java
```

in your system's command window (i.e., the **Command Prompt** in Windows, the **Terminal** application in OS X) or a Linux shell (also called **Terminal** in some versions of Linux). If the program compiles, the compiler produces a **`.class`** file called `Welcome.class` that contains the compiled version. IDEs typically provide a menu item, such as **Build** or **Make**, that invokes the `javac` command for you. If the compiler detects errors, you'll need to go back to Phase 1 and correct them. In Chapter 2, we'll say more about the kinds of errors the compiler can detect.

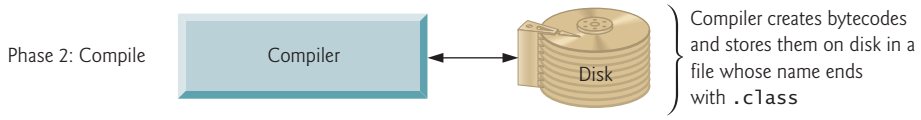

Fig. 1.7 | Typical Java development environment—compilation phase.

The Java compiler translates Java source code into **bytecodes** that represent the tasks to execute in the execution phase (Phase 5). The **Java Virtual Machine** (**JVM**)—a part of the JDK and the foundation of the Java platform—executes bytecodes. A **virtual machine** (**VM**) is a software application that simulates a computer but hides the underlying operating system and hardware from the programs that interact with it. If the same VM is implemented on many computer platforms, applications written for that type of VM can be used on all those platforms. The JVM is one of the most widely used virtual machines. Microsoft's .NET uses a similar virtual-machine architecture.

Unlike machine-language instructions, which are *platform dependent* (that is, dependent on specific computer hardware), bytecode instructions are *platform independent*. So, Java's bytecodes are **portable**—without recompiling the source code, the same bytecode instructions can execute on any platform containing a JVM that understands the version of Java in which the bytecodes were compiled. The JVM is invoked by the **java** command. For example, to execute a Java application called `Welcome`, you'd type the command

```
java Welcome
```

in a command window to invoke the JVM, which would then initiate the steps necessary to execute the application. This begins Phase 3. IDEs typically provide a menu item, such as **Run**, that invokes the `java` command for you.

Phase 3: Loading a Program into Memory

In Phase 3, the JVM places the program in memory to execute it—this is known as **loading** (Fig. 1.8). The JVM's **class loader** takes the `.class` files containing the program's bytecodes and transfers them to primary memory. It also loads any of the `.class` files provided by Java that your program uses. The `.class` files can be loaded from a disk on your system or over a network (e.g., your local college or company network, or the Internet).

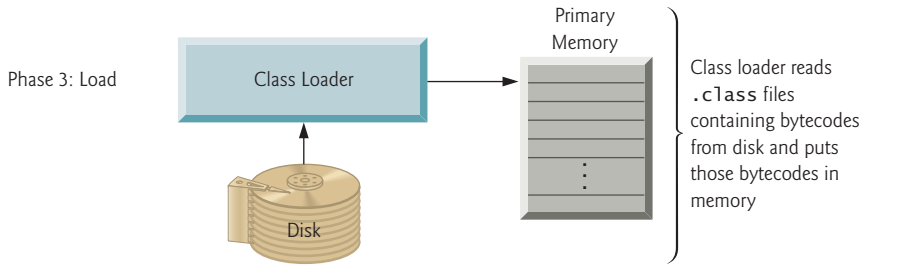

Fig. 1.8 | Typical Java development environment—loading phase.

Phase 4: Bytecode Verification

In Phase 4, as the classes are loaded, the **bytecode verifier** examines their bytecodes to ensure that they're valid and do not violate Java's security restrictions (Fig. 1.9). Java enforces strong security to make sure that Java programs arriving over the network do not damage your files or your system (as computer viruses and worms might).

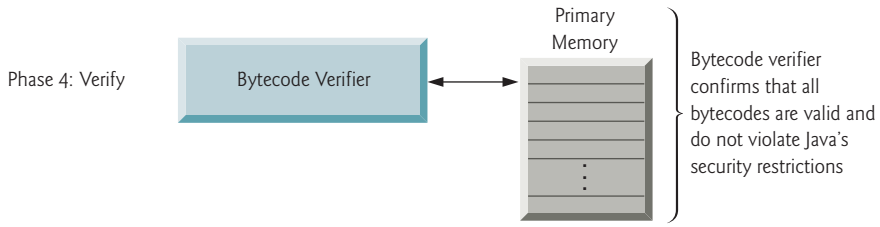

Fig. 1.9 | Typical Java development environment—verification phase.

