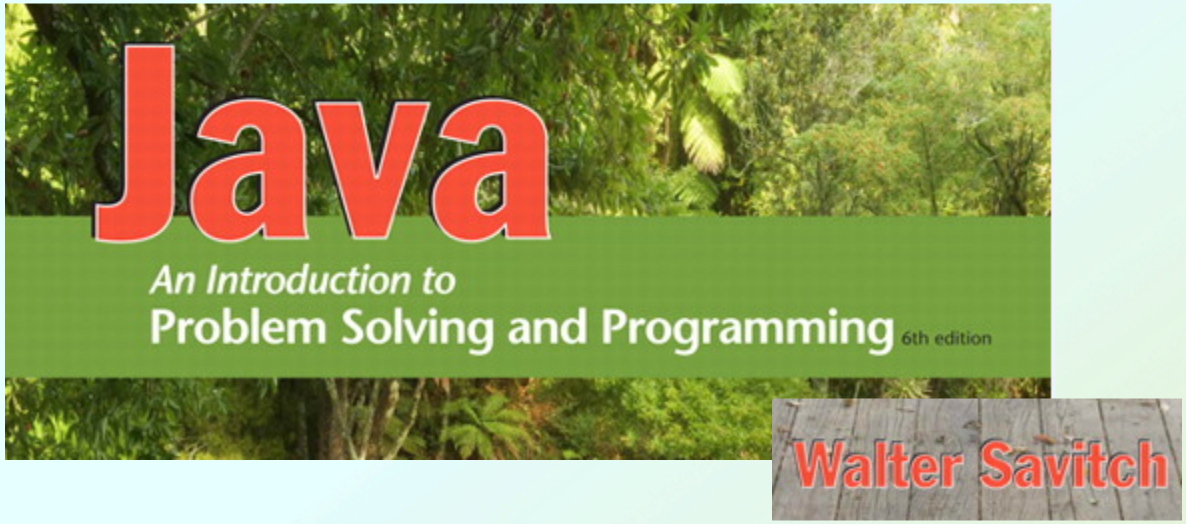


# Introduction to Computers and Java

Chapter 1

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# Objectives

- Overview of computer hardware and software
- Introduce program design and object-oriented programming
- Overview of the Java programming language
- (Optional) introduce applets and graphics basics

# Outline

- Computer Basics
- Designing Programs
- A Sip of Java
- Graphics Supplement

# Computer Basics: Outline

- Hardware and Memory
- Programs
- Programming Languages and Compilers
- Java Byte-Code
- Graphics Supplement

# Hardware and Software

- Computer systems consist of *hardware* and *software.*
  - Hardware includes the *tangible* parts of computer systems.
  - Software includes *programs* - sets of instructions for the computer to follow.
- Familiarity with hardware basics helps us understand software.

# Hardware and Memory

- Most modern computers have similar components including
  - Input devices (keyboard, mouse, etc.)
  - Output devices (display screen, printer, etc.)
  - A processor
  - Two kinds of memory (main memory and auxiliary memory).

# The Processor

- Also called the *CPU* (central processing unit) or the *chip* (e.g. Pentium processor)
- The processor **processes** a program's instructions.
- It can process only very simple instructions.
- The power of computing comes from speed and program intricacy.

# Memory

- Memory holds
  - programs
  - data for the computer to process
  - the results of intermediate processing.
- Two kinds of memory
  - main memory
  - auxiliary memory

# Main memory

- Working memory used to store
  - The current program
  - The data the program is using
  - The results of intermediate calculations
- Usually measured in gigabytes (e.g. 8 gigabytes of RAM)
  - RAM is short for *random access memory*
  - A *byte* is a quantity of memory

