ST.MARY'S ENGINEERING COLLEGE, DESHMUKHI

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

JAVA Lecture Notes

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UNIT 1.1

Need for oop paradigm

- The object oriented paradigm is a methodology for producing reusable software components
- The object-oriented paradigm is a programming methodology that promotes the efficient design and development of software systems using reusable components that can be quickly and safely assembled into larger systems.
- Object oriented programming has taken a completely different direction and will place an emphasis on object s and information. With object oriented programming, a problem will be broken down into a number of units .these are called objects .The foundation of oop is the fact that it will place an emphasis on objects and classes. There are number of advantages to be found with using the oop paradigm, and some of these are oop paradigm
- Object oriented programming is a concept that was created because of the need to overcome the problems that were found with using structured programming techniques. While structured programming uses an approach which is top down, oop uses an approach which is bottom up.
- A **paradigm** is a way in which a computer language looks at the problem to be solved. We divide computer languages into four paradigms: *procedural*, *object-oriented*, *functional* and *declarative*
- A paradigm shift from a function-centric approach to an object-centric approach to software development
- A program in a procedural paradigm is an active agent that uses passive objects that we refer to as data or data items.
- The basic unit of code is the **class** which is a template for creating run-time objects.
- Classes can be composed from other classes. For example, Clocks can be constructed as an aggregate of Counters.
- The object-oriented paradigm deals with active objects instead of passive objects. We encounter many active objects in our daily life: a vehicle, an automatic door, a dishwasher and so on. The actions to be performed on these objects are included in the object: the objects need only to receive the appropriate stimulus from outside to perform one of the actions.
- A file in an object-oriented paradigm can be packed with all the procedures—called methods in the object-oriented paradigm—to be performed by the file: printing, copying,

deleting and so on. The program in this paradigm just sends the corresponding request to the object

- Java provides automatic garbage collection, relieving the programmer of the need to ensure that unreferenced memory is regularly deallocated.

Object Oriented Paradigm – Key Features

- Encapsulation
- Abstraction
- Inheritance
- Polymorphis

A Way of viewing World- Agents

- The word *agent* has found its way into a number of technologies. It has been applied to aspects of artificial intelligence research and to constructs developed for improving the experience provided by collaborative online social environments (MUDS, MOOs, and the like). It is a branch on the tree of distributed computing. There are agent development toolkits and agent programming languages.
- The Agent Identity class defines agent identity. An instance of this class uniquely identifies an agent. Agents use this information to identify the agents with whom they are interested in collaborating.
- The Agent Host class defines the agent host. An instance of this class keeps track of every agent executing in the system. It works with other hosts in order to transfer agents.
- The Agent class defines the agent. An instance of this class exists for each agent executing on a given agent host.
- OOP uses an approach of treating a real world agent as an object.
- 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 by switching the controlling entity to data.

Responsibility

- In object-oriented design, the chain-of-responsibility pattern is a design pattern consisting of a source of command objects and a series of processing objects..
- Each processing object contains logic that defines the types of command objects that it can handle; the rest are passed to the next processing object in the chain. A mechanism also exists for adding new processing objects to the end of this chain.

- Primary motivation is the need for a platform-independent (that is, architecture- neutral) language that could be used to create software to be embedded in various consumer electronic devices, such as microwave ovens and remote controls.
- Objects with clear responsibilities
- Each class should have a clear responsibility.
- If you can't state the purpose of a class in a single, clear sentence, then perhaps your class structure needs some thought.
- In **object-oriented programming,** the **single responsibility principle** states that every class should have a single responsibility, and that responsibility should be entirely encapsulated by the class. All its services should be narrowly aligned with that responsibility.

Messages

- Message implements the Part interface. Message contains a set of attributes and a "content".
- Message objects are obtained either from a Folder or by constructing a new Message object of the appropriate subclass. Messages that have been received are normally retrieved from a folder named "INBOX".
- A Message object obtained from a folder is just a lightweight reference to the actual message. The Message is 'lazily' filled up (on demand) when each item is requested from the message.
- Note that certain folder implementations may return Message objects that are pre-filled with certain user-specified items. To send a message, an appropriate subclass of Message (e.g., Mime Message) is instantiated, the attributes and content are filled in, and the message is sent using the Transport. Send method.
- We all like to use programs that let us know what's going on. Programs that keep us informed often do so by displaying status and error messages.
- These messages need to be translated so they can be understood by end users around the world.
- The Section discusses translatable text messages. Usually, you're done after you move a message String into a Resource Bundle.
- If you've embedded variable data in a message, you'll have to take some extra steps to prepare it for translation.

Methods

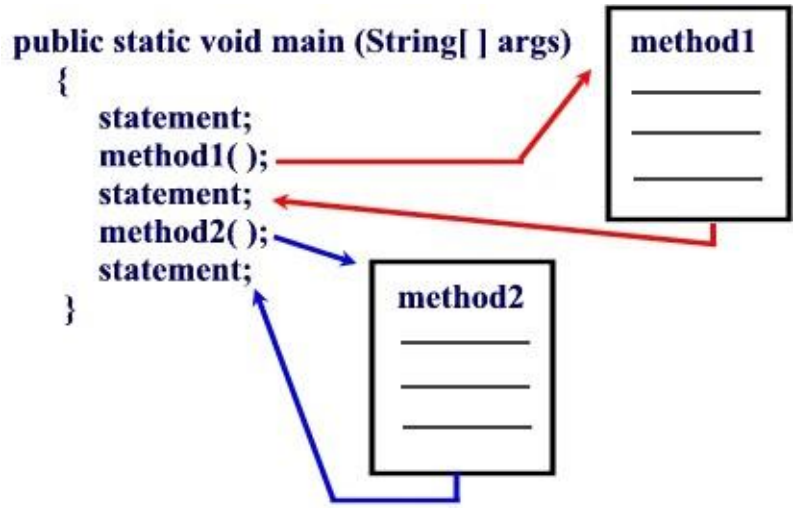
- **The only required elements** of a method declaration are the method's return type, name, a pair of parentheses, (), and a body between braces, {}.
- Two of the components of a method declaration comprise the *method signature*—the method's name and the parameter types.
- More generally, method declarations have six components, in order:
- Modifiers—such as public, private, and others you will learn about later.

- The return type—the data type of the value returned by the method, or void if the method does not return a value.
- The method name—the rules for field names apply to method names as well, but the convention is a little different.
- The parameter list in parenthesis—a comma-delimited list of input parameters, preceded by their data types, enclosed by parentheses, (). If there are no parameters, you must use empty parentheses.
- The method body, enclosed between braces—the method's code, including the declaration of local variables, goes here.

Naming a Method

Although a method name can be any legal identifier, code conventions restrict method names. By convention, method names should be a verb in lowercase or a multi-word name that begins with a verb in lowercase, followed by adjectives, nouns, etc. In multi-word names, the first letter of each of the second and following words should be capitalized. Here are some examples:

run
run Fast
getBackground
getFinalData
compareTo setX isEmpty



Typically, a method has a unique name within its class. However, a method might have the same name as other methods due to *method overloading*.

Overloading Methods

- The Java programming language supports *overloading* methods, and Java can distinguish between methods with different *method signatures*. This means that methods within a class can have the same name if they have different parameter lists (there are some qualifications to this that will be discussed in the lesson titled "Interfaces and Inheritance").

- In the Java programming language, you can use the same name for all the drawing methods but pass a different argument list to each method. Thus, the data drawing class might declare four methods named draw, each of which has a different parameter list.
- Overloaded methods are differentiated by the number and the type of the arguments passed into the method.
- You cannot declare more than one method with the same name and the same number and type of arguments, because the compiler cannot tell them apart.
- The compiler does not consider return type when differentiating methods, so you cannot declare two methods with the same signature even if they have a different return type.
- Overloaded methods should be used sparingly, as they can make code much less readable.

Classes

- In object-oriented terms, we say that your bicycle is an *instance* of the *class of objects* known as bicycles. A *class* is the blueprint from which individual objects are created.
- Java classes contain *fields* and *methods*. A field is like a C++ data member, and a method is like a C++ member function. In Java, each class will be in its own .java file.

Each field and method has an *access level*:

- private: accessible only in this class
- (package): accessible only in this package
- protected: accessible only in this package and in all subclasses of this class
- public: accessible everywhere this class is available
- Each class has one of two possible access levels:
- (package): class objects can only be declared and manipulated by code in this package
- Public: class objects can be declared and manipulated by code in any package.
- Object: Object-oriented programming involves *inheritance*. In Java, all classes (built-in or user-defined) are (implicitly) subclasses of Object. Using an array of Object in the List class allows any kind of Object (an instance of any class) to be stored in the list. However, primitive types (int, char, etc) cannot be stored in the list.
- A method should be made static when it does not access any of the non-static fields of the class, and does not call any non-static methods.
- Java class objects exhibit the properties and behaviors defined by its class. A class can contain fields and methods to describe the behavior of an object. Current states of a class‘s corresponding object are stored in the object‘s instance variables.
- Creating a class:

A class is created in the following way

Class <class name>
{
Member variables;
Methods;
}

- An object is a software bundle of related state and behavior. Software objects are often used to model the real-world objects that you find in everyday life. This lesson explains how state and behavior are represented within an object, introduces the concept of data encapsulation, and explains the benefits of designing your software in this manner.

Class Variables – Static Fields

- We use class variables also know as Static fields when we want to share characteristics across all objectswithin a class. When you declare a field to be static, only a single instance of the associated variable is created common to all the objects of that class. Hence when one object changes the value of a class variable, it affects all objects of the class. We can access a class variable by using the name of the class, and not necessarily using a reference to an individual object within the class. Static variables can be accessed even though no objects of that class exist. It is declared using static keyword.

Class Methods – Static Methods

Class methods, similar to Class variables can be invoked without having an instance of the class. Class methods are often used to provide global functions for Java programs. For example, methods in the java.lang.Math package are class methods. You cannot call non-static methods from inside a static method.

Bundling code into individual software objects provides a number of benefits, including:

- **Modularity:** The source code for an object can be written and maintained independently of the source code for other objects. Once created, an object can be easily passed around inside the system.
- **Information-hiding**: By interacting only with an object's methods, the details of its internal implementation remain hidden from the outside world.
- **Code re-use**: If an object already exists (perhaps written by another software developer), you can use that object in your program. This allows specialists to implement/test/debug complex, task-specific objects, which you can then trust to run in your own code.
- **Pluggability and debugging ease**: If a particular object turns out to be problematic, you can simply remove it from your application and plug in a different object as its replacement. This is analogous to fixing mechanical problems in the real world. If a bolt breaks, you replace *it*, not the entire machine.

An instance or an object for a class is created in the following way <class name> <object name>=new <constructor>();

Encapsulation:

- *Encapsulation* is the mechanism that binds together code and the data it manipulates, and keeps both safe from outside interference and misuse.

- One way to think about encapsulation is as a protective wrapper that prevents the code and data from being arbitrarily accessed by other code defined outside the wrapper.
- Access to the code and data inside the wrapper is tightly controlled through a well-defined interface.
- To relate this to the real world, consider the automatic transmission on an automobile.
- It encapsulates hundreds of bits of information about your engine, such as how much we are accelerating, the pitch of the surface we are on, and the position of the shift.
- The power of encapsulated code is that everyone knows how to access it and thus can use it regardless of the implementation details—and without fear of unexpected side effects.

Polymorphism:

Polymorphism (from the Greek, meaning ―many forms‖) is a feature that allows one interface to be used for a general class of actions.