Phase 5: Execution

In Phase 5, the JVM **executes** the program's bytecodes, thus performing the actions specified by the program (Fig. 1.10). In early Java versions, the JVM was simply an *interpreter* for Java bytecodes. Most Java programs would execute slowly, because the JVM would interpret and execute one bytecode at a time. Some modern computer architectures can execute several instructions in parallel. Today's JVMs typically execute bytecodes using a combination of interpretation and so-called **just-in-time (JIT) compilation**. In this process, the JVM analyzes the bytecodes as they're interpreted, searching for *hot spots*—parts of the bytecodes that execute frequently. For these parts, a **just-in-time (JIT) compiler**, such as Oracle's **Java HotSpot™ compiler**, translates the bytecodes into the underlying computer's machine language. When the JVM encounters these compiled parts again, the faster machine-language code executes. Thus Java programs actually go through *two* compilation phases—one in which source code is translated into bytecodes (for portability across JVMs on different computer platforms) and a second in which, during execution, the *bytecodes* are translated into *machine language* for the actual computer on which the program executes.

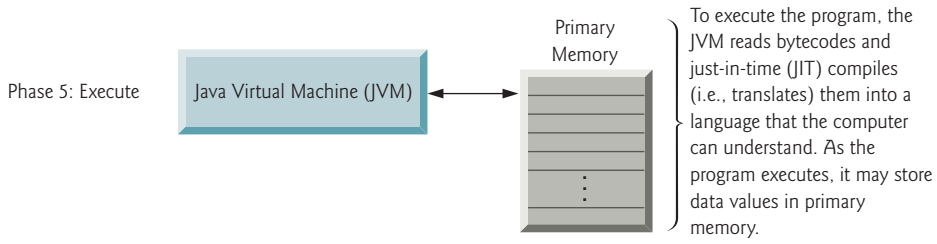

Fig. 1.10 | Typical Java development environment—execution phase.

Problems That May Occur at Execution Time

Programs might not work on the first try. Each of the preceding phases can fail because of various errors that we'll discuss throughout this book. For example, an executing program

might try to divide by zero (an illegal operation for whole-number arithmetic in Java). This would cause the Java program to display an error message. If this occurred, you'd have to return to the edit phase, make the necessary corrections and proceed through the remaining phases again to determine that the corrections fixed the problem(s). [*Note:* Most programs in Java input or output data. When we say that a program displays a message, we normally mean that it displays that message on your computer's screen. Messages and other data may be output to other devices, such as disks and hardcopy printers, or even to a network for transmission to other computers.]

Common Programming Error 1.1

Errors such as division by zero occur as a program runs, so they're called runtime errors or execution-time errors. Fatal runtime errors cause programs to terminate immediately without having successfully performed their jobs. Nonfatal runtime errors allow programs to run to completion, often producing incorrect results.

1.10 Test-Driving a Java Application

In this section, you'll run and interact with your first Java application. The **Painter** application, which you'll build over the course of several exercises, allows you to drag the mouse to "paint." The elements and functionality you see here are typical of what you'll learn to program in this book. Using the **Painter**'s graphical user interface (GUI), you can control the drawing color, the shape to draw (line, rectangle or oval) and whether the shape is filled with the drawing color. You can also undo the last shape you added to the drawing or clear the entire drawing. [*Note:* We use fonts to distinguish between features. Our convention is to emphasize screen features like titles and menus (e.g., the **File** menu) in a semibold **sans-serif Helvetica** font and to emphasize nonscreen elements, such as file names, program code or input (e.g., `ProgramName.java`), in a `sans-serif Lucida` font.]

The steps in this section show you how to execute the **Painter** app from a **Command Prompt** (Windows), **Terminal** (OS X) or shell (Linux) window on your system. Throughout the book, we'll refer to these windows simply as *command windows*. Perform the following steps to use the **Painter** application to draw a smiley face:

1. ***Checking your setup.*** Read the Before You Begin section to confirm that you've set up Java properly on your computer, that you've copied the book's examples to your hard drive and that you know how to open a command window on your system.
2. ***Changing to the completed application's directory.*** Open a command window and use the `cd` command to change to the directory (also called a *folder*) for the **Painter** application. We assume that the book's examples are located in `C:\examples` on Windows or in your user account's `Documents/examples` folder on Linux/OS X. On Windows type `cd C:\examples\ch01\painter`, then press *Enter*. On Linux/OS X, type `cd ~/Documents/examples/ch01/painter`, then press *Enter*.
3. ***Running the* Painter *application.*** Recall that the `java` command, followed by the name of the application's `.class` file (in this case, `Painter`), executes the application. Type the command `java Painter` and press *Enter* to execute the app. Figure 1.11 shows the app running on Windows, Linux and OS X, respectively—we shortened the windows to save space.