# Auxiliary Memory

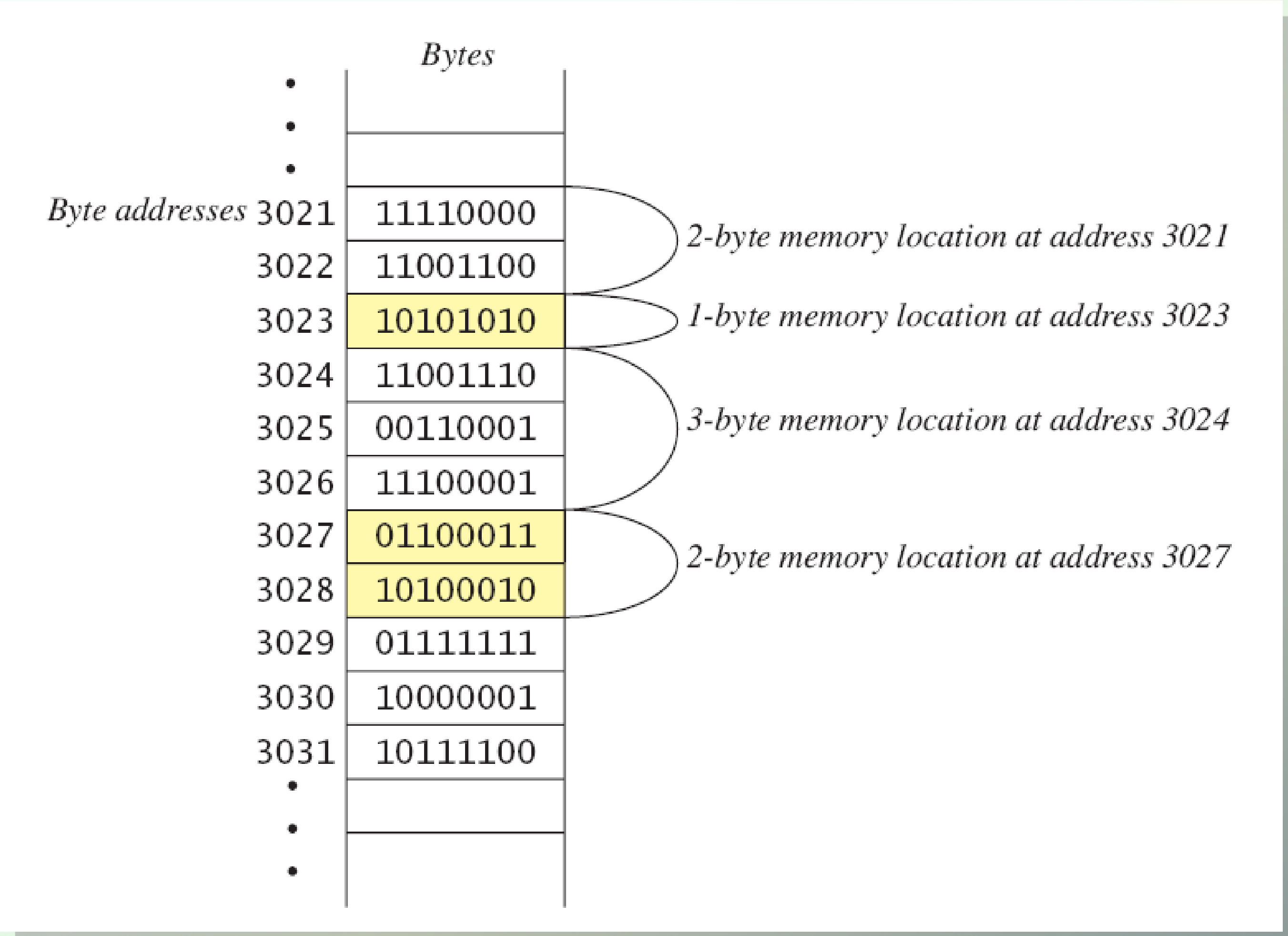
- Also called *secondary memory*
- Disk drives, CDs, DVDs, flash drives, etc.
- More or less permanent (nonvolatile)
- Usually measured in gigabytes (e.g. 50 gigabyte hard drive)

# Bits, Bytes, and Addresses

- A *bit* is a digit with a value of either 0 or 1.
- A *byte* consists of 8 bits.
- Each byte in main memory resides at a numbered location called its *address.*

# Main Memory

- Figure 1.1



# Storing Data

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

# Files

- Large groups of bytes in auxiliary memory are called *files.*
- Files have names.
- Files are organized into groups called *directories* or *folders.*
- Java programs are stored in files.
- Programs files are copied from auxiliary memory to main memory in order to be run.

# 0s and 1s

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

# Programs

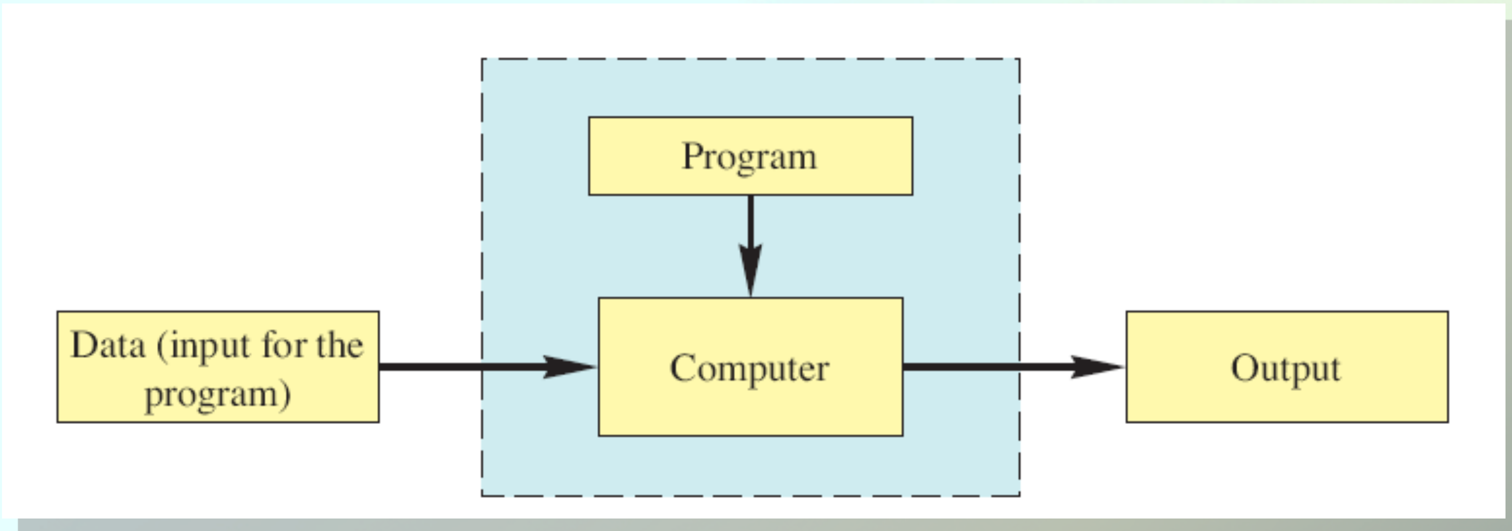
- A *program* is a set of instructions for a computer to follow.
- We use programs almost daily (email, word processors, video games, bank ATMs, etc.).
- Following the instructions is called *running* or *executing* the program.