- The specific action is determined by the exact nature of the situation. Consider a stack (which is a last-in, first-out list). We might have a program that requires three types of stacks. One stack is used for integer values, one for floating-point values, and one for characters. The algorithm that implements each stack is the same, even though the data being stored differs.
- In Java we can specify a general set of stack routines that all share the same names. More generally, the concept of polymorphism is often expressed by the phrase ―one interface, multiple methods.‖ This means that it is possible to design a generic interface to a group of related activities.
- This helps reduce complexity by allowing the same interface to be used to specify a *general class of action.*
- Polymorphism allows us to create clean, sensible, readable, and resilient code.

class Hierarchies (Inheritance):

- Object-oriented programming allows classes to *inherit* commonly used state and behavior from other classes. Different kinds of objects often have a certain amount in common with each other.
- In the Java programming language, each class is allowed to have one direct superclass, and each superclass has the potential for an unlimited number of *subclasses*:
- Mountain bikes, road bikes, and tandem bikes, for example, all share the characteristics of bicycles (current speed, current pedal cadence, current gear). Yet each also defines additional features that make them different: tandem bicycles have two seats and two sets of handlebars; road bikes have drop handlebars; some mountain bikes have an additional chain ring, giving them a lower gear ratio. In this example, Bicycle now becomes the *super class* of Mountain Bike, Road Bike, and Tandem Bike.
- The syntax for creating a subclass is simple. At the beginning of your class declaration, use the extends keyword, followed by the name of the class to inherit from:

```
class <sub class> extends <super class> {
    // new fields and methods defining a sub class would go here
}
```

The different types of inheritance are
1. Single level Inheritance.
2. Multilevel Inheritance.
3. Hierarchical inheritance.
4. Multiple inheritance.
5. Hybrid inheritance.

Multiple,hybrid inheritance is not used in the way as other inheritances but it needs a special concept called interfaces.

Method Binding:

- Binding denotes association of a name with a class.
- Static binding is a binding in which the class association is made during compile time. This is also called as early binding.
- Dynamic binding is a binding in which the class association is not made until the object is created at execution time. It is also called as late binding.

Abstraction:

Abstraction in Java or Object oriented programming is a way to segregate implementation from interface and one of the five fundamentals along with Encapsulation, Inheritance, Polymorphism, Class and Object.

- An essential component of object oriented programming is Abstraction
- Humans manage complexity through abstraction.
- For example people do not think a car as a set of tens and 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 ignoring all details of how the engine, transmission and braking systems work.
- In computer programs the data from a traditional process oriented program can be transformed by abstraction into its component objects.
- A sequence of process steps can become a collection of messages between these objects.Thus each object describes its own behavior.

Overriding:

- In a class hierarchy when a sub class has the same name and type signature as a method in the super class, then the method in the subclass is said to override the method in the super class.
- When an overridden method is called from within a sub class, it will always refer to the version of that method defined by the sub class.
- The version of the method defined by the super class will be hidden.

Exceptions:

- An exception is an abnormal condition that arises in a code sequence at run time.
- In other words an exception is a run time error.
- A java exception is an object that describes an exceptional condition that has occurred in a piece of code.
- When an exceptional condition arises, an object representing that exception is created and thrown in the method that caused the error.
- Now the exception is caught and processed.

Summary of oops concepts

- **Object-oriented programming** (**OOP**) is a programming paradigm that represents concepts as "objects" that have data fields (attributes that describe the object) and associated procedures known as methods. Objects, which are usually instances of classes, are used to interact with one another to design applications and computer programs.
- Object-oriented programming is an approach to designing modular, reusable software systems.
- The goals of object-oriented programming are:
- Increased understanding.
- Ease of maintenance
- Ease of evolution.
- Object orientation eases maintenance by the use of encapsulation and information hiding.
-

Object-Oriented Programming – Summary of Key Terms

Definitions of some of the key concepts in Object Oriented Programming(OOP).

Term	Definition
Abstract Data Type	A user-defined data type, including both attributes (its state) and methods (its behaviour). An object oriented language will include means to define new types (see class) and create instances of those classes (see object). It will also provide a number of primitive types.
Aggregation	Objects that are made up of other objects are known as aggregations. The relationship is generally of one of two types: • Composition – the object is composed of other objects. This form of aggregation is a form of code reuse. *E.g. A Car is composed of Wheels, a Chassis and an Engine* • Collection – the object contains other objects. *E.g. a List contains several Items; A Set several Members.*

Attribute	A characteristic of an object. Collectively the attributes of an object describe its state. *E.g. a Car may have attributes of Speed, Direction, Registration Number and Driver.*
Class	The definition of objects of the same abstract data type. In Java class is the keyword used to define new types.
Dynamic (Late) Binding	The identification at run time of which version of a method is being called (see polymorphism). When the class of an object cannot be identified at compile time, it is impossible to use static binding to identify the correct object method, so dynamic binding must be used.
Encapsulation	The combining together of attributes (data) and methods (behaviour/processes) into a single abstract data type with a public interface and a private implementation. This allows the implementation to be altered without affecting the interface.
Inheritance	The derivation of one class from another so that the attributes and methods of one class are part of the definition of another class. The first class is often referred to the base or parent class. The child is often referred to as a derived or sub-class. Derived classes are always _a kind of' their base classes. Derived classes generally add to the attributes and/or behaviour of the base class. Inheritance is one form of object-oriented code reuse. *E.g. Both Motorbikes and Cars are kinds of MotorVehicles and therefore share some common attributes and behaviour but may add their own that are unique to that particular type.*
Interface	The behaviour that a class exposes to the outside world; its public face. Also called its _contract'. In Java interface is also a keyword similar to class. However a Java interface contains no implementation: it simply describes the behaviour expected of a particular type of object, it doesn't so how that behaviour should be implemented.
Member Variable	See attribute
Method	The implementation of some behaviour of an object.
Message	The invoking of a method of an object. In an object-oriented application objects send each other messages (i.e. execute each others methods) to achieve the desired behaviour.

Object	An instance of a class. Objects have state, identity and behaviour.
Overloading	Allowing the same method name to be used for more than one implementation. The different versions of the method vary according to their parameter lists. If this can be determined at compile time then static binding is used, otherwise dynamic binding is used to select the correct method as runtime.
Polymorphism	Generally, the ability of different classes of object to respond to the same message in different, class-specific ways. Polymorphic methods are used which have one name but different implementations for different classes. *E.g. Both the Plane and Car types might be able to respond to a turnLeft message. While the behaviour is the same, the means of achieving it are specific to each type.*
Primitive Type	The basic types which are provided with a given object-oriented programming language. *E.g. int, float, double, char, Boolean*
Static(Early) Binding	The identification at compile time of which version of a polymorphic method is being called. In order to do this the compiler must identify the class of an object.

Java Basics

Java was conceived by James gosling, Patrick Naughton, chriswarth, Ed frank and Mike Sheridan at sun Microsystems.

The original impetus for java was not internet instead primary motivation was the need for a platform independent (i.e. Architectural neutral) independent language.

Java's Byte code:

The key that allows java to solve the both security and portability problems is that the output of a java compiler is not executable code rather it is byte code.

Byte code is highly optimized set of instructions designed to be executed by java runtime systems, which is called Java Virtual Machine (JVM). JVM is interpreter for byte code. Translating a java program into byte code helps makes it much easier to run a Program in a wide variety of environments. The reason is straightforward: only the JVM needs to be implemented for each platform. Once the run-time package exists for a given system, any Java program can run on it.

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 mol ding 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++

Robust

The multiplatform 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 were given a high priority in the design of Java.

To gain reliability, Java restricts you in a few key areas, to force you to find your mistakes early in program development. At the same time, Java frees you from having to worry about many of the most common causes of programming errors. Because Java is a strictly typed language, it checks your code at compile time. However, it also checks your code at run time. 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 task in traditional programming environments. For example, in C/C++, the programmer 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. (In fact, deallocation is completely automatic,

because Java provides garbage collection for unused objects.) Exceptional conditions in traditional environments often arise in situations such as division by zero or ―file not found,‖ and they must be managed with clumsy and hard-to-read constructs. Java helps in this area by providing object-oriented exception handling. In a well-written Java program, all run-time errors can—and should—be managed by your program.

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.

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 upgrades, 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. Their goal was ―write once; run anywhere, anytime, forever.‖ To a great extent, this goal was accomplished.

Interpreted and High Performance

Java enables the creation of cross-platform programs by compiling into an intermediate representation called Java byte code. 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. Java was engineered for interpretation, the Java byte code was carefully designed so that it would be easy to translate directly into native machine code for very high performance by using a just-in-time compiler. Java run-time systems that provide this feature lose none of the benefits of the platform-independent code. ―High-performance cross-platform‖ is no longer an oxymoron.

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 intraaddress-space messaging. This allowed objects on two different computers to execute procedures remotely. Java revived these interfaces in a package called *Remote Method Invocation* (*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 byte code may be dynamically updated on a running system.

Security

Every time that you download a ―normal‖ program, you are risking a viral infection. Even so, most users still worried about the possibility of infecting their systems with a virus. In addition to viruses, another type of malicious program exists that must be guarded against. This type of program can gather private information, such as credit card numbers, bank account balances, and passwords, by searching the contents of your computer‘s local file system. Java answers both of these concerns by providing a ―firewall‖ between a networked application and your computer. When you use a Java-compatible Web browser, you can safely download Java applets without fear of viral infection or malicious intent. Java achieves this protection by confining a Java program to the Java execution environment and not allowing it access to other parts of the computer.

Portability

Many types of computers and operating systems are in use throughout the world—and many are connected to the Internet. For programs to be dynamically downloaded to all the various types of platforms connected to the Internet, some means of generating portable executable code is needed. As you will soon see, the same mechanism that helps ensure security also helps create portability.

Data Types:

Java defines eight simple 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:

The width and ranges of these integer types vary widely, as shown in this table:

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

Floating-point:

There are two kinds of floating-point types, **float** and **double**, which represent single- and double-precision numbers, respectively. Their width and ranges are shown here:

Name	Width in Bits	Approximate Range
double	64	4.9e–324 to 1.8e+308
float	32	1.4e−045 to 3.4e+038

Variables:

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. 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 name of a class or interface. The *identifier* is the name of the variable. You can initialize the variable by specifying an equal sign and a value. To declare more than one variable of the specified type, use a comma-separated list.

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
byte z = 22; // initializes z.
double pi = 3.14159; // declares an approximation of pi.
char x = 'x'; // the variable x has the value 'x'.
```

The Scope and Lifetime of Variables:

All of the variables used till now have been declared at the start of the **main( )** method. However, Java allows variables to be declared within any block. A block is begun with an opening curly brace and ended by a closing curly brace. A block defines a *scope*. Thus, each time you start a new block, you are creating 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. The scope defined by a method begins with its opening curly brace. However, if that method has parameters, they too are included within the method‘s scope. variables declared inside a scope are not visible (that is, accessible)to code that is defined outside that scope. Thus, when you declare a variable within a scope, you are localizing that variable and protecting it from unauthorized access and/or modification. Scopes can be nested. For example, each time you create a block of code, you are creating a new, nested scope. When this occurs, the outer scope encloses the inner scope. This means that

objects declared in the outer scope will be visible to code within the inner scope. However, the reverse is not true. Objects declared within the inner scope will not be visible outside it.

To understand the effect of nested scopes, consider the following program:

```
// demonstrate block scope.
class Scope
 {
    public static void main(String args[])
    {
      int x; // known to all code within main
      x = 10;
      if(x == 10)
       {    // start new scope
         int y = 20; // known only to this block
         // x and y both known here.
         System.out.println("x and y: " + x + " " + y);
         x = y * 2;
       }
       // y = 100; // Error! y not known here
       // x is still known here.
      System.out.println("x is " + x);
    }}
```

As the comments indicate, the variable **x** is declared at the start of **main( )**'s scope and is accessible to all subsequent code within **main( )**. Within the **if** block, **y** is declared. Since a block defines a scope, **y** is only visible to other code within its block. This is why outside of its block, the line **y = 100;** is commented out. If you remove the leading comment symbol, a compile-time error will occur, because **y** is not visible outside of its block. Within the **if** block, **x** can be used because code within a block (that is, a nested scope) has access to variables declared by an enclosing scope.

Here is another important point to remember: variables are created when their scope is entered and destroyed when their scope is left. This means that a variable will not hold its value once it has gone out of scope. Therefore, variables declared within a method will not hold their values between calls to that method. Also, a variable declared within a block will lose its value when the block is left. Thus, the lifetime of a variable is confined to its scope. If a variable declaration includes an initializer, then that variable will be reinitialized each time the block in which it is declared is entered.

For example, consider the next program.