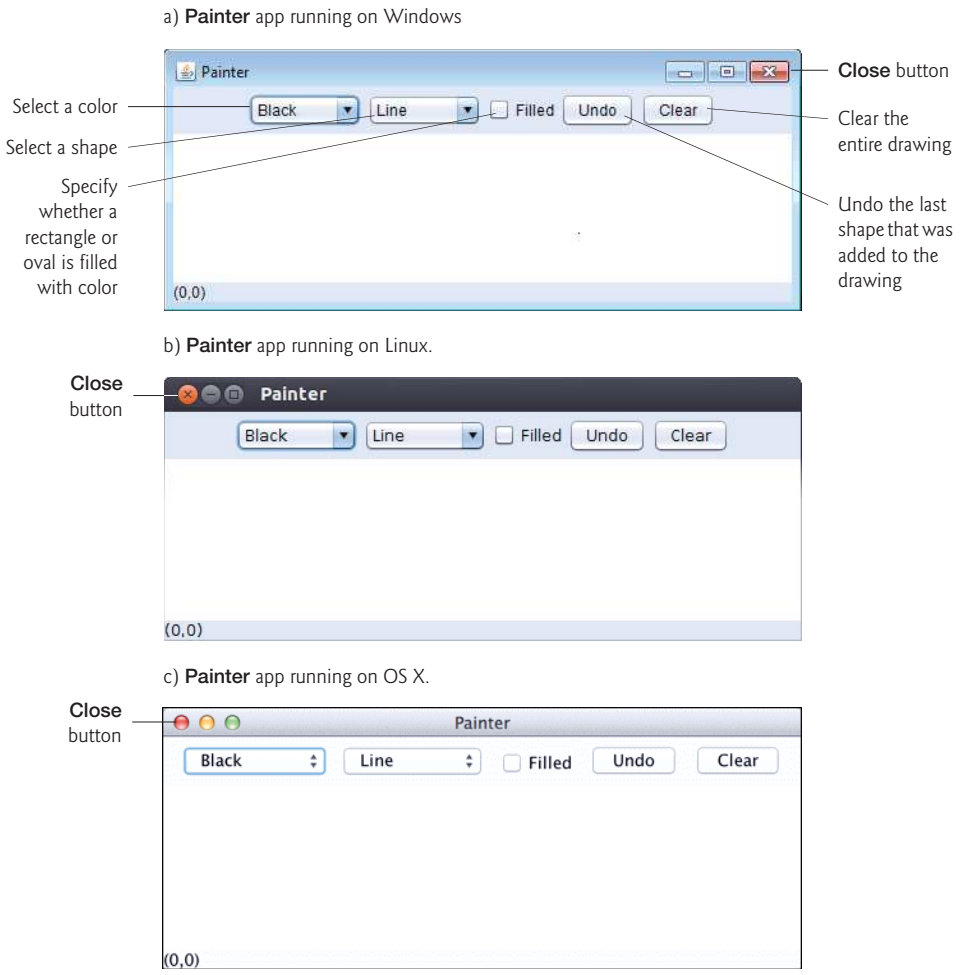

Fig. 1.11 | **Painter** app executing in Windows 7, Linux and OS X.

[*Note:* Java commands are *case sensitive*—that is, uppercase letters are different from lowercase letters. It's important to type the name of this application as `Painter` with a capital `P`. Otherwise, the application will *not* execute. Specifying the `.class` extension when using the `java` command results in an error. Also, if you receive the error message, "`Exception in thread "main" java.lang.NoClassDefFoundError: Painter`," your system has a `CLASSPATH` problem. Please refer to the Before You Begin section for instructions to help you fix this problem.]

4. ***Drawing a filled yellow oval for the face.*** Select **Yellow** as the drawing color, **Oval** as the shape and check the **Filled** checkbox, then drag the mouse to draw a large oval (Fig. 1.12).

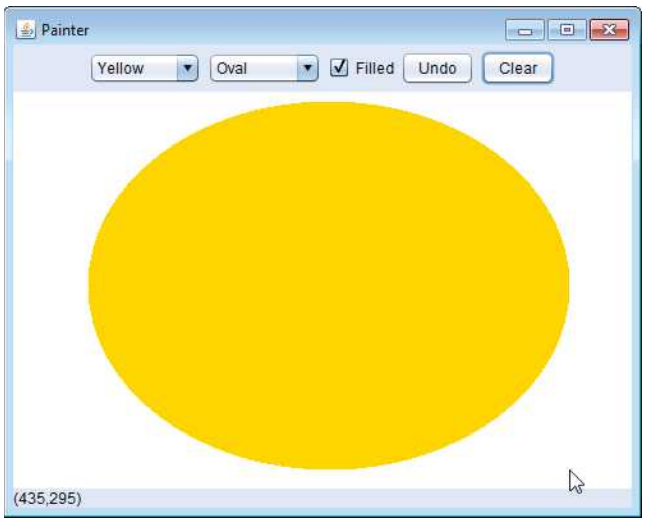

Fig. 1.12 | Drawing a filled yellow oval for the face.

5. *Drawing blue eyes.* Select **Blue** as the drawing color, then draw two small ovals as the eyes (Fig. 1.13).

