TECH LEARNING

LEARN ABOUT COMPUTER ENGINEERING

# DIGITAL NOTES ON JAVA PROGRAMMING

FOR

COMPUTER ENGG. STUDENT

PROVIEDED BY: -

SHAKTI RAJ SINGH, PROGRAMMER

# UNIT: - I

## Introduction

Everywhere you look in the real world you see objects—people, animals, plants, cars, planes, buildings, computers and so on. Humans think in terms of objects. Telephones, houses, traffic lights, microwave ovens and water coolers are just a few more objects. Computer programs, such

as the Java programs you'll read in this book interacting software objects.

We sometimes divide objects into two categories: animate and inanimate. Animate objects are ―alive‖ theyinmovesomearound andsensedothings. ―Inanimate objects, on the other hand, do not move on their own .Objects of both types, however, have some things in common. They all have attributes (e.g., size, shape, color and weight), and they all exhibit behaviors (e.g., a ball rolls, bounces, inflates and deflates; a baby cries, sleep crawls, walks and blinks; a car accelerates, brakes and turns; a towel absorbs water). We will study the kinds of attributes and behaviors that software objects have. Humans learn about existing objects by studying their attributes and observing their behaviors. Different objects can have similar attributes and can exhibit similar behaviors. Comparisons can be made, for example, between babies and adults and between humans and chimpanzees. Object-oriented design provides a natural and intuitive way to view the software design process—namely, modeling objects by their attributes and behaviors just as we describe real- world objects. OOD also models communication between objects. Just as people send messages to one another (e.g., a sergeant commands a soldier to stand at attention), objects also communicate via messages. A bank account object may receive a message to decrease its balance by a certain amount because the customer has withdrawn that amount of money.

**Object-Oriented:**

Although influenced by its predecessors, Java was not designed to be source-code compatible with any other language. This allowed the Java team the freedom to design with a blank slate. One outcome of this was a clean, usable, pragmatic approach to objects. Borrowing liberally from many seminal object-software environments of the last few decades, Java manages to strike

a balance between the purist's ―everything is of my way‖ model. The object model in Java i such as integers, are kept as high-performance non objects

OOD encapsulates (i.e., wraps) attributes and operations (behaviors) into objects, an object's attributes and operations are intim information hiding. This means that objects may know how to communicate with one another across well-defined interfaces, but normally they are not allowed to know how other objects are implemented, implementation details are hidden within the objects themselves. Wecan drive a car effectively, for instance, without knowing the details of how engines, transmissions, brakes and exhaust systems work internally—as long as we know how to use the accelerator pedal, the brake pedal, the wheel and so on. Information hiding, as we will see, is crucial to good software engineering.

Languages like Java are object oriented. Programming in such a language is called object-oriented programming (OOP), and it allows computer programmers to implement an object-oriented design as a working system. Languages like C, on the other hand, are procedural, so programming tends to be action oriented. In C, the unit of programming is the function. Groups of actions that perform some common task are formed into functions, and functions are grouped to form programs. In Java, the unit of programming is the class from which objects are eventually instantiated (created). Java classes contain methods (which implement operations and are similar to functions in C) as well as fields (which implement attributes).

Java programmers concentrate on creating classes. Each class contains fields, and the set of methods that manipulate the fields and provide services to clients (i.e., other classes that use the class). The programmer uses existing classes as the building blocks for constructing new classes. Classes are to objects as blueprints are to houses. Just as we can build many houses from one blueprint, we can instantiate (create) many objects from one class.
Classes can have relationships with other classes. For example, in an object-oriented design of a bank, the ―bank teller‖ class needs to relate ―safe‖ class, and so on. These relationships

Packaging software as classes makes it possible for future software systems to reuse the classes.
Groups of related classes are often packaged as reusable components. Just as realtors often say
that the three most important factors affect location, ‖ people in the software community affecting
the future of software development are ―reuse, classes when building new classes and programs
saves time and effort. Reuse also helps

programmers build more reliable and effective systems, because existing classes and components often have gone through extensive testing, debugging and performance tuning.

Indeed, with object technology, you can build much of the software you will need by combining classes, just as automobile manufacturers combine interchangeable parts. Each new class you create will have the potential to become a valuable software asset that you and other programmers can use to speed and enhance the quality of future software development efforts.

## NEED FOR OOP PARADIGM:

### Object-Oriented Programming:

Object-oriented programming is at the core of Java. In fact, all Java programs are object-oriented this isn't an option the way that it is Therefore, this chapter begins with a discussion of the theoretical aspects of OOP.

### Two Paradigms of Programming:

As you know, all computer programs consist of two elements: code and data. Furthermore,a program can be conceptually organized around its code or around its data. That is, some programs are writtenhappening‖aroundand―whatothersis are wri affected.‖ These are the two paradigms that g

The first way is called the process-oriented model. This approach characterizes a program as a series of linear steps (that is, code). The process-oriented model can be thought of as code acting on data. Procedural languages such as C employ this model to considerable success. Problems with this approach appear as programs grow larger and more complex. To manage increasing complexity, the second approach, called object-oriented programming, was conceived.

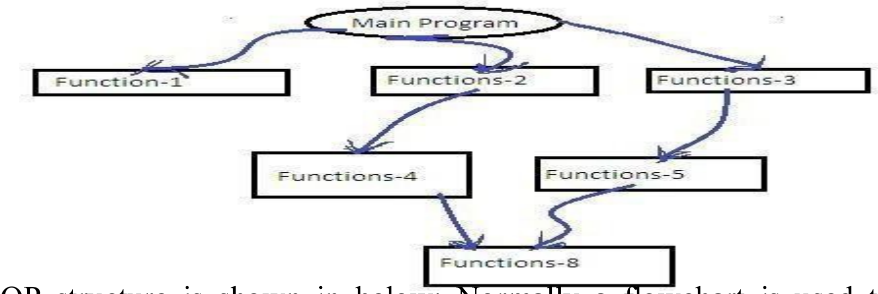
Object-oriented programming organizes a program around its data (that is, objects) and a set of well-defined interfaces to that data. An object-oriented program can be characterized as data controlling access to code. As you will see, by switching the controlling entity to data, you can achieve several organizational benefits.

### Procedure oriented Programming:

In this approach, the problem is always considered as a sequence of tasks to be done. A number of functions are written to accomplish these attention on data.

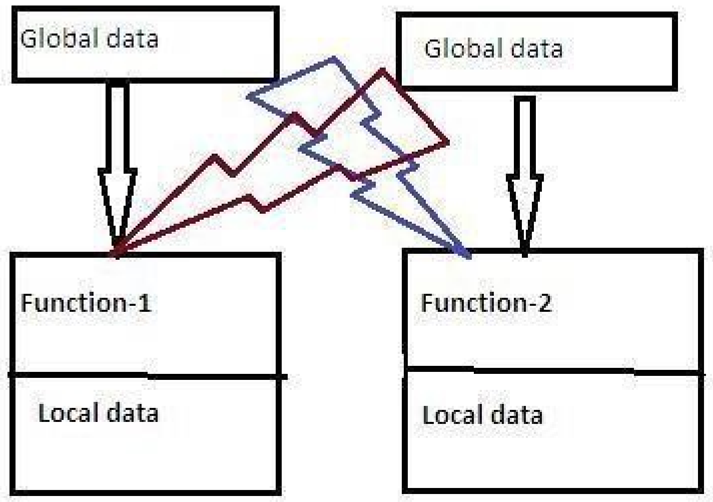
There are many high level languages like COBOL, FORTRAN, PASCAL, C used for conventional programming commonly known as POP.