# Input and Output

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

# Running a Program

- Figure 1.2




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

# The Operating System

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

# Programming Languages

- *High-level languages* are relatively easy to use
  - Java, C#, C++, Visual Basic, Python, Ruby.
- Unfortunately, computer hardware does not understand high-level languages.
  - Therefore, a high-level language program must be translated into a *low-level language.*

# Compilers

- A *compiler* translates a program from a high-level language to a low-level language the computer can run.
- You *compile* a program by running the compiler on the high-level-language version of the program called the *source program.*
- Compilers produce *machine-* or *assembly-language* programs called *object programs.*

# Compilers

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

# Java Byte-Code

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

# Java Byte-Code

- A byte-code program is easy to translate into machine language for any particular computer.
- A program called an *interpreter* translates each byte-code instruction, executing the resulting machine-language instructions on the particular computer before translating the next byte-code instruction.
- Most Java programs today are executed using a Just-In-Time or *JIT* compiler in which byte-code is compiled as needed and stored for later reuse without needing to be re-compiled.

# Compiling, Interpreting, Running

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

# Portability

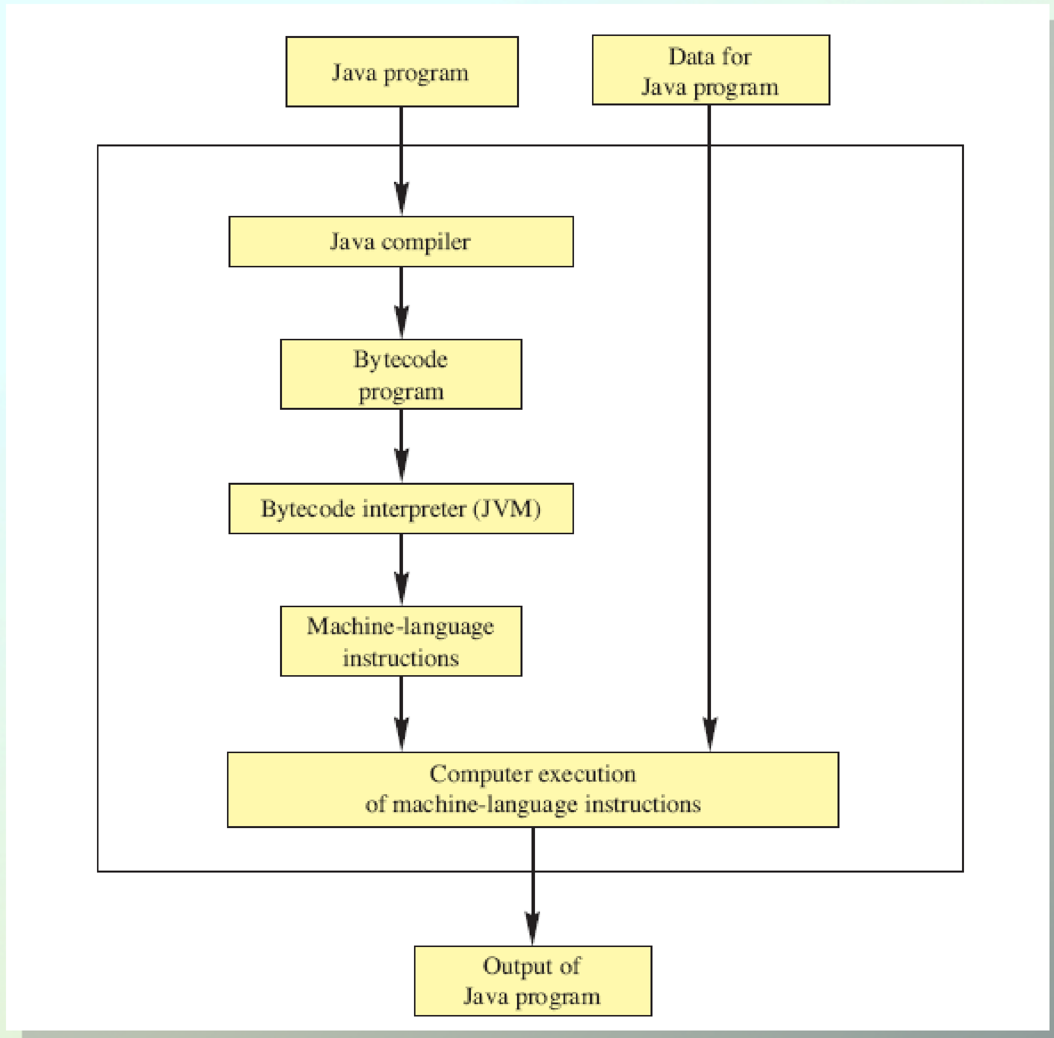
- After compiling a Java program into byte-code, that byte-code can be used on any computer with a byte-code interpreter and without a need to recompile.
- Byte-code can be sent over the Internet and used anywhere in the world.
- This makes Java suitable for Internet applications.

# Class Loader

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

# Compiling and Running a Program

- Figure 1.3



# A Sip of Java: Outline

- History of the Java Language
- Applications and Applets
- A First Java Application Program
- Writing, Compiling, and Running a Java Program

# History of Java

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

# History of Java

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

# Applications and Applets

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

# A First Java Application

- View sample program Listing 1.1
  - `class FirstProgram`

```
Hello out there.
I will add two numbers for you.
Enter two whole numbers on a line:
12 30
The sum of those two numbers is
42
```

Sample screen output

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# Some Terminology

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

# Some Terminology

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

# Printing to the Screen

```
System.out.println ("Whatever you want to print");
```

- `System.out` is an object for sending output to the screen.
- `println` is a method to print whatever is in parentheses to the screen.