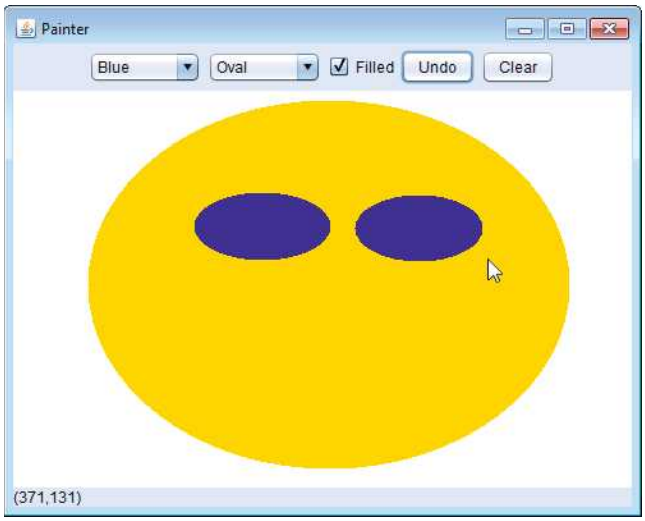

Fig. 1.13 | Drawing blue eyes.

6. *Drawing black eyebrows and a nose.* Select **Black** as the drawing color and **Line** as the shape, then draw eyebrows and a nose (Fig. 1.14). Lines do not have fill, so leaving the **Filled** checkbox checked has no effect when drawing lines.

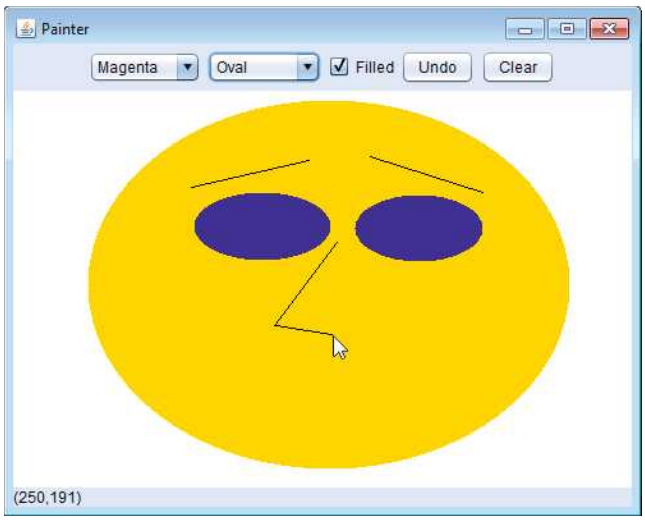

Fig. 1.14 | Drawing black eyebrows and a nose.

7. ***Drawing a magenta mouth.*** Select **Magenta** as the drawing color and **Oval** as the shape, then draw a mouth (Fig. 1.15).

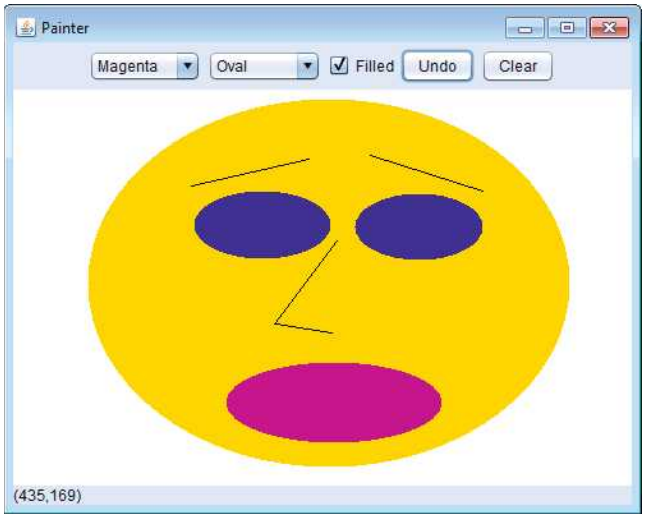

Fig. 1.15 | Drawing a magenta mouth.

8. ***Drawing a yellow oval on the mouth to make a smile.*** Select **Yellow** as the drawing color, then draw an oval to change the magenta oval into a smile (Fig. 1.16).