POP basically consists of writing a list of instructions for the computer to follow, and organizing these instructions into groups known as functions.



A typical POP structure is shown in below: Normally a flowchart is used to organize these actions and represent the flow of control logically sequential flow from one to another. In a multi-function program, many important data items are placed as global so that they may be accessed by all the functions. Each function may have its own local data. Global data are more vulnerable to an in advent change by a function. In a large program it is very difficult to identify what data is used by which function. In case we need to revise an external data structure, we should also revise all the functions that access the data. This provides an opportunity for bugs to creep in.

Drawback: It does not model real world problems very well, because functions are action oriented and do not really corresponding to the elements of the problem.



**Characteristics of POP:**

- Emphasis is on doing actions.
- Large programs are divided into smaller programs known as functions.
- Most of the functions shared global data.
- Data move openly around the program from function to function.
- Functions transform data from one form to another.
- Employs top-down approach in program design.

**OOP:**

OOP allows us to decompose a problem into a number of entities called objects and then builds data and methods around these entities.

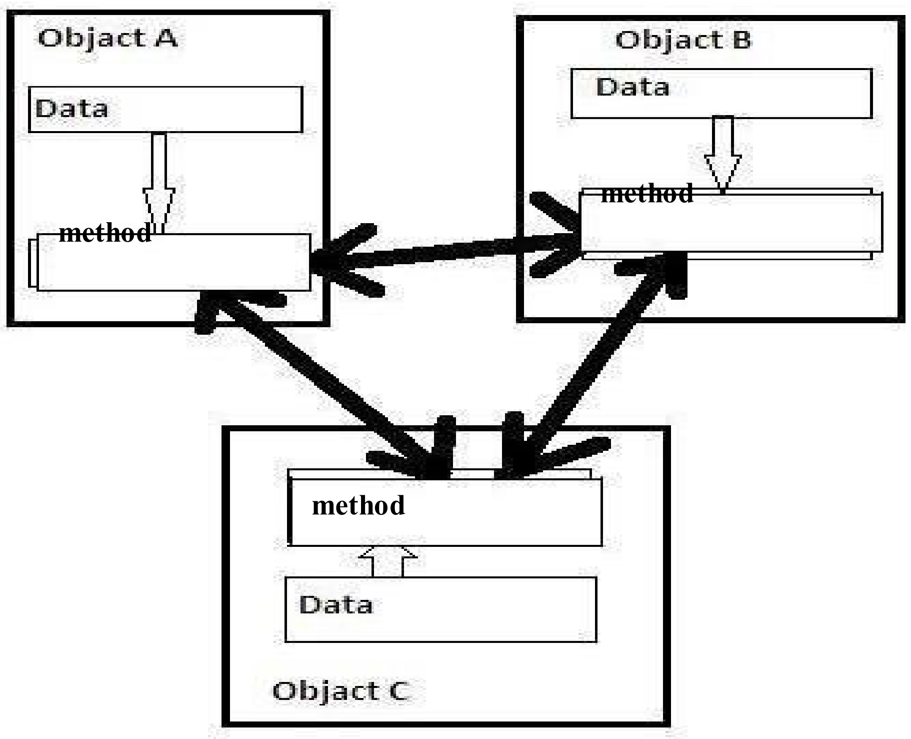
DEF: OOP is an approach that provides a way of modularizing programs by creating portioned memory area for both data and methods that can used as templates for creating copies of such modules on demand.

That is ,an object a considered to be a partitioned area of computer memory that stores data and set of operations that can access that data. Since the memory partitions are independent, the objects can be used in a variety of different programs without modifications.

OOP Chars:

- Emphasis on data .
- Programs are divided into what are known as methods.
- Data structures are designed such that they characterize the objects.
- Methods that operate on the data of an object are tied together .
- Data is hidden.
- Objects can communicate with each other through methods.
- Reusability.
- Follows bottom-up approach in program design.

Organization of OOP:



**Evolution of Computing and Programming**: Computer use is increasing in almost every field of endeavor. Computing costs have been decreasing dramatically due to rapid developments in both hardware and software technologies. Computers that might have filled large rooms and cost millions of dollars decades ago can now be inscribed on silicon chips smaller than a fingernail, costing perhaps a few dollars each. Fortunately, silicon is one of the most abundant materials on earth it is an ingredient in common sand. Silicon chip technology has made computing so economical that about a billion general-purpose computers are in use worldwide, helping people in business, industry and government, and in their personal lives. The number could easily double in the next few years. Over the years, many programmers learned the programming methodology called structured programming.
You will learn structured programming and an exciting newer methodology, object-oriented programming. Why do we teach both? Object orientation is the key programming methodology used by programmers today. You will create and work with many software objects in this text. But you will discover that their internal structure is often built using structured-programming techniques. Also, the logic of manipulating objects is occasionally expressed with structured programming.

**Language of Choice for Networked Applications**: Java has become the language of choice for implementing Internet-based applications and software for devices that communicate over a network. Stereos and other devices in homes are now being networked together by Java technology. At the May 2006 JavaOne conference, Sun announced that there were one billion java-enabled mobile phones and hand held devices! Java has evolved rapidly into the large-scale applications arena. It's the preferred-wide programming needs. Java has evolved so rapidly that this seventh edition of Java How to Program was published just 10 years after the first edition was published. Java has grown so large 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. The Java Micro Edition (Java ME) is geared toward developing applications for small, memory constrained devices, such as cell phones, pagers and PDAs.

**Data Abstraction**

An essential element of object-oriented programming is *abstraction.* Humans manage complexity through abstraction. For example, people do not think of a car as a set ofte ns of thousands of individual parts. They think of it as a well-defined object with its own unique behavior. This abstraction allows people to use a car to drive to the grocery store without being overwhelmed by the complexity of the parts that form the car. They can ignore the details of how the engine, transmission, and braking systems work. Instead they are free to utilize the object as a whole.

A powerful way to manage abstraction is through the use of hierarchical classifications. This allows you to layer the semantics of complex systems, breaking them into more manageable pieces. From the outside, the car is a single object. Once inside, you see that the car consists of several subsystems: steering, brakes, sound system, seat belts, heating, cellular phone, and so on. In turn, each of these subsystems is made up of more specialized units. For instance, the sound system consists of a radio, a CD player, and/or a tape player. The point is that you manage the complexity of the car (or any other
complex system) through the use of hierarchical abstractions.

**Encapsulation**

An object encapsulates the methods and data that are contained inside it .the rest of the system interacts with an object only through a well defined set of services that it provides.