# Printing to the Screen

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

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

# Compiling a Java Program or Class

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

# Compiling and Running

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

# Compiling and Running

- A Java program can involve any number of classes.
- The class to run will contain the words

```
public static void main(String[] args)
```

somewhere in the file

# Programming Basics: Outline

- Object-Oriented Programming
- Algorithms
- Testing and Debugging
- Software Reuse

# Programming

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

# Object-Oriented Programming

- Our world consists of *objects* (people, trees, cars, cities, airline reservations, etc.).
- Objects can perform *actions* which affect themselves and other objects in the world.
- Object-oriented programming (*OOP*) treats a program as a collection of objects that interact by means of actions.

# OOP Terminology

- Objects, appropriately, are called *objects.*
- Actions are called *methods.*
- Objects of the same kind have the same *type* and belong to the same *class.*
  - Objects within a class have a common set of methods and the same kinds of data
  - but each object can have it's own data values.

# OOP Design Principles

- OOP adheres to three primary design principles:
  - Encapsulation
  - Polymorphism
  - Inheritance

# Introduction to Encapsulation

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

# Accessibility Example

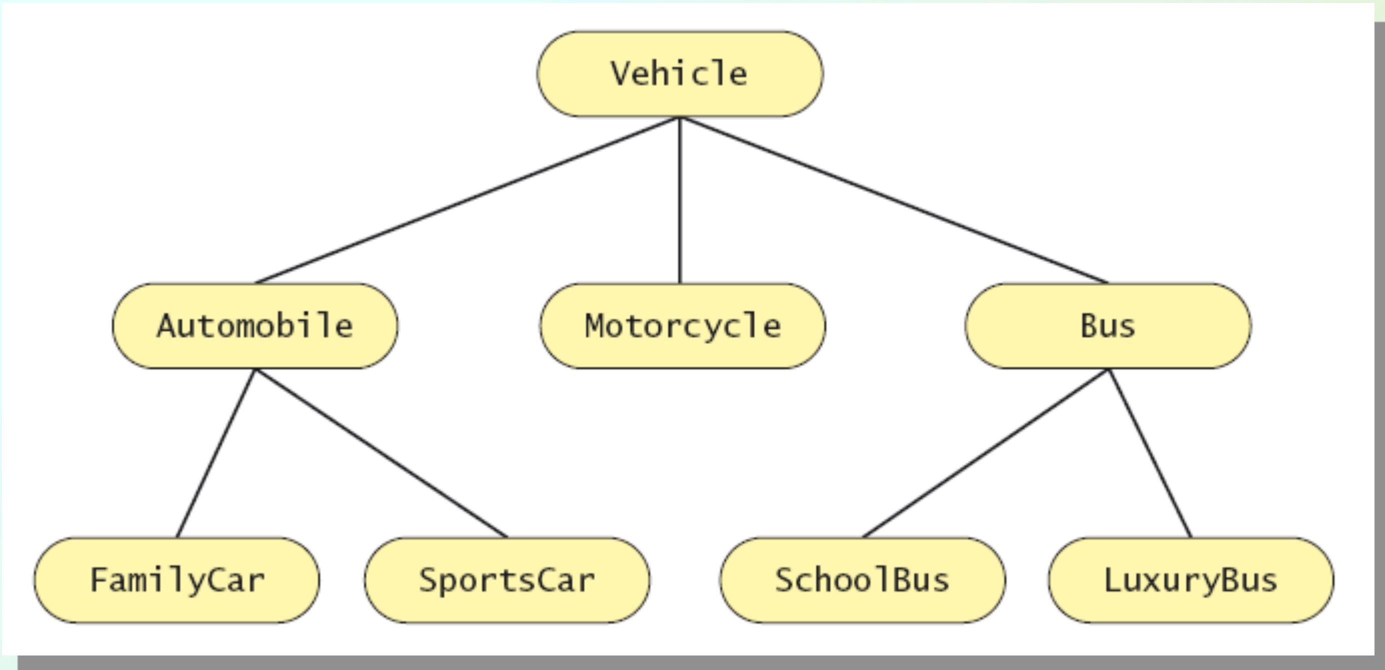
- An automobile consists of several parts and pieces and is capable of doing many useful things.
  - Awareness of the accelerator pedal, the brake pedal, and the steering wheel is important to the driver.
  - Awareness of the fuel injectors, the automatic braking control system, and the power steering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

# Introduction to Polymorphism

- From the Greek meaning "many forms"
- The same program instruction adapts to mean different things in different contexts.
  - A method name, used as an instruction, produces results that depend on the class of the object that used the method.
  - Everyday analogy: "take time to recreate" causes different people to do different activities
- More about polymorphism in Chapter 8

# Introduction to Inheritance

- Figure 1.4



# Introduction to Inheritance

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

# Inheritance in Java

- Used to organize classes
- “Inherited” characteristics do not need to be repeated.
- New characteristics are added.
- More about inheritance in chapter 8

# Algorithms

- By designing methods, programmers provide actions for objects to perform.
- An *algorithm* describes a means of performing an action.
- Once an algorithm is defined, expressing it in Java (or in another programming language) usually is easy.

# Algorithms

- An algorithm is a set of instructions for solving a problem.
- An algorithm must be expressed completely and precisely.
- Algorithms usually are expressed in English or in *pseudocode.*

# Example: Total Cost of All Items

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

# Reusable Components

- Most programs are created by combining components that exist already.
- Reusing components saves time and money.
- Reused components are likely to be better developed, and more reliable.
- New components should designed to be reusable by other applications.

# Testing and Debugging

- Eliminate errors by avoiding them in the first place.
  - Carefully design classes, algorithms and methods.
  - Carefully code everything into Java.
- Test your program with appropriate test cases (some where the answer is known), discover and fix any errors, then retest.