```
// Demonstrate lifetime of a variable.
class Lifetime
 {
    public static void main(String args[])
   {
    int x;
```

```
    for(x = 0; x < 3; x++)
    {
       int y = -1; // y is initialized each time block is entered
       System.out.println("y is: " + y); // this always prints -1
       y = 100;
      System.out.println("y is now: " + y);
    }
  }
}
```

The output generated by this program is shown here:

```
y is: -1
y is now: 100
y is: -1
y is now: 100
y is: -1
y is now: 100
```

As you can see, **y** is always reinitialized to –1 each time the inner **for** loop is entered. Even though it is subsequently assigned the value 100, this value is lost.One last point: Although blocks can be nested, you cannot declare a variable to have the same name as one in an outer scope.

Arrays:

An *array* is a group of similar-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 element in an array is accessed by its index. Arrays offer a convenient means of grouping related information.

One-Dimensional Arrays

A *one-dimensional array* is 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. For example, the following declares an array named **month** with the type –array of int‖:

```
int month [];
```

Although this declaration establishes the fact that **month** is an array variable, no array actually exists. In fact, the value of **month** is set to **null**, which represents an array with no value. To link **month** with an actual, physical array of integers, you must allocate one using **new** and assign it to **month**. **new** is a special operator that allocates memory. The general form of **new** as it applies to one-dimensional arrays appears as follows:

array-var = new *type*[*size*];
Here, *type* specifies the type of data being allocated, *size* specifies the number of elements in the array, and *array-var* is the array variable that is linked to the array. That is, to use **new** to
allocate an array, you must specify the type and number of elements to allocate. The elements in the array allocated by **new** will automatically be initialized to zero.

This example allocates a 12-element array of integers and links them to **month**
month = new int[12];
After this statement executes, **month** will refer to an array of 12 integers. Further, all elements in the array will be initialized to zero.

Another way to declare an arrayin single step is
type arr-name=new type[size];

Arrays can be initialized when they are declared. The process is much the same as that used to initialize the simple types. An *array initializer* is a list of comma-separated expressions surrounded by curly braces. The commas separate the values of the array elements. The array will automatically be created large enough to hold the number of elements you specify in the array initializer. There is no need to use **new**.
For example, to store the number of days in each month, we do as follows
// An improved version of the previous program.

```
class AutoArray
 {
    public static void main(String args[])
   {
    int month[] = { 31, 28, 31, 30, 31, 30, 31, 31, 30, 31,30, 31 };
   System.out.println("April has " + month[3] + " days.");
   }
}
```

When you run this program, in the output it prints the number of days in April. As mentioned, Java array indexes start with zero, so the number of days in April is **month[3]** or 30.
Here is one more example that uses a one-dimensional array. It finds the average of a set of numbers.

```
// Average an array of values.
class Average
{
    public static void main(String args[])
   {
    double nums[] = {10.1, 11.2, 12.3, 13.4, 14.5};
    double result = 0;
```

```
    int i;
    for(i=0; i<5; i++)
    result = result + nums[i];
   System.out.println("Average is " + result / 5);
  }
}
```
Output: Average is:12.3

Multidimensional Arrays

In Java, multidimensional arrays are actually arrays of arrays. 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**.

program :

```
// 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();
    }
  }
}
```
Output:

```
0 1 2 3 4
5 6 7 8 9
10 11 12 13 14
15 16 17 18 19
```
When you allocate memory for a multidimensional array, you need only specify the memory for the first (leftmost) dimension. You can allocate the remaining dimensions separately. We can allocates the second dimension manually.

```
int twoD[][] = new int[4][];
twoD[0] = new int[5];
twoD[1] = new int[5];
twoD[2] = new int[5];
twoD[3] = new int[5];
```

we can creates a two dimensional array in which the sizes of the second dimension are unequal.

```
// Manually allocate differing size second dimensions.
class TwoDAgain
 {
   public static void main(String args[])
  {
    int twoD[][] = new int[4][];
    twoD[0] = new int[1];
    twoD[1] = new int[2];
    twoD[2] = new int[3];
    twoD[3] = new int[4];
    int i, j, k = 0;
    for(i=0; i<4; i++)
    for(j=0; j<i+1; j++)
    {
    twoD[i][j] = k;
    k++;
    }
    for(i=0; i<4; i++)
    {
    for(j=0; j<i+1; j++)
    System.out.print(twoD[i][j] + " ");
    System.out.println();
    }
  }
}
```

Output:

```
0
1 2
3 4 5
6 7 8
```

We can create a three-dimensional array where first index specifies the number of tables, second one number o0f rows and the third number of columns.

```
// Demonstrate a three-dimensional array.
class threeDMatrix
{
    public static void main(String args[])
   {
```

```
    int threeD[][][] = new int[3][4][5];
    int i, j, k;
    for(i=0; i<3; i++)
    for(j=0; j<4; j++)
    for(k=0; k<5; k++)
    threeD[i][j][k] = i * j * k;

    for(i=0; i<3; i++)
    {
     for(j=0; j<4; j++)
     {
      for(k=0; k<5; k++)
    System.out.print(threeD[i][j][k] + " ");
    System.out.println();
   }
  System.out.println();
 }

}
}
```

Output:

```
0 0 0 0 0
0 0 0 0 0
0 0 0 0 0
0 0 0 0 0

0 0 0 0 0
0 1 2 3 4
0 2 4 6 8
0 3 6 9 12

0 0 0 0 0
0 2 4 6 8
0 4 8 12 16
0 6 12 18 24
```

Alternative Array Declaration Syntax

There is a second form that may be used to declare an array:

type[ ] var-name;

Here, the square brackets follow the type specifier, and not the name of the array variable. For example, the following two declarations are equivalent:

```
int al[] = new int[3];
int[] a2 = new int[3];
```

The following declarations are also equivalent:

```
char twod1[][] = new char[3][4];
char[][]  twod2 = new char[3][4];
```

Operators:

Operators are special symbols that perform specific operations on one, two, or three *operands*, and then return a result. The operators in the following table are listed according to precedence order. The closer to the top of the table an operator appears, the higher its precedence. Operators with higher precedence are evaluated before operators with relatively lower precedence. Operators on the same line have equal precedence. When operators of equal precedence appear in the same expression, a rule must govern which is evaluated first. All binary operators except for the assignment operators are evaluated from left to right; assignment operators are evaluated right to left.

Operator Precedence	
Operators	**Precedence**
Postfix	*expr*++, *expr*--
Unary	++*expr* --*expr* +*expr* –*expr* ~ !
multiplicative	* / %
additive	+ -
shift	<< >> >>>
relational	< > <= >= instanceof
equality	== !=
bitwise AND	&
bitwise exclusive OR	^
bitwise inclusive OR	|
logical AND	&&
logical OR	||
ternary	? :
assignment	= += -= *= /= %= &= ^= |= <<= >>= >>>=

In general-purpose programming, certain operators tend to appear more frequently than theirs; for example, the assignment operator "=" is far more common than the unsigned right shift operator ">>>".

Expressions:

An *expression* is a construct made up of variables, operators, and method invocations, which are constructed according to the syntax of the language that evaluates to a single value.

```
int a = 0;
arr[0] = 100;
System.out.println("Element 1 at index 0: " + arr[0]);

int result = 1 + 2; // result is now 3
if(value1 == value2)
System.out.println("value1 == value2");
```

The data type of the value returned by an expression depends on the elements used in the expression. The expression a= 0 returns an int because the assignment operator returns a value of the same data type as its left-hand operand; in this case, cadence is an int. As you can see from the other expressions, an expression can return other types of values as well, such as boolean or String.

For example, the following expression gives different results, depending on whether you perform the addition or the division operation first:

```
x + y / 100    // ambiguous
```

You can specify exactly how an expression will be evaluated using balanced parenthesis rewrite the expression as

```
(x + y) / 100   // unambiguous, recommended
```

If you don't explicitly indicate the order for the operations to be performed, the order is determined by the precedence assigned to the operators in use within the expression. Operators that have a higher precedence get evaluated first. For example, the division operator has a higher precedence than does the addition operator. Therefore, the following two statements are equivalent:

```
x + y / 100

x + (y / 100) // unambiguous, recommended
```

When writing compound expressions, be explicit and indicate with parentheses which operators should be evaluated first.

Control Statements:

IF Statement

The general form of the **if** statement:

if (condition) statement1;

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.
If the *condition* is true, then *statement1* is executed. Otherwise,*statement2* is executed.

IF –ELSE Statement
The general form of the **if** statement:

if (condition) statement1;
else statement2;

The if-then-else statement provides a secondary path of execution when an "if" clause evaluates to false.

```
void applyBrakes()

{

    if (isMoving)
    {
        currentSpeed--;
    }
    else
    {
       System.err.println("The bicycle has already stopped!");
    }
}
```

The switch Statement

Unlike if-then and if-then-else, the switch statement allows for any number of possible execution paths. A switch works with the byte, short, char, and int primitive data types. It also works with *enumerated types* .

Program: displays the name of the month, based on the value of month, using the switch statement.

```
class SwitchDemo
 {
   public static void main(String[] args) {

      int month = 8;
      switch (month) {
         case 1:  System.out.println("January");
                  break;
```

```
            case 2:  System.out.println("February");
                     break;
            case 3:  System.out.println("March");
                     break;
            case 4:  System.out.println("April");
                     break;
            case 5:  System.out.println("May");
                     break;
            case 6:  System.out.println("June");
                     break;
            case 7:  System.out.println("July");
                     break;
            case 8:  System.out.println("August");
                     break;
            case 9:  System.out.println("September");
                     break;
            case 10: System.out.println("October");
                     break;
            case 11: System.out.println("November");
                     break;
            case 12: System.out.println("December");
                     break;
            default: System.out.println("Invalid month.");
                     break;
        }
    }
}
```

Output:"August"

The body of a switch statement is known as a *switch block*. Any statement immediately contained by the switch block may be labeled with one or more case or default labels. The switch statement evaluates its expression and executes the appropriate case.

The while and do-while Statements

The while statement continually executes a block of statements while a particular condition is true.

Its syntax can be expressed as:

```
 while (expression)
{
   statement(s)
}
```

The while statement evaluates *expression*, which must return a boolean value. If the expression evaluates to true, the while statement executes the *statement*(s) in the while block. The while statement continues testing the expression and executing its block until

the expression evaluates to false. Using the while statement to print the values from 1 through 10 can be accomplished as in the following program:

```
class WhileDemo
{
    public static void main(String[] args)
   {
        int count = 1;
        while (count < 11)
{
            System.out.println("Count is: " + count);
            count++;
        }
    }
}
```

do-while statement

Its syntax can be expressed as:

```
do
{
    statement(s)
} while (expression);
```

The difference between do-while and while is that do-while evaluates its expression at the bottom of the loop instead of the top. Therefore, the statements within the do block are always executed at least once.

Program:

```
class DoWhileDemo
 {
    public static void main(String[] args){
        int count = 1;
        do {
            System.out.println("Count is: " + count);
            count++;
        } while (count <= 11);
    }
}
```

The for Statement

The for statement provides a compact way to iterate over a range of values. Programmers often refer to it as the "for loop" because of the way in which it repeatedly loops until a

particular condition is satisfied. The general form of the for statement can be expressed as follows:

for (*initialization*; *termination*; *increment*) {
   statement(s)
}
When using the for statement, we need to remember that

- The *initialization* expression initializes the loop; it's executed once, as the loop begins.
- When the *termination* expression evaluates to false, the loop terminates.
- The *increment* expression is invoked after each iteration through the loop; it is perfectly acceptable for this expression to increment *or* decrement a value.

Type Conversion and Casting:

We can 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. For instance, there is no conversion defined from double to byte.

But it is possible for conversion between incompatible types. To do so, you must use a c*ast, which* performs an explicit conversion between incompatible types.

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 satisfied:

- The two types are compatible.
- The destination type is larger than the source type.

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.

For widening conversions, the numeric types, including integer and floating-point types, are compatible with each other. However, the numeric types are not compatible with char or boolean. Also, char and boolean are not compatible with each other.

Java also performs an automatic type conversion when storing a literal integer constant into variables of type byte, short, or long.

Casting Incompatible Types

The automatic type conversions are helpful, they will not fulfil all needs. For example, if we want to assign an int value to a byte variable. This conversion will not be performed automatically, because a byte is smaller than an int. This kind of conversion is sometimes called a *narrowing conversion,* since you are explicitly making the value narrower so that

it will fit into the target type. To create a conversion between two incompatible types, you must use a cast. A *cast* is simply an explicit type conversion.
It has this general form:
(*target-type*) *value*
Here, *target-type* specifies the desired type to convert the specified value to.
Example:

```
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 integers do not have fractional components so,when a floating-point value is assigned to an integer type, the fractional component is lost.