**Inheritance**

- I have more information about Flora –not necessarily because she is a florist but because she is a shopkeeper.
- One way to think about how I have organized my knowledge of Flora is in terms of a hierarchy of categories:

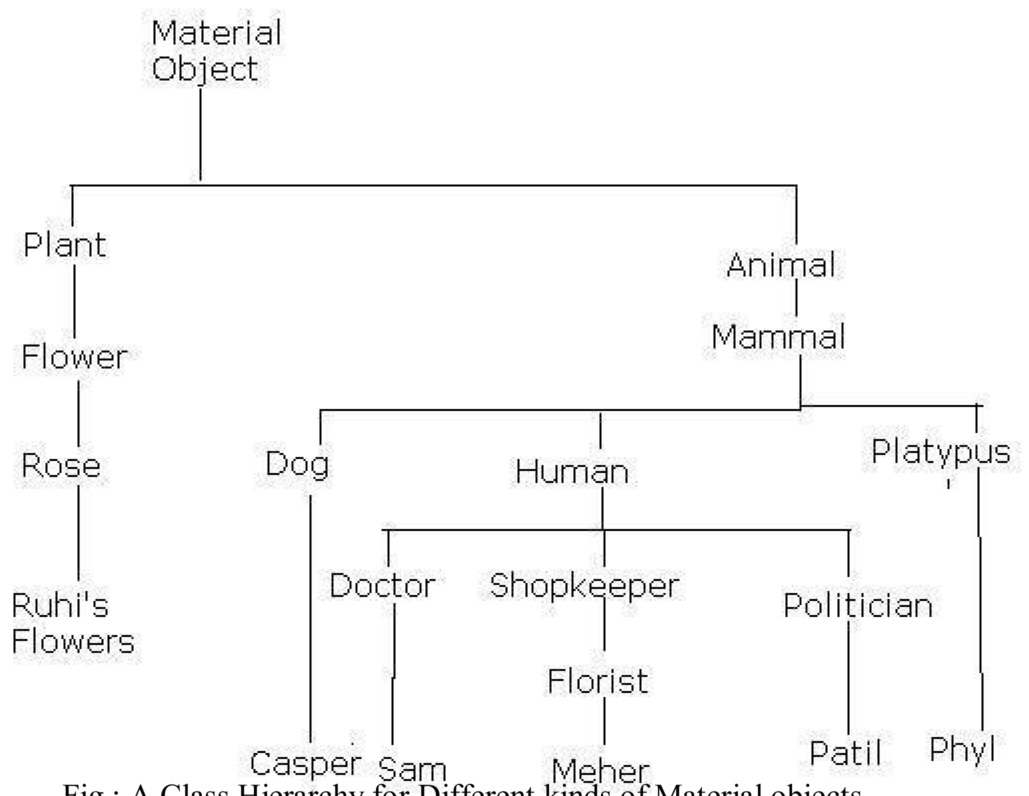


Fig : A Class Hierarchy for Different kinds of Material objects

## CLASSES AND OBJECTS

Concepts of classes and objects:

Class Fundamentals

Classes have been used since the beginning of this book. However, until now, only the most rudimentary form of a class has been used. The classes created in the preceding chapters primarily exist simply to encapsulate the **main( )** method, which has been used to demonstrate the basics of the Java syntax.

Thus, a class is a *template* for an object, and an object is an *instance* of a class. Because an object is an instance of a class, you will often see the two words *object* and *instance* used interchangeably.

**The General Form of a Class**

When you define a class, you declare its exact form and nature. You do this by specifying the data that it contains and the code that operates on that data.

A class is declared by use of the **class** keyword. The classes that have been used up to this point are actually very limited examples of its complete form. Classes can (and usually do) get much more complex. The general form of a **class** definition is shown here:

```
class classname {
type instance-
variable1; type
instance-variable2; // ...
type instance-variableN;
type methodname1(parameter-list) {
// body of method
}
type methodname2(parameter-list) {
// body of method
}
// ...
type methodnameN(parameter-list) {
// body of method
}
}
```

The data, or variables, defined within a **class** are called *instance variables.* The code is contained within *methods.* Collectively, the methods and variables defined within a class are called *members* of the class. In most classes, the instance variables are acted upon and accessed

by the methods defined for that class. Thus, it is the methods that de can be used.

**Declaring Objects**

As just explained, when you create a class, you are creating a new data type. You can use this type to declare objects of that type. However, obtaining objects of a class is a two-step process. First, you must declare a variable of the class type. This variable does not define an object. Instead, it is simply a variable that can *refer* to an object. Second, you must acquire an actual, physical copy of the object and assign it to that variable. You can do this using the **new** operator. The **new** operator dynamically allocates (that is, allocates at run time) memory for an object and returns a reference to it. This reference is, more or less, the address in memory of the object allocated by **new**.

Ex: Box mybox = new Box();

This statement combines the two steps just described. It can be rewritten like this
to show each step more clearly:

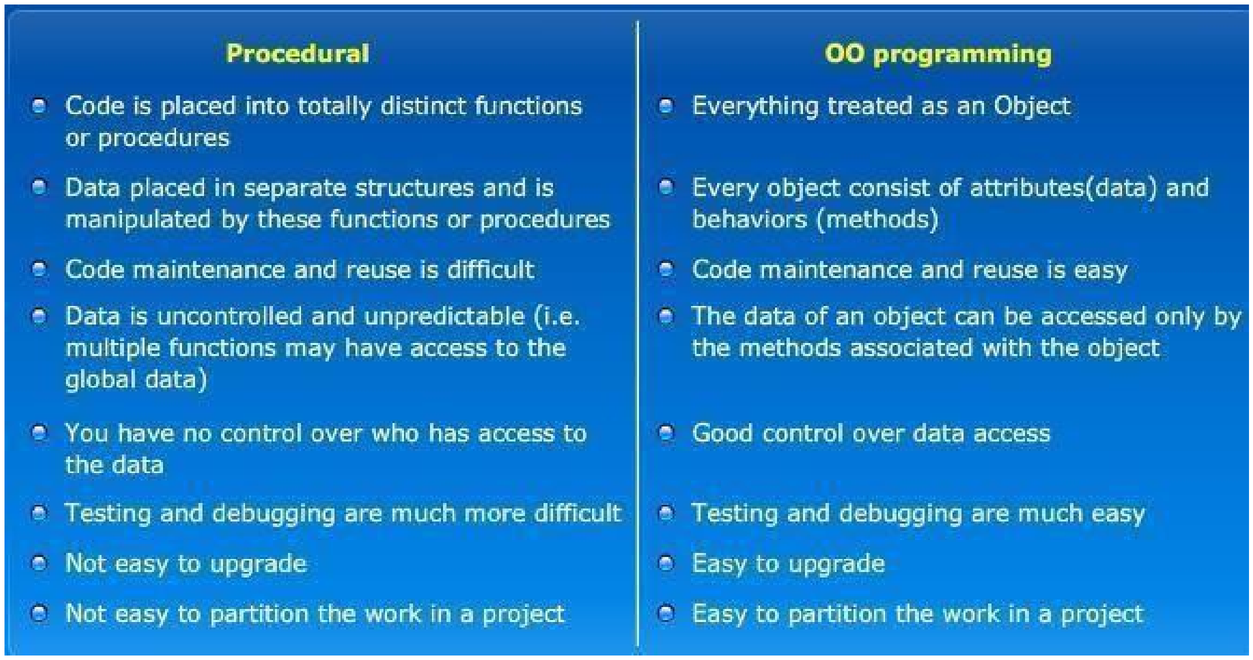
```
Box mybox; // declare reference to object
mybox = new Box(); // allocate a Box object
```