# Errors

- An error in a program is called a *bug.*
- Eliminating errors is called *debugging.*
- Three kinds or errors
  - Syntax errors
  - Runtime errors
  - Logic errors

# Syntax Errors

- Grammatical mistakes in a program
  - The grammatical rules for writing a program are very strict
- The compiler catches syntax errors and prints an error message.
- Example: using a period where a program expects a comma

# Runtime Errors

- Errors that are detected when your program is running, but not during compilation
- When the computer detects an error, it terminates the program and prints an error message.
- Example: attempting to divide by 0

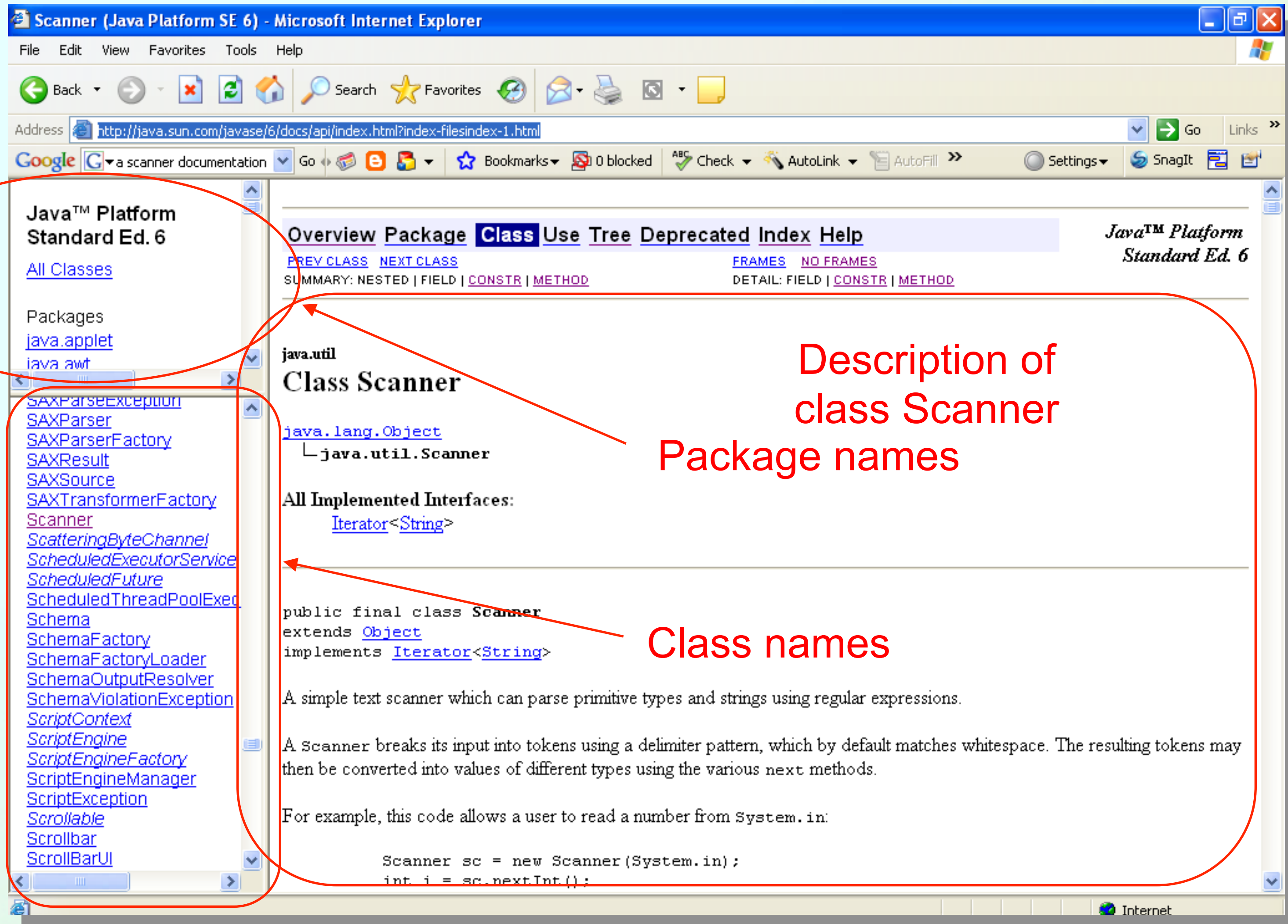
# Logic Errors

- Errors that are not detected during compilation or while running, but which cause the program to produce incorrect results
- Example: an attempt to calculate a Fahrenheit temperature from a Celsius temperature by multiplying by 9/5 and adding 23 instead of 32

# Software Reuse

- Programs not usually created entirely from scratch
- Most contain components which already exist
- Reusable classes are used
  - Design class objects which are general
  - Java provides many classes
  - Note documentation on following slide

# Software Reuse



# Graphics Supplement: Outline

- Objects and Methods
- A Sample Graphics Applet
- Drawing Ovals and Circles
- Size and Position of Figures
- Drawing Arcs
- Running and Closing an Applet