Program:

```
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);
  }
}
```

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
byte b = 50;
b = (byte)(b * 2);
```

The Type Promotion Rules:

In addition to the elevation of bytes and shorts to int, Java defines several *type promotion rules* that apply to expressions. They are as follows. First, all byte and short values are promoted to int. Then, if one operand is a long, the whole expression is promoted to long. If one operand is a float, the entire expression is promoted to float.If any of the operands is double, the result is double.

The following program demonstrates how each value in the expression gets promoted to match the second argument to each binary operator:

```
class Promote
 {
   public static void main(String args[])
   {
    byte b = 42;
    char c = 'a';
    short s = 1024;
    int i = 50000;
    float f = 5.67f;
    double d = .1234;
    double result = (f * b) + (i / c) - (d * s);
    System.out.println((f * b) + " + " + (i / c) + " - " + (d * s));
    System.out.println("result = " + result);
   }
}
```

double result = (f * b) + (i / c) - (d * s);

In the first sub expression, f * b, b is promoted to a float and the result of the sub expression is float. Next, in the sub expression i / c, c is promoted to int, and the result is of type int. Then, in d * s, the value of s is promoted to double, and the type of the sub expression is double. Finally, these three intermediate values, float, int, and double, are considered. The outcome of float plus an int is a float. Then the resultant float minus the last double is promoted to double, which is the type for the final result of the expression.

Simple Java Program:

```
 class Example
 {
   public static void main(String args[])
   {
    System.out.println("This is a simple Java program.");
   }
}
```

Here public is an access modifier, which means this method can be accessed by any one out side the class.

Static allows the main () method to be called without initiating any instance for the class.

Void tells the compiler that main() doesnot return any type.

String args[] declares a parameter named args,which is an array of instances of class string.
args takes the arguments for a command line.

Classes and Objects:

In the real world, you'll often find many individual objects all of the same kind. There may be thousands of other bicycles in existence, all of the same make and model. Each bicycle was built from the same set of blueprints and therefore contains the same components. In object-oriented terms, we say that your bicycle is an *instance* of the *class of objects* known as bicycles. A *class* is the blueprint from which individual objects are created.

Declaring Member Variables

There are several kinds of variables:

- Member variables in a class—these are called *fields*.
- Variables in a method or block of code—these are called *local variables*.
- Variables in method declarations—these are called *parameters*.

A class is declared by use of the **class** keyword

```
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. Variables defined within a class are called

instance variables because each instance of the class (that is, each object of the class) contains its own copy of these variables.Thus, the data for one object is separate and unique from the data for another.

Example:

```
Class demo
{
   int x=1;;
   int y=2;
   float z=3;
   void display()
  {
    System.out.println(–values of x, y and z are:‖+x+‖ –+y‖+‖ –+z);
  }
}
```

Declaring Objects

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**.
This reference is then stored in the variable. Thus, in Java, all class objects must be dynamically allocated.
In the above programs to declare an object of type demo:
Demo d1 = new demo();
This statement combines the two steps just described. It can be rewritten like this to show each step more clearly:

```
demo d1; // declare reference to object
d1 = new demo(); // allocate a demo object
```

The first line declares **d1 a**s a reference to an object of type demo. After this line executes, d1 contains the value **null**, which indicates that it does not yet point to an actual object. Any attempt to use d1 at this point will result in a compile-time error. The next line allocates an actual object and assigns a reference to it to **d1.**After the second line executes; you can use d1 **as** if it were a demo object. But in reality, d1 simply holds the memory address of the actual demo object. The effect of these two lines of code is depicted in Figure.

Constructors:

A class contains constructors that are invoked to create objects from the class blueprint. Constructor declarations look like method declarations—except that they use the name of the class and have no return type. A constructor initializes an object immediately upon creation.

Constructors can be default or parameterized constructors.

A default constructor is called when an instance is created for a class.

Example

```
Class demo
{
int x;
int y;
float z;
demo()
{
  X=1;
Y=2;
Z=3;
}
void display()
{
System.out.println(―values of x, y and z are:‖+x+‖ –+y‖+‖ –+z);
}
}
Class demomain
{
Public static void main(String args[])
{
demo d1=new demo(); // this is a call for the above default constructor
d1.display();
}
}
```

Parameterized constructor:

```
Class demo
{
int x;
int y;
float z;
 demo(int  x1,int y1,int z1)
{
  x=x1;
```

```
  y=y1;
  z=z1;
}
void display()
{
System.out.println(–values of x, y and z are:‖+x+‖ –+y‖+‖ –+z);
}
}
Class demomain
{
Public static void main(String args[])
{
demo d1=new demo(1,2,3); // this is a call for the above parameterized constructor
d1.display();
}
}
```

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 current class‘ type is permitted.
Example:

```
Class demo
{
int x;
int y;
float z;
 demo(int x,int y,int z)
{
  this.x=x;
  this.y=y;
  this.z=z;
}
void display()
{
System.out.println(–values of x, y and z are:‖+x+‖ –+y‖+‖ –+z);
}
}
Class demomain
{
Public static void main(String args[])
{
demo d1=new demo(1,2,3); // this is a call for the above parameterized constructor
```

```
d1.display();
}
}
```

Output:
Values of x, y and z are:1 2 3
To differentiate between the local and instance variables we have used this keyword int the constructor.

Garbage Collection:

Since objects are dynamically allocated by using the **new** operator, 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. There is no explicit need to destroy objects as in C++.
The finalize( ) Method
Sometimes an object will need to perform some action when it is destroyed. For example, if an object is holding some non-Java resource such as a file handle or window character font, then you might want to make sure these resources are freed before an object is destroyed. To handle such situations, Java provides a mechanism called *finalization.* By using finalization, you can define specific actions that will occur when an object is just about to be reclaimed by the garbage collector.
To add a finalizer to a class, you simply define the finalize( ) method. The Java run time calls that method whenever it is about to recycle an object of that class. Inside the finalize( ) method you will specify those actions that must be performed before an object is destroyed. The garbage collector runs periodically, checking for objects that are no longer referenced by any running state or indirectly through other referenced objects. Right before an asset is freed, the Java run time calls the finalize( ) method on the object.
The finalize( ) method has this general form:

```
protected void finalize( )
{
// finalization code here
}
```

Here, the keyword **protected** is a specifier that prevents access to **finalize( )** by code defined outside its class.

Overloading Methods:

The Java programming language supports *overloading* methods, and Java can distinguish between methods with different *method signatures*. This means that methods within a class can have the same name if they have different parameter lists .

Suppose that you have a class that can use calligraphy to draw various types of data (strings, integers, and so on) and that contains a method for drawing each data type. It is cumbersome to use a new name for each method—for example, drawString, drawInteger, drawFloat, and so on. In the Java programming language, you can use the same name for all the drawing methods but pass a different argument list to each method. Thus, the data drawing class might declare four methods named draw, each of which has a different parameter list.

```
public class DataArtist {
  ...
  public void draw(String s) {
        ...
  }
  public void draw(int i) {
        ...
  }
  public void draw(double f) {
        ...
  }
  public void draw(int i, double f) {
        ...
  }
}
```

Overloaded methods are differentiated by the number and the type of the arguments passed into the method. In the code sample, draw(String s) and draw(int i) are distinct and unique methods because they require different argument types. You cannot declare more than one method with the same name and the same number and type of arguments, because the compiler cannot tell them apart.The compiler does not consider return type when differentiating methods, so you cannot declare two methods with the same signature even if they have a different return type.

Overloading Constructors:

We can overload constructor methods

```
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;
```

```
}
}
```
As you can see, the **Box( )** constructor requires three parameters. This means that all declarations of **Box** objects must pass three arguments to the **Box( )** constructor. For example, the following statement is currently invalid:

```
Box ob = new Box();
```
Since **Box( )** requires three arguments.

```
/* Here, Box defines three constructors to initialize
the dimensions of a box various ways.
*/
class Box {
double width;
double height;
double depth;
// constructor used when all dimensions specified
Box(double w, double h, double d) {
width = w;
height = h;
depth = d;
}
// constructor used when no dimensions specified
Box() {
width = -1; // use -1 to indicate
height = -1; // an uninitialized
depth = -1; // box
}
// constructor used when cube is created
Box(double len) {
width = height = depth = len;
}
// compute and return volume
double volume() {
return width * height * depth;
}
}
class OverloadCons
 {
public static void main(String args[]) {
 // create boxes using the various constructors
Box mybox1 = new Box(10, 20, 15);
Box mybox2 = new Box();
Box mycube = new Box(7);
double vol;
// get volume of first box
vol = mybox1.volume();
```

```
System.out.println("Volume of mybox1 is " + vol);
// get volume of second box
vol = mybox2.volume();
System.out.println("Volume of mybox2 is " + vol);
//get volume of cube
vol = mycube.volume();
System.out.println("Volume of mycube is " + vol);
}
}
```

Output:

```
Volume of mybox1 is 3000.0
Volume of mybox2 is -1.0
Volume of mycube is 343.0
```

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-valueI.*In *t*his 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.

Java uses both approaches, depending upon what is passed.

In Java, when you pass a simple type to a method, it is passed by value. Thus, what occurs to the parameter that receives the argument has no effect outside the method.

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);
```

```
}
}
```
output :
a and b before call: 15 20
a and b after call: 15 20
we can see, the operations that occur inside **meth( )** have no effect on the values of **a** and **b** used in the call; their values here did not change to 30 and 10.
When we pass an object to a method, the situation changes dramatically, because objects are passed by reference. Keep in mind that when you create a variable of a class type, you are only creating a reference to an object. Thus, when you pass this reference to a method, the parameter that receives it will refer to the same object as that referred to by the argument. This effectively means that objects are passed to methods by use of call-by-reference. Changes to the object inside the method *do* affect the object used as an argument.
Example:
```
// Objects are passed by reference.
class Test {
int a, b;
Test(int i, int j) {
a = i;
b = j;
}
// pass an object
void meth(Test o)
{
o.a *= 2;
o.b /= 2;
}
}
class CallByRef
 {
public static void main(String args[])
{
Test ob = new Test(15, 20);
System.out.println("ob.a and ob.b before call: " +ob.a + " " + ob.b);
ob.meth(ob);
System.out.println("ob.a and ob.b after call: " +ob.a + " " + ob.b);
}
}
```
output:
ob.a and ob.b before call: 15 20
ob.a and ob.b after call: 30 10
in this case, the actions inside **meth( )** have affected the object used as an argument.

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*.
For example, 3 factorial is 1 × 2 × 3, or 6. Here is how a factorial can be computed by use of a recursive method:

```
// A simple example of recursion.
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));
}}
```

Output:

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

String Handling:

In Java a *string* is a sequence of characters. But, unlike many other languages that implement strings as character arrays, Java implements strings as objects of type **String**. Implementing strings as built-in objects allows Java to provide a full complement of features that make string handling convenient.

when you create a **String** object, you are creating a string that cannot be changed. That is, once a **String** object has been created, you cannot change the characters that comprise that string. The
difference is that each time you need an altered version of an existing string, a new **String** object is created that contains the modifications. The original string is left unchanged. This approach is used because fixed, immutable strings can be implemented more efficiently than changeable ones. For those cases in which a modifiable string is desired, there is a companion class to **String** called **StringBuffer**, whose objects contain strings that can be modified after they are created.
Both the **String** and **StringBuffer** classes are defined in **java.lang**. Thus, they are available to all programs automatically. Both are declared **final**, which means that neither of these classes may be subclassed.

The String Constructors:
The **String** class supports several constructors. To create an empty **String**, you call the default constructor.
For example,
String s = new String();
will create an instance of **String** with no characters in it.Frequently, you will want to create strings that have initial values. The **String** class provides a variety of constructors to handle this. To create a **String** initialized by an array of characters, use the constructor shown here:
String(char *chars*[ ])

Example:
char chars[] = { 'a', 'b', 'c' };
String s = new String(chars);
This constructor initializes **s** with the string –abc‖.

You can specify a subrange of a character array as an initializer using the following constructor:
String(char *chars*[ ], int *startIndex*, int *numChars*)
Here, *startIndex* specifies the index at which the subrange begins, and *numChars* specifies the number of characters to use.
Example:
char chars[] = { 'a', 'b', 'c', 'd', 'e', 'f' };
String s = new String(chars, 2, 3);
This initializes **s** with the characters **cde**.

You can construct a **String** object that contains the same character sequence as another **String** object using this constructor:
String(String *strObj*)
Here, *strObj* is a **String** object.

String Length:
The length of a string is the number of characters that it contains. To obtain this value, call the **length( )** method.
int length( )

Example:
char chars[] = { 'a', 'b', 'c' };
String s = new String(chars);
System.out.println(s.length());
It prints 3 as the output since the string as 3 characters.

charAt( )
To extract a single character from a **String**, you can refer directly to an individual character via the **charAt( )** method. It has this general form:
char charAt(int *where*)

getChars( )
If you need to extract more than one character at a time, you can use the **getChars( )** method. It has this general form:
void getChars(int *sourceStart*, int *sourceEnd*, char *target*[ ], int *targetStart*)

equals()
To compare two strings for equality, use **equals( )**. It has this general form:
boolean equals(Object *str*)
Here, *str* is the **String** object being compared with the invoking **String** object. It returns **true** if the strings contain the same characters in the same order, and **false** otherwise. The comparison is case-sensitive.
To perform a comparison that ignores case differences, call **equalsIgnoreCase( )**.When it compares two strings, it considers **A-Z** to be the same as **a-z**. It has this general form:
boolean equalsIgnoreCase(String *str*)
Here, *str* is the **String** object being compared with the invoking **String** object.

compareTo()
to know whether two strings are identical. For sorting applications, you need to know which is *less than, equal to,* or *greater than* the next. A string is less than another if it comes before the other in dictionary order. A string is
greater than another if it comes after the other in dictionary order. The **String** method **compareTo( )** serves this purpose. It has this general form:
int compareTo(String *str*)
Here, *str* is the **String** being compared with the invoking **String**.

indexOf()
The String class provides two methods that allow you to search a string for a specified character or substring:

- **indexOf( )** Searches for the first occurrence of a character or substring.
- **lastIndexOf( )** Searches for the last occurrence of a character or substring.

substring( )

>>we can extract a substring using **substring( )**. It has two forms. The first is
String substring(int *startIndex*)

>>Here, *startIndex* specifies the index at which the substring will begin. This form returns a copy of the substring that begins at *startIndex* and runs to the end of the invoking string.

>>The second form of **substring( )** allows you to specify both the beginning and ending index of the substring:

>>String substring(int *startIndex*, int *endIndex*)
Here, *startIndex* specifies the beginning index, and *endIndex* specifies the stopping point. The string returned contains all the characters from the beginning index, up to,but not including, the ending index.

replace( )

The **replace( )** method replaces all occurrences of one character in the invoking string with another character. It has the following general form:
String replace(char *original*, char *replacement*)

StringBuffer Constructors:

StringBuffer defines these three constructors:
StringBuffer( )
StringBuffer(int *size*)
StringBuffer(String *str*)

- The default constructor (the one with no parameters) reserves room for 16 characters without reallocation.
- The second version accepts an integer argument that explicitly sets the size of the buffer. The third version accepts a **String** argument that sets the initial contents of the **StringBuffer** object and reserves room for 16 more characters without reallocation.
- **StringBuffer** allocates room for 16 additional characters when no specific buffer length is requested, because reallocation is a costly process in terms of time.
  Also, frequent reallocations can fragment memory. By allocating room for a few extra characters, **StringBuffer** reduces the number of reallocations that take place.

length( ) and capacity( )

The current length of a **StringBuffer** can be found via the **length( )** method, while the total allocated capacity can be found through the **capacity( )** method. They have the following general forms:
int length( )

int capacity( )

ensureCapacity( )
If you want to preallocate room for a certain number of characters after a **StringBuffer** has been constructed, you can use **ensureCapacity( )** to set the size of the buffer. **ensureCapacity( )** has this general form:
void ensureCapacity(int *capacity*)
Here, *capacity* specifies the size of the buffer

append( )
The **append( )** method concatenates the string representation of any other type of data to the end of the invoking **StringBuffer** object. It has overloaded versions for all the built-in types and for **Object**. Here are a few of its forms:
StringBuffer append(String *str*)
StringBuffer append(int *num*)
StringBuffer append(Object *obj*)
String.valueOf( ) is called for each parameter to obtain its string representation.

insert( )

The **insert( )** method inserts one string into another.
StringBuffer insert(int *index*, String *str*)
StringBuffer insert(int *index*, char *ch*)
StringBuffer insert(int *index*, Object *obj*)
Here, *index* specifies the index at which point the string will be inserted into the invoking **StringBuffer** object

reverse( )
You can reverse the characters within a **StringBuffer** object using **reverse( )**, shown here:
StringBuffer reverse( )
This method returns the reversed object on which it was called

delete( ) and deleteCharAt( )
to delete characters using the methods **delete( )** and **deleteCharAt( )**. These methods are shown here:
StringBuffer delete(int *startIndex*, int *endIndex*)
StringBuffer deleteCharAt(int *loc*)
The **delete( )** method deletes a sequence of characters from the invoking object. Here, *startIndex* specifies the index of the first character to remove, and *endIndex* specifies an

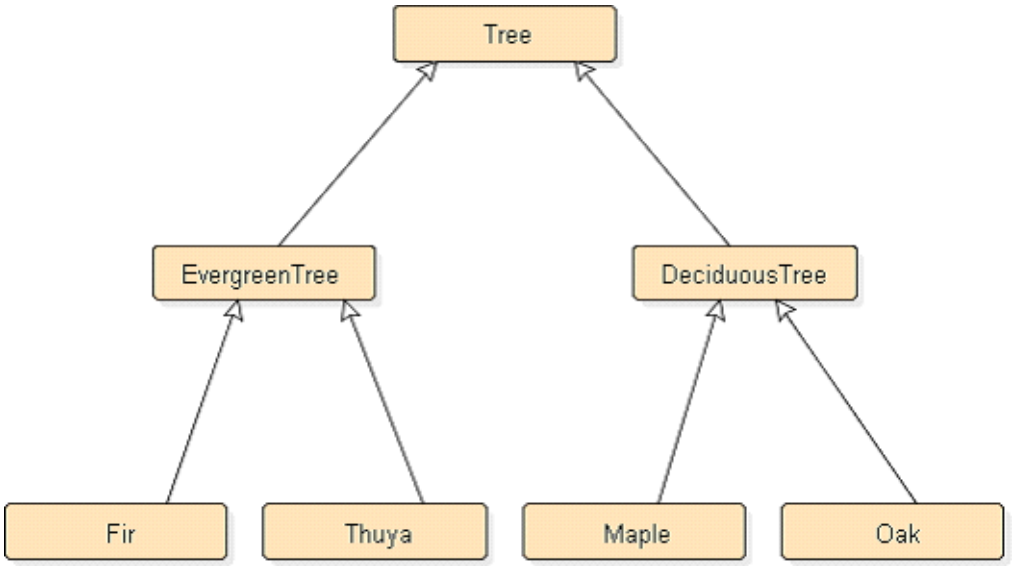
index one past the last character to remove. Thus, the substring deleted runs from *startIndex* to *endIndex*–1. The resulting **StringBuffer** object is returned.
The **deleteCharAt( )** method deletes the character at the index specified by *loc*. It returns the resulting **StringBuffer** object

replace( )
to replaces one set of characters with another set inside a **StringBuffer** object. Its signature is shown here:
StringBuffer replace(int *startIndex*, int *endIndex*, String *str*)
The substring being replaced is specified by the indexes *startIndex* and *endIndex*. Thus, the substring at *startIndex* through *endIndex*–1 is replaced.

UNIT 1.2 Inheritance

Hierarchical Abstractions

Example:



- Abstraction consists of eliminating unnecessary detail and concentrating on essential features
- The concept of an evergreen tree is an abstraction
- Fir trees, Thuya trees, Pine trees, ... have features that are common to all evergreen trees

- The concept of a deciduous tree is an abstraction
- Maple trees, Oak trees, Apple trees, ... have features that are common to all deciduous trees

INHERITANCE:

Inheritance is a Java language feature, used to model hierarchical abstraction
Inheritance means taking a class (called the base class) and defining a new class (called the subclass) by specializing the state and behaviors of the base class
Subclasses specialize the behaviors of their base class

- The subclasses inherit the state and behaviors of their base class
- They can have additional state and behaviors

Inheritance is mainly used for code reusability and to reduce the complexity of the program.

Base Class:

A class that is being inherited is known as Base class
For ex:

```
Class x
{
Void method ();
}
class y extends x
{
}
```

In the above example the class x is known as the base class.
When we create an object for the base class then that object is known as base class object.

Sub class:

The class that is inheriting the base class Is known as sub class.
In the example above since class y is inheriting the class x, class y is known as the subclass to class x.

Definition of substitutability:

- Assigning derived class object to parent class reference variables is known as substitutability.
- The concept of substitutability is fundamental to many of the powerful software development techniques in object oriented programming.
- The idea is that the type given in a declaration of variable doesn‘t have to match the type associated with value the variable is holding.
- It can also be used through interfaces.

FORMS OF INHERITANCE:

The choices between inheritance and overriding, subclass and subtypes, mean that inheritance can be used in a variety of different ways and for different purposes. Many of these types of inheritance are given their own special names. We will describe some of these specialized forms of inheritance.

- Specialization
- Specification
- Construction
- Generalization or Extension
- Limitation
- Variance

Specialization Inheritance: By far the most common form of inheritance is for specialization . A good example is the Java hierarchy of Graphical components in the AWT:

- Component
- Label
- Button
- TextComponent
- TextArea
- TextField
- CheckBox
- Scroll bar

Each child class overrides a method inherited from the parent in order to specialize the class in some way.

Specification Inheritance:

- If the parent class is abstract, we often say that it is providing a specification for the child class, and therefore it is specification inheritance (a variety of specialization inheritance).

Example: Java Event Listeners, ActionListener, MouseListener, and so on specify behavior, but must be subclassed.

Inheritance for Construction:

- If the parent class is used as a source for behavior, but the child class has no is-a relationship to the parent, then we say the child class is using inheritance for construction.

An example might be subclassing the idea of a Set from an existing List class.

- Generally not a good idea, since it can break the principle of substituability, but nevertheless sometimes found in practice. (More often in dynamically typed languages, such as Smalltalk).

Inheritance for Generalization or Extension:

- If a child class generalizes or extends the parent class by providing more functionality, and overrides any method, we call it inheritance for generalization.
- The child class doesn't change anything inherited from the parent, it simply adds new features is called extension.

  An example is Java Properties inheriting form Hashtable.

Inheritance for Limitation:

- If a child class overrides a method inherited from the parent in a way that makes it unusable (for example, issues an error message), then we call it inheritance for limitation.

  For example, you have an existing List data type that allows items to be inserted at either end, and you override methods allowing insertion at one end in order to create a Stack.

- Generally not a good idea, since it breaks the idea of substitution. But again, it is sometimes found in practice.

Inheritance for Variance:

- Two or more classes that seem to be related, but its not clear who should be the parent and who should be the child.

  Example: Mouse and TouchPad and JoyStick
- Better solution, abstract out common parts to new parent class, and use subclassing for specialization.

Summary of Forms of Inheritance:

Specialization: The child class is a special case of the parent class; in other words, the child class is a subtype of the parent class.

Specification: The parent class defines behavior that is implemented in the child class but not in the parent class.

Construction: The child class makes use of the behavior provided by the parent class, but is not a subtype of the parent class.

Generalization: The child class modifies or overrides some of the methods of the parent class.

Extension: The child class adds new functionality to the parent class, but does not change any inherited behavior.

Limitation: The child class restricts the use of some of the behavior inherited from the parent class.

Variance: The child class and parent class are variants of each other, and the class-subclass relationship is arbitrary.

Combination: The child class inherits features from more than one parent class. This is multiple inheritance and will be the subject of a later chapter.

BENEFITS OF INHERITANCE:

- Software Reuse
- Code Sharing
- Improved Reliability
- Consistency of Interface
- Rapid Prototyping
- Polymorphism
- Information Hiding

COSTS OF INHERITANCE:

- Execution speed
- Program size
- Message Passing Overhead
- Program Complexity

This does not mean you should not use inheritance, but rather than you must understand the benefits, and weigh the benefits against the costs.

TYPES OF INHERITANCE:

- **Single Level Inheritance:**

  When one base class is being inherited by one sub class then that kind of inheritance is known as single level inheritance.
- **Multi Level Inheritance:**

When a sub class is in turn being inherited then that kind of inheritance is known as multi level inheritance.

- **Hierarchical Inheritance:**

When a base class is being inherited by one or more sub class then that kind of inheritance is known as hierarchical inheritance.

A sub class uses the keyword –extends‖ to inherit a base class.

Example for Single Inheritance:

```
class x
{
     int a;
    void display()
   {
        a=0;
       System.out.println(a);
   }
}
class y extends x
{
       int b;
        void show()
     {
          B=1;
         System.out.println(b);
     }
}
class show_main
{
    Public static void main(String args[])
    {
       y y1=new y();
       y1.display();
       y1.show();
    }
}
```

Output:

0

1

Since the class y is inheriting class x, it is able to access the members of class x.
Hence the method display() can be invoked by the instance of the class y.

Example for multilevel inheritance:

```
class x
{
```

```
    int a;
  void display()
  {
        a=0;
       System.out.println(a);
   }
}
class y extends x
{
    int b;
   void show()
   {
         B=1;
        System.out.println(b);
    }
}
class z extends y
{
  int c;
  show1()
 {
        c=2;
       System.out.println(c);
  }
}
class show_main
{
   Public static void main(String args[])
   {
        z z1=new z();
         z1.display();
     z1.show();
   }
}
```

Output

0
1
2

Since class z is inheriting class y which is in turn a sub class of the class x, indirectly z can access the members of class x.

Hence the instance of class z can access the display () method in class x, the show () method in class y.

Problems:

In java multiple level inheritance is not possible easily. We have to make use of a concept called interfaces to achieve it.

Access Specifers:

The different access specifiers used are

- Public
- Private
- Protected
- Default
- Privateprotected

1. Private members can be accessed only within the class in which they are declared.
2. Protected members can be accessed inside the class in which they are declared and also in the sub classes in the same package and sub classes in the other packages.
3. Default members are accessed by the methods in their own class and in the sub classes of the same package.
4. Public members can be accessed anywhere.

Super Keyword:

Whenever a sub class needs to refer to its immediate super class, we can use the super keyword.

Super has two general forms

- The first calls the super class constructor.
- The second is used to access a member of the super class that has been hidden by a member of a sub class

Syntax:

A sub class can call a constructor defined by its super class by use of the following form of super.

super(arg-list);

here arg-list specifies any arguments needed by the constructor in the super class .

The second form of super acts like a ‐this‖ keyword. The difference between ‐this‖ and ‐super‖ is that ‐this‖ is used to refer the current object where as the super is used to refer to the super class.

The usage has the following general form:

super.member;

Example:

```
Class x
{
    int a;
   x()
   {
      a=0;
   }
  void display()
```

```
   {
      System.out.println(a);
    }
}
class y extends x
{
      int b;

    y()
   {
     super();
     b=1;
    }
  Void display()
  {
     Super.display();
     System.out.println(b);
   }
}
class super_main
{
   Public static void main(String args[])
   {
        y y1=new y();
        y.display();
    }
}
```

Using final with inheritance:

The keyword final has three uses.

- First it can be used to create the equivalent of a named constant.
- To prevent overriding.
- To prevent inheritance.

Using final to prevent overriding:

To disallow a method from being overridden, specify final as a modifier at the start of the declaration.

Methods declared as final cannot be overridden.

Syntax:

final <return type> <method name> (argument list);

Using final with inheritance:

Some times we may want to prevent a class from being inherited.

In order to do this we must precede the class declaration with final.

Declaring a class as final implicitly declares all its methods as final.

Example:

```
final class A
{
……//members
}
```

Abstract Classes:

Abstract methods:

We can require that some methods be overridden by sub classes by specifying the abstract type modifier.

These methods are sometimes referred to as sub classer responsibility as they have no implementation specified in the super class.

Thus a sub class must override them.

To declare an abstract method we have:

abstract type name (parameter list);

Any class that contains one or more abstract methods must also be declared abstract..

Such types of classes are known as abstract classes.

Abstract classes can contain both abstract and non-abstract methods.

Let us consider the following example:

```
abstract class A
{
  abstract void callme();
  void call()
  {
     System.out.println(–HELLO‖);
  }
}
class B extends A
{
  Void callme()
  {
     System.out.println(–GOOD MORNING‖);
   }
}
class abstractdemo
{
   Public static void main(String args[]){
    B b=new B();
    b.callme();
     b.call();
   }
}
```

Output:

GOOD MORINING
HELLO

UNIT-2.1 Packages & Interfaces

Packages and interfaces are two of the basic components of a Java program. In general, a Java source file can contain any (or all) of the following four internal parts:

- A single package statement (optional)
- Any number of import statements (optional)
- A single public class declaration (required)
- Any number of classes private to the package (optional)

Java provides a mechanism for partitioning the class name space into more manageable chunks. This mechanism is the package. The package is both a naming and a visibility control mechanism. You can define classes inside a package that are not accessible by code outside that package. You can also define class members that are only exposed to other members of the same package.

Defining a Package:

- Creating a package is quite easy: simply include a **package** command as the first statement in a Java source file. Any classes declared within that file will belong to the specified package. The **package** statement defines a name space in which classes are stored.

- If you omit the **package** statement, the class names are put into the default package, which has no name. While the default package is fine for short, sample programs, it is inadequate for real applications. Most of the time, you will define a package for your code.

Creating a Package:

- The general form of the **package** statement:
  package *pkg*; Here, *pkg* is the name of the package.

- For example, the following statement creates a package called **MyPackage**.
  package MyPackage;

  Java uses file system directories to store packages. For example, the **.class** files for any classes you declare to be part of **MyPackage** must be stored in a directory called M**yPackage**. Remember that case is significant, and the directory name must match the package name exactly.

  More than one file can include the same **package** statement. The **package** statement

simply specifies to which package the classes defined in a file belong. It does not exclude other classes in other files from being part of that same package. You can create a hierarchy of packages. To do so, simply separate each package name from the one above it by use of a period.

- The general form of a multileveled package statement is shown here:
  package *pkg1*[.*pkg2*[.*pkg3*]];

- A package hierarchy must be reflected in the file system of your Java development.
  For example, a package declared as **package java.awt.image;** needs to be stored in **java/awt/image**, **java\awt\image**,
  Or
  java:awt:image
  on your
  UNIX, Windows, or Macintosh file system, respectively. Be sure to choose your package names carefully.
- You cannot rename a package without renaming the directory in which the classes are stored.

Finding Packages and CLASSPATH:

Java run-time system know where to look for packages that you create? The answer has two parts.

- First, by default, the Java run-time system uses the current working directory as its starting point. Thus, if your package is in the current directory, or a subdirectory of the current directory, it will be found.
- Second, you can specify a directory path or paths by setting the **CLASSPATH** environmental variable.
  For example, consider the following package specification.
  package MyPack;

In order for a program to find **MyPack**, one of two things must be true. Either the program is executed from a directory immediately above **MyPack**, or **CLASSPATH** must be set to include the path to **MyPack**.

The first alternative is the easiest (and doesn‘t require a change to **CLASSPATH**), but the second alternative lets your program find **MyPack** no matter what directory the program is in.

Create the package directories below your current development directory, put the **.class** files into the appropriate directories and then execute the programs from the development directory.

Example:

```
// A simple package
package MyPack;
class Balance
 {
```

```
        String name;
        double bal;
        Balance(String n, double b)
        {
        name = n;
        bal = b;
        }
        void show()
        {
        if(bal<0)
        System.out.print("--> ");
System.out.println(name + ": $" + bal);
        }
 }
class AccountBalance
 {
public static void main(String args[])
{
        Balance current[] = new Balance[3];
        current[0] = new Balance("K. J. Fielding", 123.23);
        current[1] = new Balance("Will Tell", 157.02);
        current[2] = new Balance("Tom Jackson", -12.33);
        for(int i=0; i<3; i++)
        current[i].show();
}
}
```

Save this file as **AccountBalance.java**, and put it in a directory called **MyPack**. Next, compile the file. Make sure that the resulting **.class** file is also in the **MyPack** directory. Executing the **AccountBalance** class, using the following command line:

java MyPack.AccountBalance

Remember, we should be in the directory above **MyPack** when you execute this command, or to have your **CLASSPATH** environmental variable set appropriately.

AccountBalance is now part of the package **MyPack**. This means that it cannot be executed by itself. That is, you cannot use this command line:

java AccountBalance

AccountBalance must be qualified with its package name.

Access Protection:

Classes and packages are both means of encapsulating and containing the name space and scope of variables and methods. Packages act as containers for classes and other subordinate packages. Classes act as containers for data and code. The class is Java‘s smallest unit of abstraction. Because of the interplay between classes and packages, Java addresses four categories of visibility for class members:

- Subclasses in the same package

- Non-subclasses in the same package
- Subclasses in different packages
- Classes that are neither in the same package nor subclasses

Table: Class member access

	Private	No modifier	Protected	Public
Same class	Yes	Yes	Yes	Yes
Same package subclass	No	Yes	Yes	Yes
Same package non-subclass	No	Yes	Yes	Yes
Different Package subclass	No	No	Yes	Yes
Different package non-subclass	No	No	No	Yes

The three access specifiers, **private**, **public**, and **protected**, provide a variety of ways to produce the many levels of access required by these categories. A class has only two possible access levels: default and public. When a class is declared as **public**, it is accessible by any other code. If a class has default access, then it can only be accessed by other code within its same package.

Example:

- This is file **Protection.java**:

```
package p1;
public class Protection
{
        int n = 1;
        private int n_pri = 2;
        protected int n_pro = 3;
        public int n_pub = 4;
        public Protection()
        {
```

```
        System.out.println("base constructor");
        System.out.println("n = " + n);
        System.out.println("n_pri = " + n_pri);
        System.out.println("n_pro = " + n_pro);
        System.out.println("n_pub = " + n_pub);
        }
}
```

- This is file **Derived.java**:

```
package p1;
class Derived extends Protection
{
        Derived()
        {
        System.out.println("derived constructor");
        System.out.println("n = " + n);
        // class only
        // System.out.println("n_pri = " + n_pri);
        System.out.println("n_pro = " + n_pro);
        System.out.println("n_pub = " + n_pub);
        }
}
```

- This is file **SamePackage.java**:

```
package p1;
class SamePackage
{
SamePackage()
        {
        Protection p = new Protection();
        System.out.println("same package constructor");
        System.out.println("n = " + p.n);
        // class only
        // System.out.println("n_pri = " + p.n_pri);
        System.out.println("n_pro = " + p.n_pro);
        System.out.println("n_pub = " + p.n_pub);
        }
}
```

- This is file **Protection2.java**:

```
package p2;
class Protection2 extends p1.Protection
{
        Protection2()
        {
```