A Closer Look at new

As just explained, the **new** operator dynamically allocates memory for an object. It has this general form:

*class-var* = new *classname*( );

Here, *class-var* is a variable of the class type being created. The *classname* is the name of the class that is being instantiated. The class name followed by parentheses specifies the *constructor* for the class. A constructor defines what occurs when an object of a class is created. Constructors are an important part of all classes and have many significant attributes. Most real-world classes explicitly define their own constructors within their class definition. However, if no explicit constructor is specified, then Java will automatically supply a default constructor. This is the case with **Box**.



| Procedural | OO programming |
|---|---|
| Code is placed into totally distinct functions or procedures | Everything treated as an Object |
| Data placed in separate structures and is manipulated by these functions or procedures | Every object consist of attributes(data) and behaviors (methods) |
| Code maintenance and reuse is difficult | Code maintenance and reuse is easy |
| Data is uncontrolled and unpredictable (i.e. multiple functions may have access to the global data) | The data of an object can be accessed only by the methods associated with the object |
| You have no control over who has access to the data | Good control over data access |
| Testing and debugging are much more difficult | Testing and debugging are much easy |
| Not easy to upgrade | Easy to upgrade |
| Not easy to partition the work in a project | Easy to partition the work in a project |

## HISTORY OF JAVA

Java was conceived by James Gosling, Patrick Naughton, Chris Warth, Ed Frank, and Mike Sheridan at Sun Microsystems, Inc. in 1991. It took 18 months to develop the first Working version. This language was initially

Between the initial implementation of Oak in the fall of 1992 and the public Announcement of Java in the spring of 1995, many more people contributed to the designand evolution of the language. Bill Joy, Arthur van Hoff, Jonathan Payne, Frank Yellin, and Tim Lind Holm were key contributors to the maturing of the original prototype.

The trouble With C and C++ (and most other languages) is that they are designed to be compiled For a specific target. Although it is possible to compile a C++ program for just about Any type of CPU, to do so requires a full C++ compiler targeted for that CPU. The Problem is that compilers are expensive and time-consuming to create. An easier—and more cost- efficient—solution was needed. In an attempt to find such a solution,Gosling and others began work on a portable, platform-independent language thatcould be used to produce code that would run on a variety of CPUs under differing Environments. This effort ultimately led to the creation of Java.

As mentioned earlier, Java derives much of its character from C and C++. This is by intent. The Java designers knew that using the familiar syntax of C and echoing the object- oriented features of C++ would make their language appealing to the legions of experienced C/C++ programmers. In addition to the surface similarities, Java shares some of the other attributes that helped make C and C++ successful. First, Java was designed, tested, and refined by real, working programmers.

## **The Java Buzzwords:**

No discussion of the genesis of Java is complete without a look at the Java buzzwords. Although the fundamental forces that necessitated the invention of Java are portability and security, other factors also played an important role in molding the final form of the language. The key considerations were summed up by the Java team in the Following list of buzzwords:

- Simple
- Secure
- Portable
- Object-oriented
- Robust
- Multithreaded
- Architecture-neutral
- Interpreted
- High performance
- Distributed
- Dynamic

### **Simple**

Java was designed to be easy for the professional programmer to learn and use effectively. Assuming that you have some programming experience, you will not find Java hard to master. If you already understand the basic concepts of object-oriented programming, learning Java will be even easier. Best of all, if you are an experienced C++ programmer, moving to Java will require very little effort. Because Java inherits the C/C++ syntax and many of the object-oriented features of C++, most programmers have little trouble learning Java..

Object-Oriented

Although influenced by its predecessors, Java was not designed to be source-code compatible with any other language. Borrowing liberally from many seminal object-software environments of the last few decades, Java manages to strike a balance between the everything is an object‖ paradigm and the programming.

### **Robust**

The multi platformed environment of the Web places extraordinary demands on a program, because the program must execute reliably in a variety of systems. Thus, the ability to create robust programs was given a high priority in the design of Java.

To better understand how Java is robust, consider two of the main reasons for program failure: memory management mistakes and mishandled exceptional conditions (that is, run-time errors). Memory management can be a difficult, tedious ask in traditional programming environments. For example, in C/C++, the pro grammer must manually allocate and free all dynamic memory. This sometimes leads to problems, because programmers will either forget to free memory that has been previously allocated or, worse, try to free some memory that another part of their code is still using. Java virtually eliminates these problems by managing memory allocation and deallocation for you.

**Multithreaded**

Java was designed to meet the real-world requirement of creating interactive, networked programs. To accomplish this, Java supports multithreaded programming, which allows you to write programs that do many things simultaneously. The Java run-time system comes with an elegant yet sophisticated solution for multiprocess .synchronization that enables you to construct smoothly running interactive systems.

**Architecture-Neutral**

A central issue for the Java designers was that of code longevity and portability. One of the main problems facing programmers is that no guarantee exists that if you write a program today, it will run tomorrow—even on the same machine. Operating system up grades, processor upgrades, and changes in core system resources can all combine to make a program malfunction. The Java designers made several hard decisions in the Java language and the Java Virtual Machine in an attempt to alter this situation forever.‖ To a great extent, this goal was accomplished.

**Interpreted and High Performance**

As described earlier, Java enables the creation of cross-platform programs by compiling into an intermediate representation called Java bytecode. This code can be interpreted on any system that provides a Java Virtual Machine. Most previous attempts at cross platform solutions have done so at the expense of performance. Other interpreted systems, such as BASIC, Tcl, and PERL, suffer from almost insurmountable performance deficits. Java, however, was designed to perform well on very low-power CPUs.

**Distributed**

Java is designed for the distributed environment of the Internet, because it handles TCP/IP protocols. In fact, accessing a resource using a URL is not much different from accessing a file. The original version of Java (Oak) included features for intra address-space messaging. This allowed objects on two different computers to execute procedures remotely. Java revived these interfaces in a package called *Remote MethodInvocation* (*RMI*). This feature brings an unparalleled level of abstraction to client/server programming.

**Dynamic**

Java programs carry with them substantial amounts of run-time type information that is used to verify and resolve accesses to objects at run time. This makes it possible to dynamically link code in a safe and expedient manner. This is crucial to the robustness of the applet environment, in which small fragments of bytecode may be dynamically updated on a running system.

## DATA TYPES

Java defines eight simple (or elemental) types of data: **byte**, **short**, **int**, **long**, **char**, **float**,**double**, and **boolean**. These can be put in four groups:

- Integers This group includes **byte**, **short**, **int**, and **long**, which are for whole valued signed numbers.
- Floating-point numbers This group includes **float** and **double**, which represent numbers with fractional precision.
- Characters This group includes **char**, which represents symbols in a character set, like letters and numbers.
- Boolean This group includes **boolean**, which is a special type for representing true/false values.