# Objects and Methods

- Recall that a method is an action which can be performed by an object.
- In this section, we'll name our object **`canvas`** and we'll use it to draw figures inside an applet display.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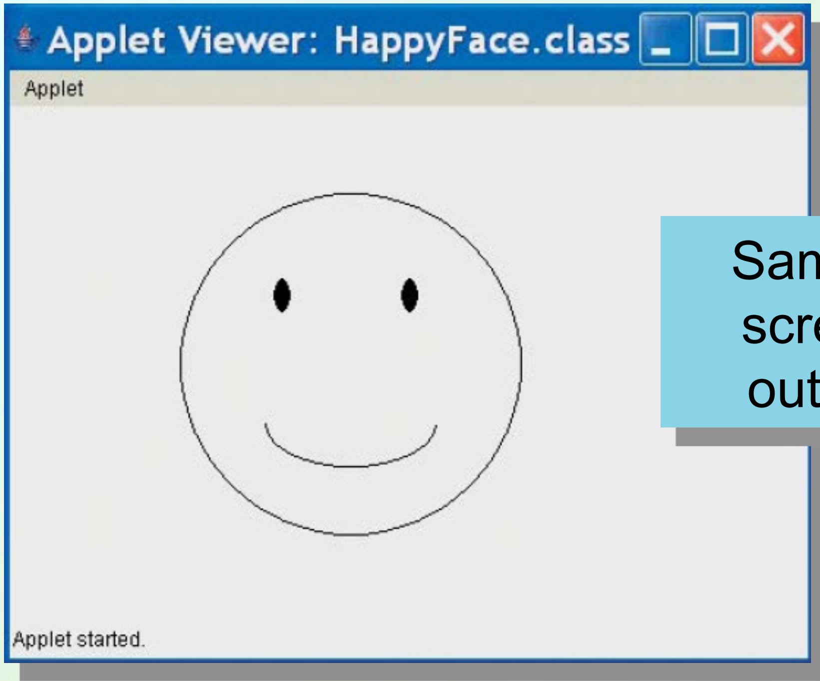
# A Sample Graphics Applet

- View sample program Listing 1.2
  - **`class HappyFace`** (page 31)




Sample screen output

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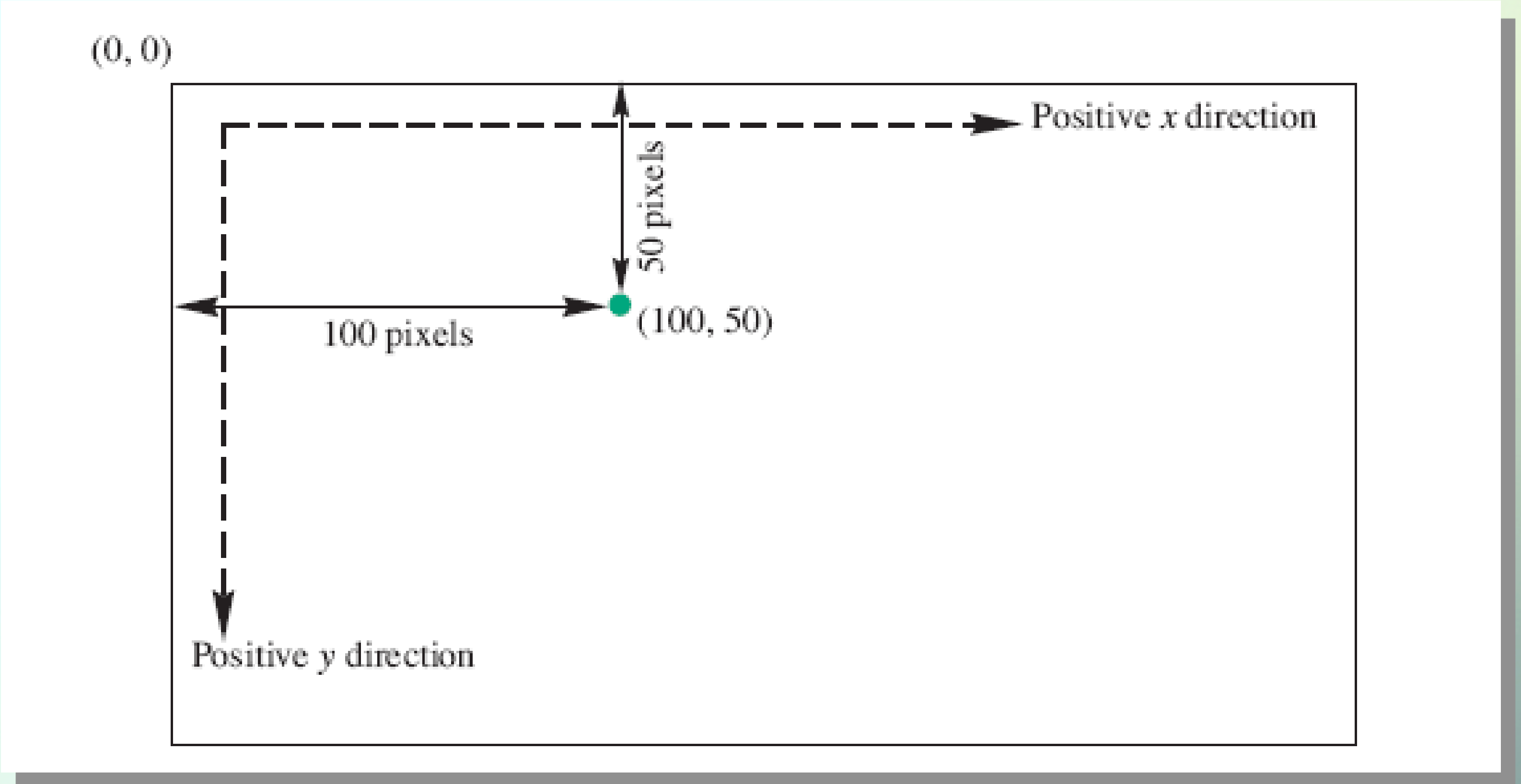
# A Sample Graphics Applet

- The `paint` method specifies what is drawn in the applet.
- The `paint` method is invoked automatically when the applet is run.