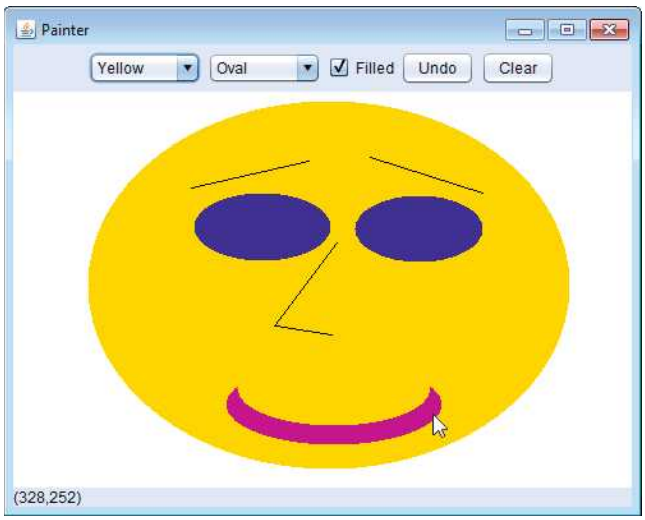

Fig. 1.16 | Drawing a yellow oval on the mouth to make a smile.

9. *Exiting the* **Painter** *application*. To exit the **Painter** application, click the **Close** button (in the window's upper-right corner on Windows and the upper-left corner on Linux and OS X). Closing the window causes the **Painter** application to terminate.

1.11 Internet and World Wide Web

In the late 1960s, ARPA—the Advanced Research Projects Agency of the United States Department of Defense—rolled out plans for networking the main computer systems of approximately a dozen ARPA-funded universities and research institutions. The computers were to be connected with communications lines operating at speeds on the order of 50,000 bits per second, a stunning rate at a time when most people (of the few who even had networking access) were connecting over telephone lines to computers at a rate of 110 bits per second. Academic research was about to take a giant leap forward. ARPA proceeded to implement what quickly became known as the ARPANET, the precursor to today's **Internet**. Today's fastest Internet speeds are on the order of billions of bits per second with trillion-bit-per-second speeds on the horizon!

Things worked out differently from the original plan. Although the ARPANET enabled researchers to network their computers, its main benefit proved to be the capability for quick and easy communication via what came to be known as electronic mail (e-mail). This is true even on today's Internet, with e-mail, instant messaging, file transfer and social media such as Facebook and Twitter enabling billions of people worldwide to communicate quickly and easily.

The protocol (set of rules) for communicating over the ARPANET became known as the **Transmission Control Protocol (TCP)**. TCP ensured that messages, consisting of sequentially numbered pieces called *packets*, were properly routed from sender to receiver, arrived intact and were assembled in the correct order.

1.11.1 The Internet: A Network of Networks

In parallel with the early evolution of the Internet, organizations worldwide were implementing their own networks for both intraorganization (that is, within an organization) and interorganization (that is, between organizations) communication. A huge variety of networking hardware and software appeared. One challenge was to enable these different networks to communicate with each other. ARPA accomplished this by developing the Internet Protocol (IP), which created a true "network of networks," the current architecture of the Internet. The combined set of protocols is now called **TCP/IP**.

Businesses rapidly realized that by using the Internet, they could improve their operations and offer new and better services to their clients. Companies started spending large amounts of money to develop and enhance their Internet presence. This generated fierce competition among communications carriers and hardware and software suppliers to meet the increased infrastructure demand. As a result, **bandwidth**—the information-carrying capacity of communications lines—on the Internet has increased tremendously, while hardware costs have plummeted.

1.11.2 The World Wide Web: Making the Internet User-Friendly

The **World Wide Web** (simply called "the web") is a collection of hardware and software associated with the Internet that allows computer users to locate and view multimedia-based documents (documents with various combinations of text, graphics, animations, audios and videos) on almost any subject. The introduction of the web was a relatively recent event. In 1989, Tim Berners-Lee of CERN (the European Organization for Nuclear Research) began to develop a technology for sharing information via "hyperlinked" text documents. Berners-Lee called his invention the **HyperText Markup Language (HTML)**. He also wrote communication protocols such as **HyperText Transfer Protocol (HTTP)** to form the backbone of his new hypertext information system, which he referred to as the World Wide Web.

In 1994, Berners-Lee founded an organization, called the **World Wide Web Consortium** (**W3C**, www.w3.org), devoted to developing web technologies. One of the W3C's primary goals is to make the web universally accessible to everyone regardless of disabilities, language or culture. In this book, you'll use Java to build web-based applications.

1.11.3 Web Services and Mashups

In online Chapter 32, we include a substantial treatment of web services (Fig. 1.17). The applications-development methodology of *mashups* enables you to rapidly develop powerful software applications by combining (often free) complementary web services and other forms of information feeds. One of the first mashups combined the real-estate listings provided by `www.craigslist.org` with the mapping capabilities of *Google Maps* to offer maps that showed the locations of homes for sale or rent in a given area.

Web services source	How it's used
Google Maps	Mapping services
Twitter	Microblogging

Fig. 1.17 | Some popular web services (`www.programmableweb.com/apis/directory/1?sort=mashups`). (Part 1 of 2.)