```
        System.out.println("derived other package constructor");
        // class or package only
        // System.out.println("n = " + n);
        // class only
        // System.out.println("n_pri = " + n_pri);
        System.out.println("n_pro = " + n_pro);
        System.out.println("n_pub = " + n_pub);
        }
}
```

- This is file **OtherPackage.java**:

```
package p2;
class OtherPackage
{
        OtherPackage()
        {
        p1.Protection p = new p1.Protection();
        System.out.println("other package constructor");
        // class or package only
        // System.out.println("n = " + p.n);
        // class only
        // System.out.println("n_pri = " + p.n_pri);
        // class, subclass or package only
        // System.out.println("n_pro = " + p.n_pro);
        System.out.println("n_pub = " + p.n_pub);
        }
}
```

- If you wish to try these two packages, here are two test files you can use. The one for package **p1** is shown here:

```
// Demo package p1.
package p1;
// Instantiate the various classes in p1.
public class Demo
{
        public static void main(String args[])
        {
        Protection ob1 = new Protection();
        Derived ob2 = new Derived();
        SamePackage ob3 = new SamePackage();
        }
}
```

- The test file for **p2** is shown next:

```
// Demo package p2.
```

```
package p2;
// Instantiate the various classes in p2.
public class Demo
 {
        public static void main(String args[])
        {
        Protection2 ob1 = new Protection2();
        OtherPackage ob2 = new OtherPackage();
        }
}
```

Importing Packages:

Java includes the **import** statement to bring certain classes, or entire packages, into visibility. Once imported, a class can be referred to directly, using only its name. The **import** statement is convenient.

In a Java source file, **import** statements occur immediately following the **package** statement (if it exists) and before any class definitions.

This is the general form of the **import** statement:

import *pkg1*[.*pkg2*].(*classname*|*);

Here, *pkg1* is the name of a top-level package, and *pkg2* is the name of a subordinate package inside the outer package separated by a dot (**.**). There is no practical limit on the depth of a package hierarchy, except that imposed by the file system. Finally, you specify either an explicit *classname* or a star (*****), which indicates that the Java compiler should import the entire package.

This code fragment shows both forms in use:

```
import java.util.Date;
import java.io.*;
```

The star form may increase compilation time—especially if you import several large packages. For this reason it is a good idea to explicitly name the classes that you want to use rather than importing whole packages. However, the star form has absolutely no effect on the run-time performance or size of your classes.

All of the standard Java classes included with Java are stored in a package called **java**. The basic language functions are stored in a package inside of the **java** package called **java.lang**. Normally, you have to import every package or class that you want to use.

If a class with the same name exists in two different packages that you import using the star form, the compiler will remain silent, unless you try to use one of the classes. In that case, you will get a compile-time error and have to explicitly name the class specifying its package.

when a package is imported, only those items within the package declared as **public** will be available to non-subclasses in the importing code.

For example, if you want the **Balance** class of the package **MyPack** shown earlier to be available as a stand-alone class for general use outside of **MyPack**, then you will need to declare it as **public** and put it into its own file, as shown here:

```
package MyPack;

/* Now, the Balance class, its constructor, and its show() method are public. This means that they can be used by non-subclass code outside their package.*/
public class Balance
{
        String name;
        double bal;
        public Balance(String n, double b)
        {
        name = n;
        bal = b;
        }
        public void show()
        {
        if(bal<0)
        System.out.print("--> ");
        System.out.println(name + ": $" + bal);
        }
}
```

As you can see, the **Balance** class is now **public**. Also, its constructor and its **show( )** method are **public**, too. This means that they can be accessed by any type of code outside the **MyPack** package. For example, here **TestBalance** imports **MyPack** and is then able to make use of the **Balance** class:

```
import MyPack.*;
class TestBalance
{
        public static void main(String args[])
        {
        /* Because Balance is public, you may use Balance class and call its constructor. */
        Balance test = new Balance("J. J. Jaspers", 99.88);
        test.show(); // you may also call show()
        }
}
```

Interfaces

Using the keyword interface, you can fully abstract a class‘ interface from its implementation.That is, using interface, you can specify what a class must do, but not how it does it. Interfaces are syntactically similar to classes, but they lack instance varia

bles, and their methods are declared without any body. In practice, this means that you can define interfaces which don‘t make assumptions about how they are implemented. Once it is defined, any number of classes can implement an interface. Also, one class can implement any number of interfaces.

To implement an interface, a class must create the complete set of methods defined by the interface. Each class can determine the details of its own implementation. By providing the interface keyword, Java allows you to fully utilize the ―one interface, multiple methods‖ aspect of polymorphism.

Interfaces are designed to support dynamic method resolution at run time. Normally, in order for a method to be called from one class to another, both classes need to be present at compile time so the Java compiler can check to ensure that the method signatures are compatible. This requirement by itself makes for a static and no extensible classing environment. Inevitably in a system like this, functionality gets pushed up higher and higher in the class hierarchy so that the mechanisms will be available to more and more subclasses. Interfaces are designed to avoid this problem. They disconnect the definition of a method or set of methods from the inheritance hierarchy. Since interfaces are in a different hierarchy from classes, it is possible for classes that are unrelated in terms of the class hierarchy to implement the same interface. This is where the real power of interfaces is realized.

Interfaces add most of the functionality that is required for many applications which would normally resort to using multiple inheritance in a language such as C++.

Defining an Interface:

- An interface is defined much like a class.
- This is the general form of an interface:

```
access interface name
 {
        return-type method-name1(parameter-list);
        return-type method-name2(parameter-list);
        type final-varname1 = value;
        type final-varname2 = value;
        return-type method-nameN(parameter-list);
        type final-varnameN = value;
}
```

Here, access is either public or not used. When no access specifier is included, then default access results, and the interface is only available to other members of the package in which it is declared. When it is declared as public, the interface can be used by any other code. name is the name of the interface, and can be any valid identifier. Notice that the methods which are declared have no bodies. They end with a semicolon after the parameter list. They are, essentially, abstract methods; there can be no default

implementation of any method specified within an interface. Each class that includes an interface must implement all of the methods.

Variables can be declared inside of interface declarations. They are implicitly final and static, meaning they cannot be changed by the implementing class. They must also be initialized with a constant value. All methods and variables are implicitly public if the interface, itself, is declared as public.

An example of an interface definition. It declares a simple interface which contains one method called **callback( )** that takes a single integer parameter.

```
interface Callback
{
        void callback(int param);
}
```

Implementing Interfaces:

Once an interface has been defined, one or more classes can implement that interface.

To implement an interface, include the implements clause in a class definition, and then create the methods defined by the interface.

- The general form of a class that implements the interface:
-

```
access class classname [extends superclass][implements interface [,interface...]]
{
// class-body
}
```

Here, access is either public or not used. If a class implements more than one interface,the interfaces are separated with a comma. If a class implements two interfaces that declare the same method, then the same method will be used by clients of either interface. The methods that implement an interface must be declared public. Also, the type signature of the implementing method must match exactly the type signature specified in the interface definition.

Example: class that implements the Callback interface shown earlier.

```
class Client implements Callback
{
        public void callback(int p)
        {
        System.out.println("callback called with " + p);
```

```
        }
}
```

Notice that callback( ) is declared using the public access specifier.When you implement an interface method, it must be declared as public.
For example, the following version of Client implements callback( ) and adds the method nonIfaceMeth( ):

```
class Client implements Callback
 {
        public void callback(int p)
        {
        System.out.println("callback called with " + p);
        }
        void nonIfaceMeth()
        {
        System.out.println("Classes that implement interfaces"+"may also define other members, too.");
        }
}
```

Accessing Implementations Through Interface References:

We can declare variables as object references that use an interface rather than a class type. Any instance of any class that implements the declared interface can be referred to by such a variable. When you call a method through one of these references, the correct version will be called based on the actual instance of the interface being referred to. This is one of the key features of interfaces. The method to be executed is looked up dynamically at run time, allowing classes to be created later than the code which calls methods on them. The calling code can dispatch through an interface without having to know anything about the ―callee.‖ This process is similar to using a superclass reference to access a subclass object.

Because dynamic lookup of a method at run time incurs a significant overhead when compared with the normal method invocation in Java, you should be careful not to use interfaces casually in performance-critical code.

The following example calls the callback( ) method via an interface reference variable:

```
class TestIface
{
        public static void main(String args[])
        {
        Callback c = new Client();
        c.callback(42);
        }
}
```

Output:
callback called with 42.

Notice that variable c is declared to be of the interface type Callback, yet it was assigned an instance of Client. Although c can be used to access the callback( ) method, it cannot access any other members of the Client class. An interface reference variable only has knowledge of the methods declared by its interface declaration.

Thus, c could not be used to access nonIfaceMeth( ) since it is defined by Client but not Callback.

The preceding example shows, mechanically, how an interface reference variable can access an implementation object, it does not demonstrate the polymorphic power of such a reference. To sample this usage, first create the second implementation of Callback, shown here:

```
// Another implementation of Callback.

class AnotherClient implements Callback
{
public void callback(int p)
        {
        System.out.println("Another version of callback");
        System.out.println("p squared is " + (p*p));
        }
}
class TestIface2
{
        public static void main(String args[])
        {
        Callback c = new Client();
        AnotherClient ob = new AnotherClient();
        c.callback(42);
        c = ob; // c now refers to AnotherClient object
        c.callback(42);
        }
}
```

Output:
callback called with 42
Another version of callback
p squared is 1764

As you can see, the version of callback( ) that is called is determined by the type of object that c refers to at run time.

If a class includes an interface but does not fully implement the methods defined by that interface, then that class must be declared as abstract.

For example:

```
abstract class Incomplete implements Callback
{
        int a, b;
        void show()
        {
        System.out.println(a + " " + b);
        }
}
```

Here, the class Incomplete does not implement callback( ) and must be declared as abstract. Any class that inherits Incomplete must implement callback( ) or be declared abstract itself.

Applying Interfaces:

We define a stack interface, leaving it to each implementation to define the specifics. Let‘s look at two examples.
First, here is the interface that defines an integer stack. Put this in a file called IntStack.java. This interface will be used by both stack implementations.
Example:

```
// Define an integer stack interface.
interface IntStack
{
        void push(int item); // store an item
        int pop(); // retrieve an item
}
```

The following program creates a class called FixedStack that implements a fixed-length version of an integer stack:
Example:

```
// An implementation of IntStack that uses fixed storage.
class FixedStack implements IntStack
{
        private int stck[];
        private int tos;
        FixedStack(int size)
        stck = new int[size];
        tos = -1;
}
// Push an item onto the stack
public void push(int item)
{
        if(tos==stck.length-1) // use length member
```

```
        System.out.println("Stack is full.");
        else
        stck[++tos] = item;
}

// Pop an item from the stack
public int pop()
{
        if(tos < 0)
        {
        System.out.println("Stack underflow.");
        return 0;
        }
        else
        return stck[tos--];
        }
}
class IFTest
 {
        public static void main(String args[])
        {
        FixedStack mystack1 = new FixedStack(5);
        FixedStack mystack2 = new FixedStack(8);
        // push some numbers onto the stack
        for(int i=0; i<5; i++) mystack1.push(i);
        for(int i=0; i<8; i++) mystack2.push(i);
        // pop those numbers off the stack
        System.out.println("Stack in mystack1:");
        for(int i=0; i<5; i++)
        System.out.println(mystack1.pop());
        System.out.println("Stack in mystack2:");
        for(int i=0; i<8; i++)
        System.out.println(mystack2.pop());
        }
}
```

Following is another implementation of IntStack that creates a dynamic stack by use of the same interface definition. In this implementation, each stack is constructed with an initial length. If this initial length is exceeded, then the stack is increased in size. Each time more room is needed, the size of the stack is doubled.
Example:

```
// Implement a "growable" stack.
class DynStack implements IntStack
```

```
{
private int stck[];
private int tos;
// allocate and initialize stack
DynStack(int size)
{
stck = new int[size];
tos = -1;
}
// Push an item onto the stack
public void push(int item)
{
// if stack is full, allocate a larger stack
if(tos==stck.length-1)
{
int temp[] = new int[stck.length * 2]; // double size
for(int i=0; i<stck.length; i++)
temp[i] = stck[i];
stck = temp;
stck[++tos] = item;
}
else
stck[++tos] = item;
}
// Pop an item from the stack
public int pop()
 {
if(tos < 0) {
System.out.println("Stack underflow.");
return 0;
}
else
return stck[tos--];
}
}
class IFTest2
{
public static void main(String args[])
 {
DynStack mystack1 = new DynStack(5);
DynStack mystack2 = new DynStack(8);
// these loops cause each stack to grow
for(int i=0; i<12; i++) mystack1.push(i);
for(int i=0; i<20; i++) mystack2.push(i);
System.out.println("Stack in mystack1:");
```

```
for(int i=0; i<12; i++)
System.out.println(mystack1.pop());
System.out.println("Stack in mystack2:");
for(int i=0; i<20; i++)
System.out.println(mystack2.pop());
}
}
```

The following class uses both the FixedStack and DynStack implementations.It does so through an interface reference. This means that calls to push( ) and pop( )are resolved at run time rather than at compile time.