# Screen Coordinate System

- Figure 1.6



# Screen Coordinate System

- The x-coordinate the the number of pixels from the left.
- The y-coordinate is the number of pixels from the top (not from the bottom).

# Drawing Ovals and Circles

- The **`drawOval`** method draws only the outline of the oval.

```
canvas.drawOval(100, 50, 90, 50);
```

- The **`fillOval`** method draws a filled-in oval.

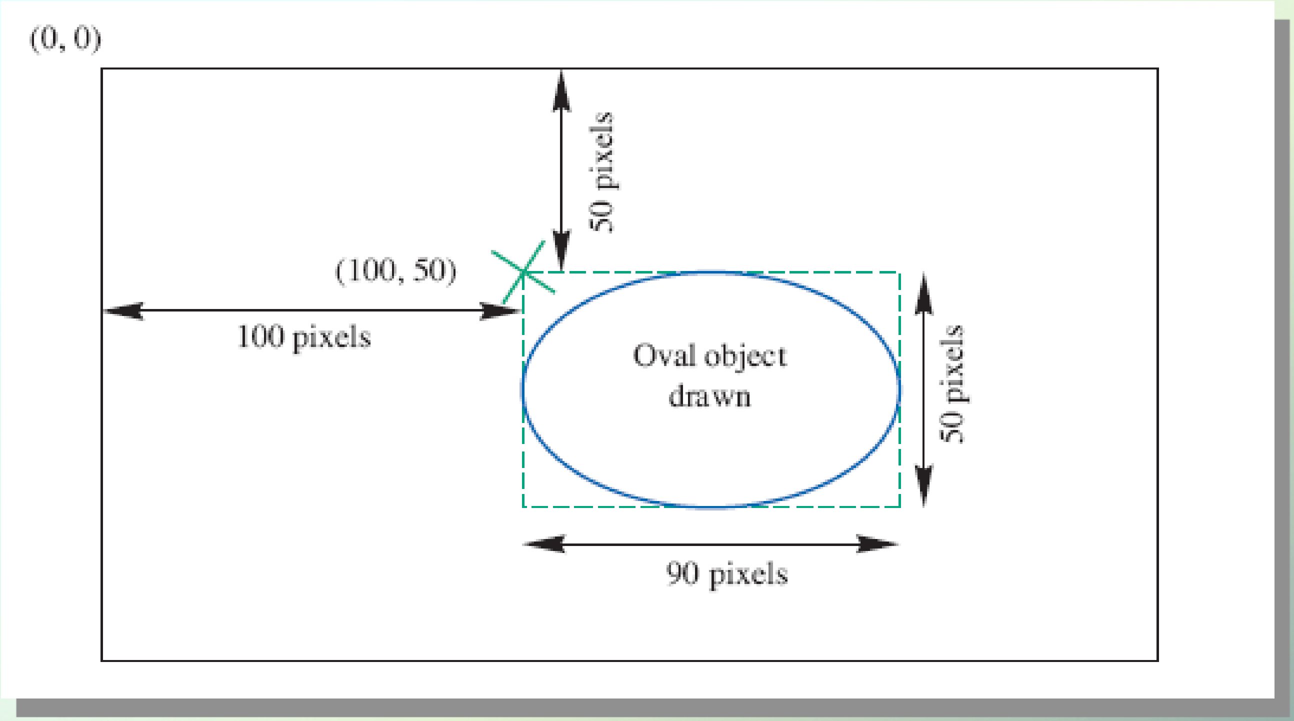
```
canvas.fillOval(100, 50, 90, 50);
```

# Drawing Ovals and Circles

- The `drawOval` and `fillOval` methods take four arguments.
  - The first two arguments indicate the upper-left corner of an invisible rectangle around the oval.
  - The last two arguments indicate the width and height of the oval.
- A circle is just an oval whose height is the same as its width.

# Drawing Ovals and Circles

- Figure1.7 The Oval Drawn by **`canvas.drawOval(100, 50, 90, 50)`**



# Size and Positions of Figures

- Sizes and positions in a Java applet are given in *pixels.*
- Think of the display surface for the applet as being a two-dimensional grid of individual pixels.