## Integers

Java defines four integer types: **byte**, **short**, **int**, and **long**. All of these are signed, positive and negative values. Java does not support unsigned, positive-only integers. Many other Computer languages, including C/C++, support both signed and unsigned integers.

| **Name** | **Width** | **Range** |
|---|---|---|
| long | 64 | –9,223,372,036,854,775,808 to 9,223,372,036,854,775,807 |
| int | 32 | –2,147,483,648 to 2,147,483,647 |
| short | 16 | –32,768 to 32,767 |
| byte | 8 | –128 to 127 |

**byte**

The smallest integer type is **byte**. This is a signed 8-bit type that has a range from –128to 127. Variables of type **byte** are especially useful when you're a network or file. They are also usefulnotbe when directly compatible-intypeswith. Java's other built

Syntax: byte b, c;

**short**

**short** is a signed 16-bit type. It has a range from –32,768 to 32,767. It is probably the least-used Java type, since it is defined as having its high byte first (called *big-endian* format). This type is mostly applicable to 16-bit computers, which are becoming increasingly scarce.
Here are some examples of **short** variable
declarations: short s;
short t;
int

The most commonly used integer type is **int**. It is a signed 32-bit type that has a range from –2,147,483,648 to 2,147,483,647. In addition to other uses, variables of type **int** are commonly employed to control loops and to index arrays. Any time you have an integer expression involving **byte**s, **short**s, **int**s, and literal numbers, the entire expression Is *promoted* to **int** before the calculation is done.
long

**long** is a signed 64-bit type and is useful for those occasions where an **int** type is notlarge enough to hold the desired value. The range of a **long** is quite large. This makesit useful when big, whole numbers are needed. For example, here is a program thatcomputes the number of miles that light will travel in a specified number of days.

**Floating-Point Types**

Floating-point numbers, also known as *real* numbers, are used when evaluating expressions that require fractional precision. For example, calculations such as square root, or transcendentals such as sine and cosine, result in a value whose precision requires a floating-point type.
Their width and ranges are shown here:

| Name | Width | Bits Approximate Range |
|---|---|---|
| **double** | 64 | 4.9e–324 to 1.8e+308 |
| **float** | 32 | |

float

The type **float** specifies a *single-precision* value that uses 32 bits of storage. Single precision is faster on some processors and takes half as much space as double precision, but will become imprecise when the values are either very large or very small. Variables of type **float** are useful when you need a fractional component, but don't require example, **float** can be useful when representing dollars and cents.

Here are some example **float** variable declarations: float hightemp, lowtemp;

**double**

Double precision, as denoted by the **double** keyword, uses 64 bits to store a value. Double precision is actually faster than single precision on some modern processors that have been optimized for high-speed mathematical calculations.

Here is a short program that uses **double** variables to compute the area of a circle:

```
// Compute the area of a circle.
class Area {
public static void main(String args[]) {
double pi, r, a;
r = 10.8; // radius of circle
pi = 3.1416; // pi, approximately a = pi * r
* r; // compute area
System.out.println("Area of circle is " + a);
}
}
```

**Characters**

In Java, the data type used to store characters is **char**. However, C/C++ programmers beware: **char** in Java is not the same as **char** in C or C++. In C/C++, **char** is an integertype that is 8 bits wide. This is *not* the case in Java. Instead, Java uses Unicode to representcharacters.. There are no negative **char**s. The standard set of characters known asASCII still ranges from 0 to 127 as always, and the extended 8-bit character set, ISO-Latin-1,ranges from 0 to 255.

Booleans

Java has a simple type, called **boolean**, for logical values. It can have only one of twopossible values, **true** or **false**. This is the type returned by all relational operators, suc has **a < b**. **boolean** is also the type *required* by the conditional expressions that govern the control statements such as **if** and **for**.

Here is a program that demonstrates the **boolean** type:

There are three interesting things to notice about this program. First, as you can see, when a **Boolean** value is output by **println()**, —true‖ or —false‖ Second, the value of a **Boolean** variable is sufficient, by itself, to control the **if** statement. Thereis no need to write an **if** statement like this:

if(b == true) ...

Third, the outcome of a relational operator, such as **<**, is a **boolean** value. This is why the expression **10 > 9** displays the value —true.‖ Further, around **10 > 9** is necessary because the **+** operato has a higher precedence than the >.

**<u>Variables</u>**

The variable is the basic unit of storage in a Java program. A variable is defined by the combination of an identifier, a type, and an optional initializer. In addition, all variables have a scope, which defines their visibility, and a lifetime. These elementsare examined next.

**Declaring a Variable**

In Java, all variables must be declared before they can be used. The basic form of a variable declaration is shown here:

*type identifier* [ = *value*][, *identifier* [= *value*] ...] ;

The *type* is one of Java's atomic types, or the nam interface types are discussed later in Part I of this book.) The *identifier* is the name of the variable.

Here are several examples of variable declarations of various types. Note that some include an initialization.

```
int a, b, c;                    // declares three ints, a, b, and c.
int d = 3, e, f = 5;            // declares three more ints, initializing
                                        // d and f.
byte z = 22;                    // initializes z.
double pi = 3.14159;            // declares an approximation of pi.
char x = 'x';                   // the variable x has the value 'x'.
```

**<u>The Scope and Lifetime of Variables</u>**

So far, all of the variables used have been declared at the start of the **main( )** method. However, Java allows variables to be declared within any block. As explained in Chapter 2, a block is begun with an opening curly brace and ended by a closing curlybrace. A block defines a *scope.* Thus, each time you start a new block, you are creating a new scope. As you probably know from your previous programming experience, a scope determines what objects are visible to other parts of your program. It also determines the lifetime of those objects.

Most other computer languages define two general categories of scopes: global and local. However, these traditional scopes do not fit scope defined by a method begins with its opening curly brace.

To understand the effect of nested scopes, consider the following program: // Demonstrate block scope.

**<u>Arrays</u>**

An *array* is a group of like-typed variables that are referred to by a common name. Arrays of any type can be created and may have one or more dimensions. A specific elementin an array is accessed by its index. Arrays offer a convenient means of grouping related information.