```
/* Create an interface variable and access stacks through it.
*/
class IFTest3
{
public static void main(String args[])
{
IntStack mystack; // create an interface reference variable
DynStack ds = new DynStack(5);
FixedStack fs = new FixedStack(8);
mystack = ds; // load dynamic stack
// push some numbers onto the stack
for(int i=0; i<12; i++)
mystack.push(i);
mystack = fs; // load fixed stack
for(int i=0; i<8; i++)
mystack.push(i);
mystack = ds;
System.out.println("Values in dynamic stack:");
for(int i=0; i<12; i++)
System.out.println(mystack.pop());
mystack = fs;
System.out.println("Values in fixed stack:");
for(int i=0; i<8; i++)
System.out.println(mystack.pop());
}
}
```

In this program, mystack is a reference to the IntStack interface. Thus, when it refers to ds, it uses the versions of push( ) and pop( ) defined by the DynStack implementation. When it refers to fs, it uses the versions of push( ) and pop( ) defined by FixedStack.

These determinations are made at run time. Accessing multiple implementations of an interface through an interface reference variable is the most powerful way that Java achieves run-time polymorphism.

Variables in Interfaces:

Interfaces can be used to import shared constants into multiple classes by simply declaring an interface that contains variables which are initialized to the desired values. When we include that interface in a class (that is, when you –implement‖ the interface), all of those variable names will be in scope as constants. This is similar to using a header file in C/C++ to create a large number of #defined constants or const declarations. If an interface contains no methods, then any class that includes such an interface doesn‘t actually implement anything. It is as if that class were importing the constant variables into the class name space as final variables

Example:

```
import java.util.Random;
interface SharedConstants
 {
int NO = 0;
int YES = 1;
int MAYBE = 2;
int LATER = 3;
int SOON = 4;
int NEVER = 5;
}
class Question implements SharedConstants
 {
Random rand = new Random();
int ask()
 {
int prob = (int) (100 * rand.nextDouble());
if (prob < 30)
return NO; //  30%
else if (prob < 60)
return YES; // 30%
else if (prob < 75)
return LATER; // 15%
else if (prob < 98)
return SOON; // 13%
else
return NEVER; // 2%
}
}
class AskMe implements SharedConstants
{
static void answer(int result)
 {
switch(result)
 {
case NO:
```

```
System.out.println("No");
break;
case YES:
System.out.println("Yes");
break;
case MAYBE:
System.out.println("Maybe");
break;
case LATER:
System.out.println("Later");
break;
case SOON:
System.out.println("Soon");
break;
case NEVER:
System.out.println("Never");
break;
}
}
public static void main(String args[])
{
Question q = new Question();
answer(q.ask());
answer(q.ask());
answer(q.ask());
answer(q.ask());
}
}
```

Output:

```
Later
Soon
No
Yes
```

This program makes use of one of Java‘s standard classes: Random. This class provides pseudorandom numbers. It contains several methods which allow you to obtain random numbers in the form required by your program. In this example, the method nextDouble( ) is used. It returns random numbers in the range 0.0 to 1.0.

In this sample program, the two classes, Question and AskMe, both implement the SharedConstants interface where NO, YES, MAYBE, SOON, LATER, and NEVER are defined. Inside each class, the code refers to these constants as if each class had defined or inherited them directly.

Interfaces Can Be Extended:

One interface can inherit another by use of the keyword extends. The syntax is the same as for inheriting classes. When a class implements an interface that inherits another interface, it must provide implementations for all methods defined within the interface inheritance chain.

Example:

```
// One interface can extend another.
interface A
 {
void meth1();
void meth2();
}
// B now includes meth1() and meth2() -- it adds meth3().
interface B extends A
{
void meth3();
}
// this class must implement all of A and B
class MyClass implements B
{
public void meth1()
 {
System.out.println("Implement meth1().");
}
public void meth2()
{
System.out.println("Implement meth2().");
}
public void meth3()
{
System.out.println("Implement meth3().");
}
}
class IFExtend
{
public static void main(String arg[])
{
MyClass ob = new MyClass();
ob.meth1();
ob.meth2();
ob.meth3();
}
}
```

Any class that implements an interface must implement all methods defined by that interface, including any that are inherited from other interfaces.

UNIT 2.2 STREAM BASEDI/O

EXPLORING JAVA.IO PACKAGE:

java.io, which provides support for I/O operations Data is retrieved from an *input* source. The results of a program are sent to an *output* destination. In Java, these sources or destinations are defined very broadly. For example, a network connection, memory buffer, or disk file can be manipulated by the Java I/O classes. Although physically different, these devices are all handled by the same abstraction: the *stream.* A stream is a logical entity that either produces or consumes information. A stream is linked to a physical device by the Java I/O system. All streams behave in the same manner, even if the actual physical devices they are linked to differ.

Some of the I/O classes defined by **java.io** are:

FileWriter, BufferedOutputStream, FilterInputStream, BufferedReader, FilterOutputStream, BufferedWriter, FilterReader, DataInputStream, RandomAccessFile DataOutputStream.

File:

most of the classes defined by **java.io** operate on streams, the **File** class does not. It deals directly with files and the file system. That is, the **File** class does not specify how information is retrieved from or stored in files; it describes the properties of a file itself. A **File** object is used to obtain or manipulate the information associated with a disk file, such as the permissions, time, date, and directory path, and to navigate subdirectory hierarchies.

Files are a primary source and destination for data within many programs.Files are still a central resource for storing persistent and shared information. A directory in Java is treated simply as a **File** with one additional property—a list of filenames that can be examined by the **list( )** method.

The following constructors can be used to create **File** objects:

File(String *directoryPath*)
File(String *directoryPath*, String *filename*)
File(File *dirObj*, String *filename*)
File(URI *uriObj*)

Here, *directoryPath* is the path name of the file, *filename* is the name of the file, *dirObj* is a **File** object that specifies a directory, and *uriObj* is a **URI** object that describes a file.

The following example demonstrates several of the **File** methods:

```
// Demonstrate File.
import  java.io.File;
class FileDemo
```

```
 {
static void p(String s)
{
      System.out.println(s);
}
public static void main(String args[])
{
File f1 = new File("/java/COPYRIGHT");
p("File Name: " + f1.getName());
p("Path: " + f1.getPath());
p("Abs Path: " + f1.getAbsolutePath());
p("Parent: " + f1.getParent());
p(f1.exists() ? "exists" : "does not exist");
p(f1.canWrite() ? "is writeable" : "is not writeable");
p(f1.canRead() ? "is readable" : "is not readable");
p("is " + (f1.isDirectory() ? "" : "not" + " a directory"));
p(f1.isFile() ? "is normal file" : "might be a named pipe");
p(f1.isAbsolute() ? "is absolute" : "is not absolute");
p("File last modified: " + f1.lastModified());
p("File size: " + f1.length() + " Bytes");
}
}
```

When you run this program, you will see something similar to the following:

```
File Name: COPYRIGHT
Path: /java/COPYRIGHT
Abs Path: /java/COPYRIGHT
Parent: /java
exists
is writeable
is readable
is not a directory
is normal file
is absolute
File last modified: 812465204000
File size: 695 Bytes
```

The Stream Classes:

Java‘s stream-based I/O is built upon four abstract classes: **InputStream**, **OutputStream**, **Reader**, and **Writer**. They are used to create several concrete stream

subclasses. Although your programs perform their I/O operations through concrete subclasses, the top-level classes define the basic functionality common to all stream classes.

InputStream and **OutputStream** are designed for byte streams.

Reader and **Writer** are designed for character streams.

The byte stream classes and the character stream classes form separate hierarchies. In general, you should use the character stream classes when working with characters or strings, and use the byte stream classes when working with bytes or other binary objects.

Byte Stream Classes:

- **InputStream**

  InputStream is an abstract class that defines Java's model of streaming byte input. All of the methods in this class will throw an **IOException** on error conditions.

  Some of the methods in this class are:

- int available( ): Returns the number of bytes of input currently available for reading.
- void close( ): Closes the input source. Further read attempts will generate an IOException.
- int read( ): Returns an integer representation of the next available byte of input. –1 is returned when the end of the file is encountered.
- int read(byte *buffer*[ ]): Attempts to read up to *buffer*.*length* bytes into *buffer* and returns the actual number of bytes that were successfully read. –1 is returned when the end of the file is encountered.

- **OutputStream**

  OutputStream is an abstract class that defines streaming byte output. All of the methods in this class return a **void** value and throw an **IOException** in the case of errors.

  Some of the methods in this class are:

- void close( ): Closes the output stream. Further write attempts will generate an IOException.
- void write(int *b*): Writes a single byte to an output stream. Note that the parameter is an **int**, which allows you to call **write( )** with expressions without having to cast them back to **byte**.
- void write(byte *buffer*[ ]): Writes a complete array of bytes to an output stream.

- **FileInputStream**

  The **FileInputStream** class creates an **InputStream** that you can use to read bytes from a file. Its two most common constructors are shown here:

  FileInputStream(String *filepath*)

  FileInputStream(File *fileObj*)

  Either can throw a **FileNotFoundException**. Here, *filepath* is the full path name of a file, and *fileObj* is a **File** object that describes the file.

- **FileOutputStream**

  FileOutputStream creates an OutputStream that you can use to write bytes to a file. Its most commonly used constructors are shown here:

FileOutputStream(String *filePath*)
FileOutputStream(File *fileObj*)
FileOutputStream(String *filePath*, boolean *append*)
FileOutputStream(File *fileObj*, boolean *append*)
They can throw a FileNotFoundException or a SecurityException. Here, *filePath* is the full path name of a file, and *fileObj* is a File object that describes the file. If *append* is true, the file is opened in append mode

The Character Streams:

While the byte stream classes provide sufficient functionality to handle any type of I/O
operation, they cannot work directly with Unicode characters. Since one of the main purposes of Java is to support the ―write once, run anywhere‖ philosophy, it was necessary to include direct I/O support for characters. In this section, several of the character I/O classes are discussed. As explained earlier, at the top of the character stream hierarchies are the **Reader** and **Writer** abstract classes.

- **Reader**

Reader is an abstract class that defines Java‘s model of streaming character input. All of the methods in this class will throw an **IOException** on error conditions. Table 17-3 provides a synopsis of the methods in **Reader**.

Writer

Writer is an abstract class that defines streaming character output. All of the methods in this class return a **void** value and throw an **IOException** in the case of errors. Table 17-4 shows a synopsis of the methods in **Writer**.

- **FileReader**

The **FileReader** class creates a **Reader** that you can use to read the contents of a file. Its two most commonly used constructors are shown here:
FileReader(String *filePath*)
FileReader(File *fileObj*)

- **FileWriter**

FileWriter creates a **Writer** that you can use to write to a file. Its most commonly used constructors are shown here:
FileWriter(String *filePath*)
FileWriter(String *filePath,* boolean *append)*
FileWriter(File *fileObj*)
FileWriter(File *fileObj*, boolean *append*)
They can throw an **IOException**. Here, *filePath* is the full path name of a file, and *fileObj*
is a **File** object that describes the file. If *append* is **true**, then output is appended to the end of the file.