Web services source	How it's used
YouTube	Video search
Facebook	Social networking
Instagram	Photo sharing
Foursquare	Mobile check-in
LinkedIn	Social networking for business
Groupon	Social commerce
Netflix	Movie rentals
eBay	Internet auctions
Wikipedia	Collaborative encyclopedia
PayPal	Payments
Last.fm	Internet radio
Amazon eCommerce	Shopping for books and many other products
Salesforce.com	Customer Relationship Management (CRM)
Skype	Internet telephony
Microsoft Bing	Search
Flickr	Photo sharing
Zillow	Real-estate pricing
Yahoo Search	Search
WeatherBug	Weather

Fig. 1.17 | Some popular web services (`www.programmableweb.com/apis/directory/1?sort=mashups`). (Part 2 of 2.)

1.11.4 Ajax

Ajax helps Internet-based applications perform like desktop applications—a difficult task, given that such applications suffer transmission delays as data is shuttled back and forth between your computer and server computers on the Internet. Using Ajax, applications like Google Maps have achieved excellent performance and approach the look-and-feel of desktop applications. Although we don't discuss "raw" Ajax programming (which is quite complex) in this text, we do show in online Chapter 31 how to build Ajax-enabled applications using JavaServer Faces (JSF) Ajax-enabled components.

1.11.5 The Internet of Things

The Internet is no longer just a network of computers—it's an **Internet of Things**. A *thing* is any object with an IP address and the ability to send data automatically over a network—e.g., a car with a transponder for paying tolls, a heart monitor implanted in a human, a smart meter that reports energy usage, mobile apps that can track your movement and location, and smart thermostats that adjust room temperatures based on weather forecasts and activity in the home. You'll use IP addresses to build networked applications in online Chapter 28.

1.12 Software Technologies

Figure 1.18 lists a number of buzzwords that you'll hear in the software development community. We've created Resource Centers on most of these topics, with more on the way.

Technology	Description
Agile software development	**Agile software development** is a set of methodologies that try to get software implemented faster and using fewer resources. Check out the Agile Alliance (`www.agilealliance.org`) and the Agile Manifesto (`www.agilemanifesto.org`).
Refactoring	**Refactoring** involves reworking programs to make them clearer and easier to maintain while preserving their correctness and functionality. It's widely employed with agile development methodologies. Many IDEs contain built-in *refactoring tools* to do major portions of the reworking automatically.
Design patterns	**Design patterns** are proven architectures for constructing flexible and maintainable object-oriented software. The field of design patterns tries to enumerate those recurring patterns, encouraging software designers to *reuse* them to develop better-quality software using less time, money and effort. We discuss Java design patterns in the online Appendix N.
LAMP	**LAMP** is an acronym for the open-source technologies that many developers use to build web applications—it stands for *Linux*, *Apache*, *MySQL* and *PHP* (or *Perl* or *Python*—two other scripting languages). MySQL is an open-source database management system. PHP is the most popular open-source server-side "scripting" language for developing web applications. Apache is the most popular web server software. The equivalent for Windows development is WAMP—*Windows*, Apache, MySQL and PHP.
Software as a Service (SaaS)	Software has generally been viewed as a product; most software still is offered this way. If you want to run an application, you buy a software package from a software vendor—often a CD, DVD or web download. You then install that software on your computer and run it as needed. As new versions appear, you upgrade your software, often at considerable cost in time and money. This process can become cumbersome for organizations that must maintain tens of thousands of systems on a diverse array of computer equipment. With **Software as a Service (SaaS)**, the software runs on servers elsewhere on the Internet. When that server is updated, all clients worldwide see the new capabilities—no local installation is needed. You access the service through a browser. Browsers are quite portable, so you can run the same applications on a wide variety of computers from anywhere in the world. Salesforce.com, Google, and Microsoft's Office Live and Windows Live all offer SaaS.
Platform as a Service (PaaS)	**Platform as a Service (PaaS)** provides a computing platform for developing and running applications as a service over the web, rather than installing the tools on your computer. Some PaaS providers are Google App Engine, Amazon EC2 and Windows Azure™.

Fig. 1.18 | Software technologies. (Part 1 of 2.)

Technology	Description
Cloud computing	SaaS and PaaS are examples of **cloud computing**. You can use software and data stored in the "cloud"—i.e., accessed on remote computers (or servers) via the Internet and available on demand—rather than having it stored on your desktop, notebook computer or mobile device. This allows you to increase or decrease computing resources to meet your needs at any given time, which is more cost effective than purchasing hardware to provide enough storage and processing power to meet occasional peak demands. Cloud computing also saves money by shifting the burden of managing these apps to the service provider.
Software Development Kit (SDK)	**Software Development Kits (SDKs)** include the tools and documentation developers use to program applications. For example, you'll use the Java Development Kit (JDK) to build and run Java applications.

Fig. 1.18 | Software technologies. (Part 2 of 2.)