# Drawing Arcs

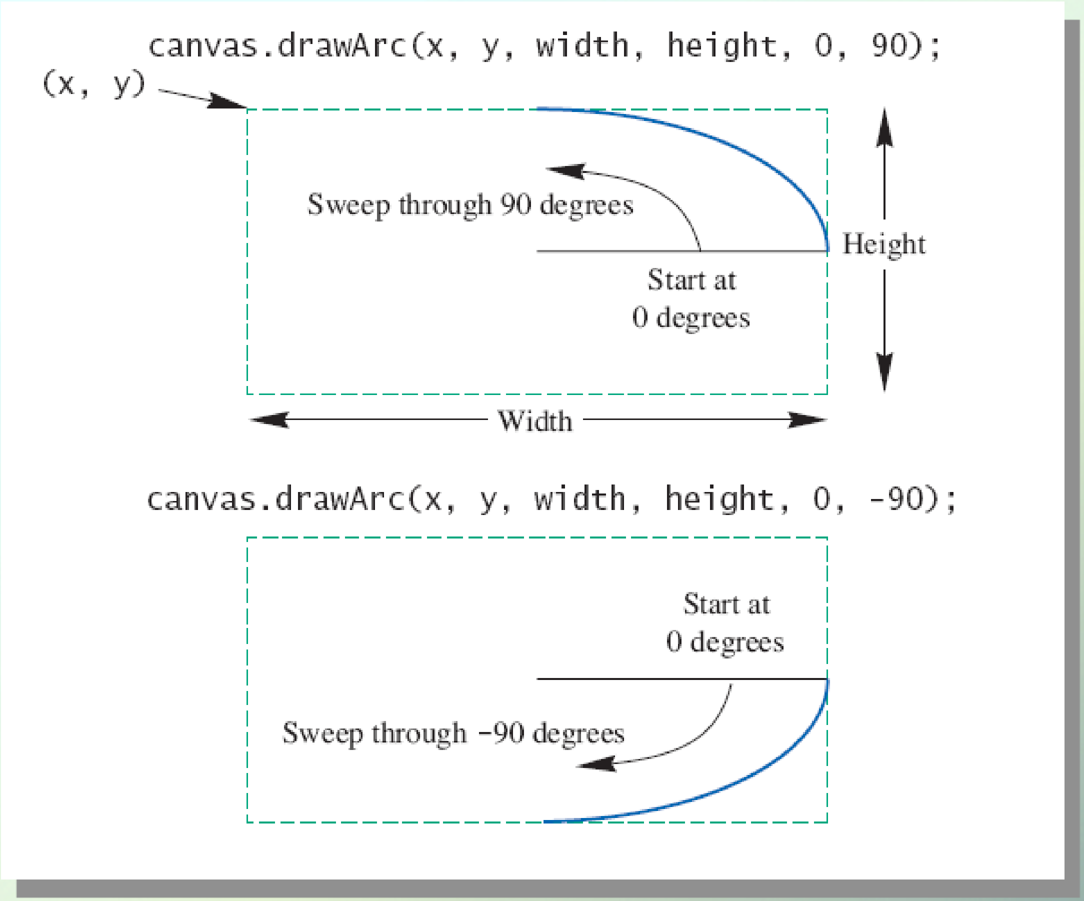
- The **`drawArc`** method draws an arc.

  **`drawArc(100, 50, 200, 200, 180, 180);`**

- The **`drawArc`** method takes six arguments.
  - The first four arguments are the same as the four arguments needed by the **`drawOval`** method.
  - The last two arguments indicate where the arc starts, and the number of degrees through which is sweeps.
  - 0 degrees is horizontal and to the right.

# Specifying an Arc

- Figure 1.8a

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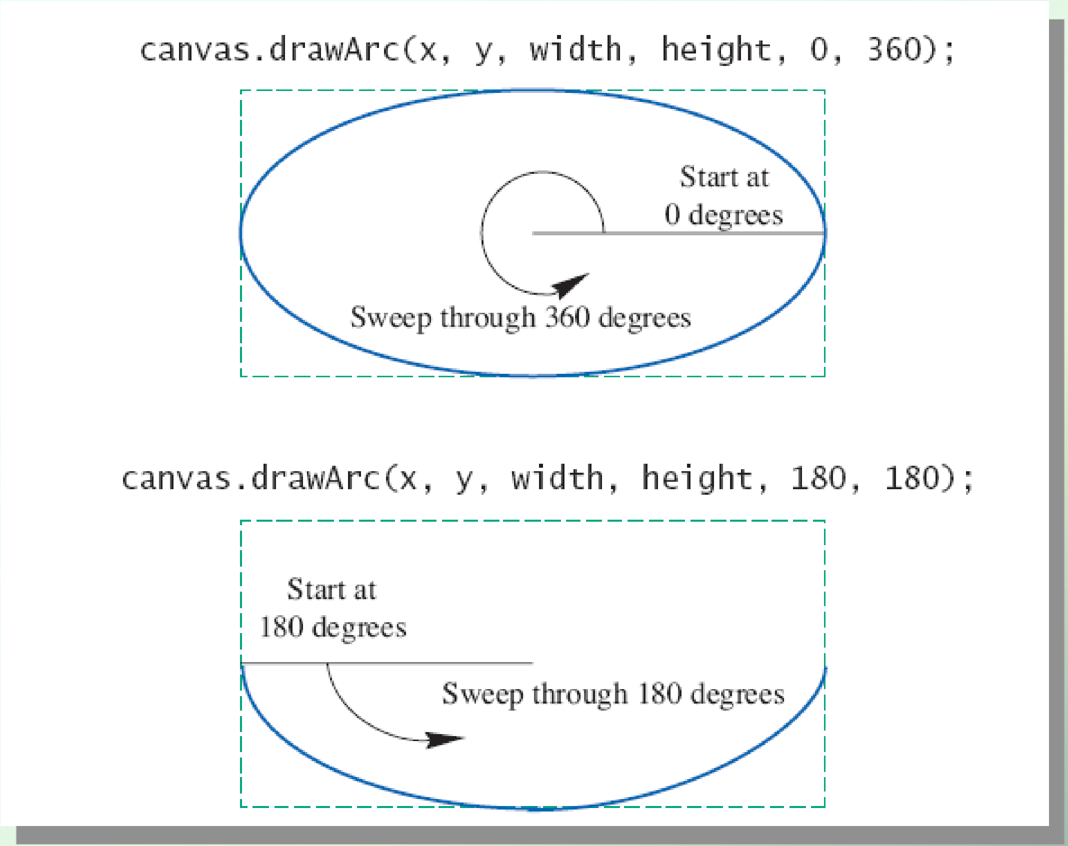
# Specifying an Arc

- Figure 1.8b



# Running and Closing an Applet

- There are two ways to run an applet:
  - Embed the applet in a Web page and run it
  - Use an *applet viewer* from the IDE.
- There are two corresponding ways to end an applet:
  - If you are running the applet from a web site, close the page or navigate away from the page
  - If you are using an applet viewer, use the mouse to click the close-window button.

# Summary

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