<u>One-Dimensional Arrays</u>

A *one-dimensional array* is, essentially, a list of like-typed variables. To create an array, you first must create an array variable of the desired type. The general form of a one dimensional array declaration is

*type var-name*[ ];

Here, *type* declares the base type of the array. The base type determines the data type of each element that comprises the array.

```
// Demonstrate a one-dimensional array.
class Array {
public static void main(String args[]) {
int month_days[];
month_days = new int[12];
month_days[0] = 31;
month_days[1] = 28;
month_days[2] = 31;
month_days[3] = 30;
month_days[4] = 31;
month_days[5] = 30;
month_days[6] = 31;
month_days[7] = 31;
month_days[8] = 30;
month_days[9] = 31;
month_days[10] = 30;
month_days[11] = 31;

System.out.println("April has " + month_days[3] + " days.");
}
}
```

**Multidimensional Arrays**

In Java, *multidimensional arrays* are actually arrays of arrays. These, as you mightexpect, look and act like regular multidimensional arrays. However, as you will see there are a couple of subtle differences. To declare a multidimensional array variable,specify each additional index using another set of square brackets. For example, the following declares a two-dimensional array variable called **twoD**.

```
int twoD[][] = new int[4][5];
```

This allocates a 4 by 5 array and assigns it to **twoD**. Internally this matrix is implemented as an *array* of *arrays* of **int**.

```
// Demonstrate a two-dimensional
array. class TwoDArray {
public static void main(String args[]) {
int twoD[][]= new int[4][5];
int i, j, k = 0;
for(i=0; i<4; i++)
for(j=0; j<5; j++)
{ twoD[i][j] = k;
k++;
}
for(i=0; i<4; i++) { for(j=0; j<5;
j++)
System.out.print(twoD[i][j] + "
"); System.out.println();
}
}
}
```

This program generates the following
output: 0 1 2 3 4 5 6 7 8 9

```
10 11 12 13 14
15 16 17 18 19
```

As stated earlier, since multidimensional arrays are actually arrays of arrays, the length of each array is under your control. For example, the following program creates a two dimensional array in which the sizes of the second dimension are unequal.

## OPERATORS

Arithmetic operators are used in mathematical expressions in the same way that they are used in algebra. The following table lists the arithmetic operators:

| Operator | Result |
|---|---|
| + | Addition |
| – | Subtraction (also unary minus) |
| * | Multiplication |
| / | Division |
| % | Modulus |
| ++ | Increment |
| += | Addition assignment |
| –= | Subtraction assignment |
| *= | Multiplication assignment |
| /= | Division assignment |
| %= | Modulus assignment |
| — | Decrement |

The operands of the arithmetic operators must be of a numeric type. You cannot use them on **boolean** types, but you can use them on **char** types, since the **char** type in Java is, essentially, a subset of **int**.

The Bitwise Operators

Java defines several *bitwise operators* which can be applied to the integer types, **long**, **int**, **short**, **char**, and **byte**. These operators act upon the individual bits of their operands. They are summarized in the following table:

| Operator | Result |
|---|---|
| ~ | Bitwise unary NOT |
| & | Bitwise AND |
| \| | Bitwise OR |
| ^ | Bitwise exclusive OR |
| >> | Shift right |
| >>> | Shift right zero fill |
| << | Shift left |
| &= | Bitwise AND assignment |
| \|= | Bitwise OR assignment |
| ^= | Bitwise exclusive OR assignment |
| >>= | Shift right assignment |
| >>>= | Shift right zero fill assignment |
| <<= | Shift left assignment |

**Relational Operators**

The *relational operators* determine the relationship that one operand has to the other. Specifically, they determine equality and ordering. The relational operators are shown here:

| Operator | Result |
|---|---|
| == | Equal to |
| != | Not equal to |
| > | Greater than |
| < | Less than |
| >= | Greater than or equal to |
| <= | Less than or equal to |

The outcome of these operations is a **boolean** value. The relational operators are most frequently used in the expressions that control the **if** statement and the various loop statements.

**The Assignment Operator**

You have been using the assignment operator since Chapter 2. Now it is time to take a formal look at it. The *assignment operator* is the single equal sign, =. The assignment operator works in Java much as it does in any other computer language. It has this general form:

*var = expression*;

Here, the type of *var* must be compatible with the type of *expression.*

The assignment operator does have one interesting attribute that you may not be familiar with: it allows you to create a chain of assignments. For example, consider this fragment:

```
int x, y, z;
x = y = z = 100; // set x, y, and z to 100
```

This fragment sets the variables **x**, **y**, and **z** to 100 using a single statement. This works because the = is an operator that yields the value of the right-hand expression. Thus, the value of **z = 100** is 100, which is then assigned to **y**, which in turn is assigned to **x**. Using a —cha assignment‖ is an ease way to set a group of

**The ? Operator**

Java includes a special *ternary* (three-way) *operator* that can replace certain types ofif-then-else statements. This operator is the **?**, and it works in Java much like it doesin C, C++, and C#. It can seem somewhat confusing at first, but the **?** can be used very effectively once mastered. The **?** has this general form:

*expression1* **?** *expression2* **:** *expression3*

Here, *expression1* can be any expression that evaluates to a **boolean** value. If *expression1* is **true**, then *expression2* is evaluated; otherwise, *expression3* is evaluated. The result of the **?** operation is that of the expression evaluated. Both *expression2* and *expression3* are required to return the same**void**type,. which can't be

**<u>CONTROL STATEMENTS</u>**

**if**

The **if** statement was introduced in Chapter 2. It is examined in detail here. The **if** statement is Java's conditionalprogrambranchexecution state through two different paths. Here is the general form of the **if** statement:

if (*condition*) *statement1*;
else *statement2*;

Here, each *statement* may be a single statement or a compound statement enclosed in curly braces (that is, a *block*). The *condition* is any expression that returns a **boolean** value. The **else** clause is optional.

```
int a,
b; // ...
if(a < b) a = 0;
else b = 0;
```

**The if-else-if Ladder**

A common programming construct that is based upon a sequence of nested **if**s is the ***if-else-if*** *ladder*. It looks like this:

if(*condition*)
*statement;*
else if*(condition*)

*statement*;
else if(*condition*)
*statement*;
...
else
*statement*;

**switch**

The **switch** statement is Java's multiway branch dispatch execution to different parts of your code based on the value of an expression. As such, it often provides a better alternative than a large series of **if-else-if** statements.
Here is the general form of a **switch** statement:

```
switch (expression)
{ case value1:
// statement sequence
break;
case value2:
// statement sequence
break;
...
case valueN:
// statement sequence
break;
default:
// default statement sequence
}
```

The *expression* must be of type **byte**, **short**, **int**, or **char**; each of the *values* specified in the **case** statements must be of a type compatible with the expression. Each **case** value must be a unique literal (that is, it must be a constant, not a variable). Duplicate **case** values are not allowed

## Iteration Statements

Java's iteration**for**,**while**, andstatements**do-while**.Thesestatementsarecreate what we commonly call *loops.* As you probably know, a loop repeatedly executes the same set of instructions until a termination condition is met. As you will see, Java has a loop to fit any programming need.

While

The **while** loop is Java'sfundamentalloopingmoststatement. It repeats a statement or block while its controlling expression is true. Here is its general form:

```
While (condition) {
// body of loop
}
```

The *condition* can be any Boolean expression. The body of the loop will be executed as long as the conditional expression is true. When *condition* becomes false, control passes to the next line of code immediately following the loop. The curly braces are unnecessary if only a single statement is being repeated.

do-while

As you just saw, if the conditional expression controlling a **while** loop is initially false, then the body of the loop will not be executed at all. However, sometimes it is desirable to execute the body of a **while** loop at least once, even if the conditional expression is false to begin with.