Software is complex. Large, real-world software applications can take many months or even years to design and implement. When large software products are under development, they typically are made available to the user communities as a series of releases, each more complete and polished than the last (Fig. 1.19).

Version	Description
Alpha	*Alpha* software is the earliest release of a software product that's still under active development. Alpha versions are often buggy, incomplete and unstable and are released to a relatively small number of developers for testing new features, getting early feedback, etc.
Beta	*Beta* versions are released to a larger number of developers later in the development process after most major bugs have been fixed and new features are nearly complete. Beta software is more stable, but still subject to change.
Release candidates	*Release candidates* are generally *feature complete*, (mostly) bug free and ready for use by the community, which provides a diverse testing environment—the software is used on different systems, with varying constraints and for a variety of purposes.
Final release	Any bugs that appear in the release candidate are corrected, and eventually the final product is released to the general public. Software companies often distribute incremental updates over the Internet.
Continuous beta	Software that's developed using this approach (for example, Google search or Gmail) generally does not have version numbers. It's hosted in the *cloud* (not installed on your computer) and is constantly evolving so that users always have the latest version.

Fig. 1.19 | Software product-release terminology.

1.13 Keeping Up-to-Date with Information Technologies

Figure 1.20 lists key technical and business publications that will help you stay up-to-date with the latest news and trends and technology. You can also find a growing list of Internet- and web-related Resource Centers at `www.deitel.com/ResourceCenters.html`.

Publication	URL
AllThingsD	`allthingsd.com`
Bloomberg BusinessWeek	`www.businessweek.com`
CNET	`news.cnet.com`
Communications of the ACM	`cacm.acm.org`
Computerworld	`www.computerworld.com`
Engadget	`www.engadget.com`
eWeek	`www.eweek.com`
Fast Company	`www.fastcompany.com/`
Fortune	`money.cnn.com/magazines/fortune`
GigaOM	`gigaom.com`
Hacker News	`news.ycombinator.com`
IEEE Computer Magazine	`www.computer.org/portal/web/computingnow/computer`
InfoWorld	`www.infoworld.com`
Mashable	`mashable.com`
PCWorld	`www.pcworld.com`
SD Times	`www.sdtimes.com`
Slashdot	`slashdot.org/`
Technology Review	`technologyreview.com`
Techcrunch	`techcrunch.com`
The Next Web	`thenextweb.com`
The Verge	`www.theverge.com`
Wired	`www.wired.com`

Fig. 1.20 | Technical and business publications.

Self-Review Exercises

1.1 Fill in the blanks in each of the following statements:

a) Computers process data under the control of sets of instructions called _____.

b) The key logical units of the computer are the _____, _____, _____, _____, _____ and _____.

c) The three types of languages discussed in the chapter are _____, _____ and _____.

d) The programs that translate high-level language programs into machine language are called _____.

e) _____ is an operating system for mobile devices based on the Linux kernel and Java.
f) _____ software is generally feature complete, (supposedly) bug free and ready for use by the community.
g) The Wii Remote, as well as many smartphones, use a(n) _____ which allows the device to respond to motion.

1.2 Fill in the blanks in each of the following sentences about the Java environment:
a) The _____ command from the JDK executes a Java application.
b) The _____ command from the JDK compiles a Java program.
c) A Java source code file must end with the _____ file extension.
d) When a Java program is compiled, the file produced by the compiler ends with the _____ file extension.
e) The file produced by the Java compiler contains _____ that are executed by the Java Virtual Machine.

1.3 Fill in the blanks in each of the following statements (based on Section 1.5):
a) Objects enable the design practice of _____—although they may know how to communicate with one another across well-defined interfaces, they normally are not allowed to know how other objects are implemented.
b) Java programmers concentrate on creating _____, which contain fields and the set of methods that manipulate those fields and provide services to clients.
c) The process of analyzing and designing a system from an object-oriented point of view is called _____.
d) A new class of objects can be created conveniently by _____ —the new class (called the subclass) starts with the characteristics of an existing class (called the superclass), possibly customizing them and adding unique characteristics of its own.
e) _____ is a graphical language that allows people who design software systems to use an industry-standard notation to represent them.
f) The size, shape, color and weight of an object are considered _____ of the object's class.

Answers to Self-Review Exercises

1.1 a) programs. b) input unit, output unit, memory unit, central processing unit, arithmetic and logic unit, secondary storage unit. c) machine languages, assembly languages, high-level languages. d) compilers. e) Android. f) Release candidate. g) accelerometer.

1.2 a) `java`. b) `javac`. c) `.java`. d) `.class`. e) bytecodes.

1.3 a) information hiding. b) classes. c) object-oriented analysis and design (OOAD). d) inheritance. e) The Unified Modeling Language (UML). f) attributes.

Exercises

1.4 Fill in the blanks in each of the following statements:
a) The logical unit that receives information from outside the computer for use by the computer is the _____.
b) The process of instructing the computer to solve a problem is called _____.
c) _____ is a type of computer language that uses Englishlike abbreviations for machine-language instructions.
d) _____ is a logical unit that sends information which has already been processed by the computer to various devices so that it may be used outside the computer.
e) _____ and _____ are logical units of the computer that retain information.
f) _____ is a logical unit of the computer that performs calculations.
g) _____ is a logical unit of the computer that makes logical decisions.

h) _____ languages are most convenient to the programmer for writing programs quickly and easily.
i) The only language a computer can directly understand is that computer's _____.
j) _____ is a logical unit of the computer that coordinates the activities of all the other logical units.

1.5 Fill in the blanks in each of the following statements:
a) The _____ programming language is now used to develop large-scale enterprise applications, to enhance the functionality of web servers, to provide applications for consumer devices and for many other purposes.
b) _____ initially became widely known as the development language of the UNIX operating system.
c) The _____ ensures that messages, consisting of sequentially numbered pieces called bytes, were properly routed from sender to receiver, arrived intact and were assembled in the correct order.
d) The _____ programming language was developed by Bjarne Stroustrup in the early 1980s at Bell Laboratories.

1.6 Fill in the blanks in each of the following statements:
a) Java programs normally go through five phases—_____, _____, _____, _____ and _____.
b) A(n) _____ provides many tools that support the software development process, such as editors for writing and editing programs, debuggers for locating logic errors in programs, and many other features.
c) The command `java` invokes the _____, which executes Java programs.
d) A(n) _____ is a software application that simulates a computer, but hides the underlying operating system and hardware from the programs that interact with it.
e) The _____ takes the `.class` files containing the program's bytecodes and transfers them to primary memory.
f) The _____ examines bytecodes to ensure that they're valid.

1.7 Explain the two compilation phases of Java programs.

1.8 One of the world's most common objects is a wrist watch. Discuss how each of the following terms and concepts applies to the notion of a watch: object, attributes, behaviors, class, inheritance (consider, for example, an alarm clock), modeling, messages, encapsulation, interface and information hiding.

Making a Difference

Throughout the book we've included Making a Difference exercises in which you'll be asked to work on problems that really matter to individuals, communities, countries and the world. For more information about worldwide organizations working to make a difference, and for related programming project ideas, visit our Making a Difference Resource Center at `www.deitel.com/makingadifference`.

1.9 ***(Test-Drive: Carbon Footprint Calculator)*** Some scientists believe that carbon emissions, especially from the burning of fossil fuels, contribute significantly to global warming and that this can be combatted if individuals take steps to limit their use of carbon-based fuels. Organizations and individuals are increasingly concerned about their "carbon footprints." Websites such as TerraPass

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http://www.terrapass.com/carbon-footprint-calculator/
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and Carbon Footprint

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http://www.carbonfootprint.com/calculator.aspx
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provide carbon-footprint calculators. Test-drive these calculators to determine your carbon footprint. Exercises in later chapters will ask you to program your own carbon-footprint calculator. To prepare for this, use the web to research the formulas for calculating carbon footprints.

1.10 *(Test-Drive: Body Mass Index Calculator)* Obesity causes significant increases in illnesses such as diabetes and heart disease. To determine whether a person is overweight or obese, you can use a measure called the body mass index (BMI). The United States Department of Health and Human Services provides a BMI calculator at `http://www.nhlbi.nih.gov/guidelines/obesity/BMI/bmicalc.htm`. Use it to calculate your own BMI. A forthcoming exercise will ask you to program your own BMI calculator. To prepare for this, use the web to research the formulas for calculating BMI.

1.11 *(Attributes of Hybrid Vehicles)* In this chapter you learned some basics of classes. Now you'll "flesh out" aspects of a class called "Hybrid Vehicle." Hybrid vehicles are becoming increasingly popular, because they often get much better mileage than purely gasoline-powered vehicles. Browse the web and study the features of four or five of today's popular hybrid cars, then list as many of their hybrid-related attributes as you can. Some common attributes include city-miles-per-gallon and highway-miles-per-gallon. Also list the attributes of the batteries (type, weight, etc.).

1.12 *(Gender Neutrality)* Many people want to eliminate sexism in all forms of communication. You've been asked to create a program that can process a paragraph of text and replace gender-specific words with gender-neutral ones. Assuming that you've been given a list of gender-specific words and their gender-neutral replacements (e.g., replace both "wife" and "husband" with "spouse," "man" and "woman" with "person," "daughter" and "son" with "child"), explain the procedure you'd use to read through a paragraph of text and manually perform these replacements. How might your procedure generate a strange term like "woperchild?" You'll soon learn that a more formal term for "procedure" is "algorithm," and that an algorithm specifies the steps to be performed and the order in which to perform them. We'll show how to develop algorithms then convert them to Java programs which can be run on computers.