Systex:

```
do {
// body of loop
} while (condition);
```

Each iteration of the **do-while** loop first executes the body of the loop and then evaluates the conditional expression. If this expression is true, the loop will repeat. Otherwise, the loop terminates.

```
// Demonstrate the do-while loop.
class DoWhile {
public static void main(String args[]) {
int n = 10;
do {
System.out.println("tick " +
n); n--;
} while(n > 0);
}
}
```

For

You were introduced to a simple form of the **for** loop in Chapter 2. As you will see, it is a powerful and versatile construct. Here is the general form of the **for** statement:

```
for(initialization; condition; iteration) {
// body
}
```

If only one statement is being repeated, there is no need for the curly braces.

The **for** loop operates as follows. When the loop first starts, the *initialization* portion of the loop is executed. Generally, this is an expression that sets the value of the *loopcontrol variable,* which acts as a counter that controls the loop.. Next, *condition* is evaluated. This must be a Boolean expression. It usually tests the loop control variable against a target value. If this expression is true, then the body of the loop is executed. If it is false, the loop terminates. Next, the *iteration* portion of the loop is executed. This is usually an expression that increments or decrements the loop control variable.

```
// Demonstrate the for loop.
class ForTick {
public static void main(String args[]) {
int n;
for(n=10; n>0; n--)
System.out.println("tick " + n);
}
}
```

**Using break**

In Java, the **break** statement has three uses. First, as you have seen, it terminates a statement sequence in a **switch** statement. Second, it can be used to exit a loop. Third, it can be used as a ―civilized‖ form of goto. The last

Return

The last control statement is **return**. The **return** statement is used to explicitly return from a method. That is, it causes program control to transfer back to the caller of the method. As such, it is categorized as a jump statement. Although a full discussion of **return** must wait until methods are discussed in Chapter 7, a brief look at **return** is presented here.

As you can see, the final **println( )** statement is not executed. As soon as **return** is executed, control passes back to the caller.

**Type Conversion and Casting**

If you have previous programming experience, then you already know that it is fairly common to assign a value of one type to a variable of another type. If the two types are compatible, then Java will perform the conversion automatically. For example, it is always possible to assign an **int** value to a **long** variable. However, not all types are compatible, and thus, not all type conversions are implicitly allowed.

**Java's Automatic Conversions**

When one type of data is assigned to another type of variable, an *automatic type conversion* will take place if the following two conditions are met:

■ The two types are compatible.

■ The destination type is larger than the sou

When these two conditions are met, a *widening conversion* takes place. For example, the **int** type is always large enough to hold all valid **byte** values, so no explicit cast statement is required.

It has this general form:

***(target-type) value***

Here, *target-type* specifies the desired type to convert the specified value to. For example, the following fragment casts an **int** to a **byte**. If the integer's valu than the range of a **byte**, it will be reduced modulo (the remainder of an integer division by the) **byte**'s range.

```
int a;
byte b;
// ...
b = (byte) a;
```

A different type of conversion will occur when a floating-point value is assigned to an integer type: *truncation*. As you know, integers do not have fractional components.Thus, when a floating-point value is assigned to an integer type, the fractional component is lost. For example, if the value 1.23 is assigned to an integer, the resulting value will simply be 1. The 0.23 will have been truncated. Of course, if the size of the whole number component is too large to fit into the target integer type, then that value will be
The following program demonstrates some type conversions that require casts:

**// Demonstrate casts.**

```
class Conversion {
public static void main(String args[]) {
byte b;
int i = 257;
double d = 323.142;
System.out.println("\nConversion of int to
byte."); b = (byte) i;
System.out.println("i and b " + i + " " + b);
System.out.println("\nConversion of double to
int."); i = (int) d;
System.out.println("d and i " + d + " " + i);
System.out.println("\nConversion of double to
byte."); b = (byte) d;
System.out.println("d and b " + d + " " + b);
}
}
```

This program generates the following output:

```
Conversion of int to byte.
i and b 257 1
Conversion of double to int.
d and i 323.142 323
Conversion of double to byte.
d and b 323.142 67
```

## SIMPLE JAVA PROGRAM

```
/*
This is a simple Java program.
Call this file "Example.java".
*/
class Example {
// Your program begins with a call to main(). public
static void main(String args[]) {
System.out.println("This is a simple Java program.");
}
}
```

## Access Control

As you know, encapsulation links data with the code that manipulates it. However, encapsulation provides another important attribute: *access control.*

How a member can be accessed is determined by the *access specifier* that modifies its declaration. Java supplies a rich set of access specifiers. Some aspects of access control are related mostly to inheritance or packages. (A *package* is, essentially, a grouping of classes.) These parts of Java's access control mechanism examining access control as it applies to a single class. Once you understand the fundamentals of access control, the rest will**public**, **private**be, andeasy**protected**. . Java's
Java also defines a
default access level. **protected** applies only when inheritance is involved. The other access specifiers are described next.

Let's begin**public**byand **private**defining.Whenamember of a class is modified by the **public** specifier, then that member can be accessed by any other code. When a member of a class is specified as **private**, then that member can only be accessed byother members of its class. Now you can understand why **main( )** has always been preceded by the **public** specifier. It is called by code that is outside the program—that is, by the Java run-time system. When no access specifier is used, then by default the member of a class is public within its own package, but cannot be accessed outside of its package.

## this Keyword

Sometimes a method will need to refer to the object that invoked it. To allow this, Java defines the **this** keyword. **this** can be used inside any method to refer to the *current* object. That is, **this** is always a reference to the object on which the method was invoked. You can use **this** anywhere a reference to an object of the cur what **this** refers to, consider the following version of **Box( )**:

```
// A redundant use of this.
Box(double w, double h, double d)
{ this.width = w;
this.height = h;
this.depth = d;
}
```

This version of **Box( )** operates exactly like the earlier version. The use of **this** is redundant, but perfectly correct. Inside **Box( )**, **this** will always refer to the invoking object. While it is redundant in this case, **this** is useful in other contexts, one of which is explained in the next section.

### Instance Variable Hiding

As you know, it is illegal in Java to declare two local variables with the same name inside the same or enclosing scopes. Interestingly, you can have local variables, including formal parameters to methods, which instance variables. However, when a local variable has the same name as an instance variable, the local variable *hides* the instance variable.

```
// Use this to resolve name-space collisions.
Box(double width, double height, double depth) {
this.width = width;
this.height = height;
this.depth = depth;
}
```

A word of caution: The use of **this** in such a context can sometimes be confusing, and some programmers are careful not to use local variables and formal parameter names that hide instance variables.

## Garbage Collection

Since objects are dynamically allocated by using the **new** operator, you might be wondering how such objects are destroyed and their memory released for later reallocation. In some languages, such as C++, dynamically allocated objects must be manually released by use of a **delete** operator. Java takes a different approach; it handles deallocation for you automatically. The technique that accomplishes this is Called *garbage collection*. It works like this: when no references to an object exist, that object is assumed to be no longer needed, and the memory occupied by the object can be reclaimed. Furthermore, different Java run-time implementations will take varying approaches to garbage collection, but for the most part, you should not have to think about it while writing your programs.

**<u>Overloading methods and constructors</u>**

Overloading Methods

In Java it is possible to define two or more methods within the same class that share the same name, as long as their parameter declarations are different. When this is the case, the methods are said to be *overloaded,* and the process is referred to as
*method overloading.* Method overloading is one of the ways that Java implements polymorphism.

```
// Demonstrate method
overloading. class OverloadDemo {
void test() {
System.out.println("No parameters");
}
// Overload test for one integer
parameter. void test(int a) {
System.out.println("a: " + a);
}
// Overload test for two integer parameters.
void test(int a, int b) { System.out.println("a
and b: " + a + " " + b);
}
// overload test for a double
parameter double test(double a) {
System.out.println("double a: " + a);
return a*a;
}
}
class Overload {
public static void main(String args[]) {
OverloadDemo ob = new
OverloadDemo(); double result;
// call all versions of test()
ob.test();
ob.test(10);
ob.test(10, 20);
result = ob.test(123.25);
System.out.println("Result of ob.test(123.25): " + result);
}
}
```

This program generates the following
output: No parameters

```
a: 10
a and b: 10 20
double a: 123.25
Result of ob.test(123.25): 15190.5625
```

As you can see, **test( )** is overloaded four times.

## Overloading Constructor

In addition to overloading normal methods, you can also overload constructor methods. In fact, for most real-world classes that you create, overloaded constructors will be the norm, not the exception. To **Box**understandclass why developed in the preceding chapter. Following is the latest version of **Box**:

```
class Box {
double width;
double height;
double depth;
// This is the constructor for Box.
Box(double w, double h, double d)
{ width = w;
height = h;
depth = d;
}
// compute and return volume
double volume() {
return width * height * depth;
}
}
```

## Argument/Parameter passing

In general, there are two ways that a computer language can pass an argument to a subroutine. The first way is *call-by-value.* This method copies the *value* of an argument into the formal parameter of the subroutine. Therefore, changes made to the parameter of the subroutine have no effect on the argument. The second way an argument can be passed is *call-by-reference.* In this method, a reference to an argument (not the value of the argument) is passed to the parameter. Inside the subroutine, this reference is used to access the actual argument specified in the call. This means that changes made to the parameter will affect the argument used to call the subroutine. As you will see, Java uses both approaches, depending upon what is passed.
For example, consider the following program:

```
// Simple types are passed by value.
class Test {
void meth(int i, int j)
{ i *= 2;
j /= 2;
}
}
class CallByValue {
public static void main(String args[]) {
Test ob = new Test();
int a = 15, b = 20;
System.out.println("a and b before call: "
+ a + " " + b);
ob.meth(a, b);
System.out.println("a and b after call: " +
a + " " + b);
}
}
```

The output from this program is shown here:

```
a and b before call: 15 20
a and b after call: 15 20
```

## Recursion

Java supports *recursion.* Recursion is the process of defining something in terms of itself. As it relates to Java programming, recursion is the attribute that allows a method to call itself. A method that calls itself is said to be *recursive.*The classic example of recursion is the computation of the factorial of a number. The factorial of a number *N* is the product of all the whole numbers between 1 and *N.*

```
// A simple example of
recursion(factorial). class Factorial {
// this is a recursive function
int fact(int n) {
int result;
if(n==1) return 1;
result = fact(n-1) * n;
return result;
}
}

class Recursion {
public static void main(String args[]) {
Factorial f = new Factorial();
System.out.println("Factorial of 3 is " + f.fact(3));
System.out.println("Factorial of 4 is " + f.fact(4));
System.out.println("Factorial of 5 is " + f.fact(5));
}
}
```

The output from this program is shown here:

```
Factorial of 3 is 6
Factorial of 4 is 24
Factorial of 5 is 120
```

## String class

Although the **String** class will be examined in depth in Part II of this book, a short exploration of it is warranted now, because we will be using strings in some of the example programs shown toward the end of Part I. **String** is probably the most commonly used class in Java's class library. The obviousareaveryimportantreasonpartof for programming.

The first thing to understand about strings is that every string you create is actually an object of type **String**. Even string constants are actually **String** objects. For example, in the statement

```
System.out.println("This is a String, too");
```

the string —This**String**isconstant. Fortunately,String,Javahandlestoo‖**String** isconstants in the same way that other computer language worry about this.

The second thing to understand about strings is that objects of type **String** are immutable; once a **String** object is created, its contents cannot be altered. While this may seem like a serious restriction, it is not, for two reasons:

■ If you need to change a string, youthe can modifications.

■ Java defines**String** ,calledpeer**StringBuffer**class,whichallowsofstrings to be altered, so all of the normal string manipulations are still available in Java.

(**StringBuffer** is described in Part II of this book.)
Strings can be constructed a variety of ways. The easiest is to use a statement like this:

```
String myString = "this is a test";
```

Once you have created a **String** object, you can use it anywhere that a string is allowed. For example, this statement displays **myString**:

```
System.out.println(myString);
```

Java defines one operator for **String** objects: **+**. It is used to concatenate two strings.
For example, this statement

```
String myString = "I" + " like " + "Java.";
```

results in **myString** containing ―I like  Java.‖

The following program demonstrates the preceding concepts:

```
// Demonstrating Strings.
class StringDemo {
public static void main(String args[]) {
String strOb1 = "First String";
String strOb2 = "Second String";
String strOb3 = strOb1 + " and " + strOb2;
System.out.println(strOb1);
System.out.println(strOb2);
System.out.println(strOb3);
}
}
```

The output produced by this program is shown here:

```
First String
Second String
First String and Second String
```

The **String** class contains several methods that you can use. Here are a few. You can test two strings for equality by using **equals( )**. You can obtain the length of a string by calling the **length( )** method. You can obtain the character at a specified index within a string by calling **charAt( )**. The general forms of these three methods are shown here:

boolean equals(String *object*)
int length( )
char charAt(int *index*)

Here is a program that demonstrates these methods:

```
// Demonstrating some String methods.
class StringDemo2 {
public static void main(String args[]) {
String strOb1 = "First String";
String strOb2 = "Second
String"; String strOb3 = strOb1;
System.out.println("Length of strOb1: "
+ strOb1.length());
System.out.println("Char at index 3 in strOb1: "
+ strOb1.charAt(3));
if(strOb1.equals(strOb2))
System.out.println("strOb1 == strOb2");
else
System.out.println("strOb1 != strOb2");
if(strOb1.equals(strOb3))
System.out.println("strOb1 == strOb3");
else
System.out.println("strOb1 != strOb3");
}
}
```

This program generates the following output:

```
Length of strOb1: 12
Char at index 3 in strOb1: s
strOb1 != strOb2
strOb1 == strOb3
```

Of course, you can have arrays of strings, just like you can have arrays of any other type of object. For example:

```
// Demonstrate String
arrays. class StringDemo3 {
public static void main(String args[]) {
String str[] = { "one", "two", "three" };
for(int i=0; i<str.length; i++)
System.out.println("str[" + i + "]: "
+ str[i]);
}
}
```

Here is the output from this
program: str[0]: one

```
str[1]: two
str[2]: three
```

As you will see in the following section, string arrays play an important part in many Java programs.